Volume 38 Supplement 1 2022

ELSEVIER

Indexing Services
Dental Materials is indexed by *Index Medicus*, *BIOSIS*, *Current Contents*, SciSearch, Research Alert, UnCover, Reference Update, UMI, Silver Platter, *Excerpta Medica*, CAB International and CINAHL. The journal is available in microfilm from UMI.

0109-5641(2022)38:S1;1-W

Printed by Henry Ling Ltd., The Dorset Press, Dorchester, UK

ELSEVIER

Volume 38 Supplement 1 2022 ISSN 0109-5641

dental materials

Journal for Oral and Craniofacial Biomaterials Sciences

www.demajournal.com

Abstracts of the Academy of Dental Materials Virtual Meeting, 07-09 October 2021

Official Publication of the Academy of Dental Materials

academy of dental materials
corporate members

3M

GC Dental Company

SDI

DMG

Dentsply Sirona

dental materials
Journal for Oral and Craniofacial Biomaterials Sciences

dental materials

Official Publication of the Academy of Dental Materials

Academy of Dental Materials
President: Ulrich Lohbauer
Local event organizer: RES Seminars
Executive Manager: Lynn Reeves

doi:10.1016/S0109-5641(22)00030-6

Volume 38 Supplement 1 2022
ISSN 0109-5641

dental materials

Official Publication of the
Academy of Dental Materials
www.academydentalmaterials.org

Contents

Indexing Services

Dental Materials is indexed by *Index Medicus*, *BIOSIS*, *Current Contents*, SciSearch, Research Alert, UnCover, Reference Update, UMI, Silver Platter, *Excerpta Medica*, CAB International and CINAHL. The journal is available in microfilm from UMI.

Amsterdam • Boston • London • New York • Oxford • Paris • Philadelphia • San Diego • St. Louis

Paffenbarger Award Finalists

P1. Calcium Silicate Loaded-Porous Chitosan Scaffold for Pulp-Dentin Complex Regeneration. **M.L. Leite*[1]**, C. Anselmi[1], I.P.M. Soares[1], A. Manso[2], J. Hebling[1], R.M. Carvalho[2], C.A. De Souza Costa[1] ([1] São Paulo State University, Brazil; [2] University of British Columbia, Canada)

P2. Optimization of Mechanical Properties of Electrospun PLGA/SEP/HAp based GTR/GBR Membrane. **L. Kalluri*[1]**, J.A. Griggs[1], A.V. Janorkar[1], R. Chandran[1], X. Xu[2], Y. Duan[1] ([1] University of Mississippi Medical Center, Jackson, USA; [2] School of Dentistry, Louisiana State University Health, New Orleans, USA)

P3. Effect of Dental Implant Design Parameters on Its Fatigue Limit. **M. Satpathy*[1]**, R.M. Jose[1], M.J. Sinclair[1], Y. Duan[1], A. Della Bona[2], J.A. Griggs [1] ([1] University of Mississippi Medical Center, Jackson, USA; [2] University of Passo Fundo, Passo Fundo, Brazil)

P4. Prevention of Alveolar Bone Loss of Colocasia Esculenta Varnish. **S.J. Shin*[1]**, S.H. Moon[2], S.H. Oh[1,2], J.M. Bae[1,2] ([1] Department of Dental Biomaterials, College of Dentistry, Wonkwang University, Iksan, Korea; [2] Institute of Biomaterials & Implant, Wonkwang University, Iksan, Korea)

P5. Photocatalytic Activity and Antibacterial Behavior of Polyaniline-Doped Titanium Oxide Layers. **A Ali*[1]**, A Janorkar[1], M Marquart[2], J Griggs[1], J. Bumgardner[3], M Roach[1] ([1] Department of Biomedical Materials Science, University of Mississippi Medical Center; [2] Department of Microbiology and Immunology, University of Mississippi Medical Center; [3] Biomedical Engineering, University of Memphis)

P6. Deterioration of composite restorations in tooth wear patients: translational approach. **V.P. Lima*[1,2]**, L.A.M.J. Crins[2], E.M. Bronkhorst[2], N.J.M. Opdam[2], Jan L. Ruben[2], Marie-Charlotte D.N.J.M. Huysmans[2], Bas A.C. Loomans[2], R.R. Moraes[1] ([1] Federal University of Pelotas, Brazil; [2] Radboud University Medical Center, the Netherlands)

P7. Durability of Cell Adhesion Peptides Coatings for Dental Implants. **J He***, N. Fischer, C. Aparicio (Minnesota Dental Research Center for Biomaterials and Biomechanics, University of Minnesota, Minneapolis, USA)

P8. Polycaprolactone/Nano-Hydroxyapatite Nanofibrous Scaffold as a Cell Homing-Based Therapy. **I.P. Mendes Soares***, C. Anselmi, M.L. Leite, F.A. Kitagawa, R.A.O. Ribeiro, C.A. De Souza Costa, J. Hebling (School of Dentistry, São Paulo State University (Unesp), Araraquara, Brazil)

Marshalls Award Finalists

M1. Fracture Toughness and Fractal Dimension of Two Dental Glass-Ceramics. **K.S. Jodha*[1]**, N. Kaur[1], S.M. Salazar Marocho[1], J.J. Mecholsky Jr.[2], S.T. Lirette[3], Y. Duan[1], J.A. Griggs[1] ([1] Biomedical Materials Science, University of Mississippi Medical Center, Jackson, USA; [2] Materials Science and Engineering, Herbert Wertheim College of Engineering, University of Florida, Gainesville, USA; [3] Data Science, University of Mississippi Medical Center, Jackson, USA)

M2. Fatigue-Crack Propagation in Thermosetting Polymers with Self-Healing Capability. **A.P.P. Fugolin***, M. Logan, J.L. Ferracane, C.S. Pfeifer (Oregon Health & Science University, Portland, USA)

M3. Exploring the Inclusion of Photosensitive Compounds on Methacrylate-Based Resin Properties. **P. Comeau***, J. Burgess, N. Malekafzali, N. Rezqi Qomi, A. Manso (University of British Columbia, Oral Health Sciences, Vancouver, Canada)

Orals Award Finalists

O1. Temperature Impacts on Streptococcus Mutans Growth and Substrate Utilization Kinetics. E. OBrien[1], K. Mondal[1], C. C. Chen[2], J. L. Drummond[3], L. Hanley[2], **K. Rockne[1*]** ([1] Dept of Civil, Materials, and Environmental Engineering; [2] Dept of Chemistry, University of Illinois at Chicago, Chicago, USA; [3] JLD Consulting, USA)

O2. Antimicrobial and Angiogenic Hybrid Scaffold for Regenerative Endodontics. **N. Dubey[1,2*]**, J.S. Ribeiro[1], J.A. Ferreira[1], J. Xu[1], E.A. Bordini[1], L. Qu[1], L. Mei[3], A. Schwendeman[3], M.C. Bottino[1] ([1] School of Dentistry, University of Michigan, Ann Arbor, USA; [2] Faculty of Dentistry, National University of Singapore, Singapore; [3] College of Pharmacy and Biointerfaces Institute, University of Michigan, Ann Arbor, USA)

O3. Water and Protein Content Influence Creep Behavior In Dental Enamel. **J. Koldehoff*[1]**, M.V. Swain[2], G.A. Schneider[1] ([1] Institute of Advanced Ceramics, Hamburg University of Technology, Hamburg, Germany; [2] Faculty of Dentistry, University of Sydney, Sydney, Australia and Biomechanics and Biomaterials Lab, Don State Technical University, Rostov-On Don)

O4. Silane Containing Universal Adhesive/Cement for Bonding to Silica-Coated High-Translucent Zirconia. **L. Nasiry Khanlar*[1]**, A. Abdou[2], T. Takagaki[3], S. Mori[4], T. Nikaido[1], A Zandinejad[5], J Tagami [1] ([1] Department of Cariology and Operative Dentistry, Tokyo Medical and Dental University, Japan; [2] Faculty of Dentistry, King Salman International University, El Tur, South Sinai, Egypt; [3] Department of Operative Dentistry, Asahi University, Japan ; [4] Department of Chemical Science and Engineering, Tokyo Institute of Technology, Japan; [5] Department of Comprehensive Dentistry, Texas A&M University, USA)

O5. Self-Adhesive Luting Composites: Effect of Curing-Mode and Storage on KIc. A. Woeschler, R. Belli, U. Lohbauer, A. Petschelt, **J. Zorzin*** (Dental Clinic 1- Department for Operarive Dentistry and Periodontology, Friedrich-Alexander-University Erlangen-Nuernberg, Germany)

O6. Algorithm to Predict the Final Color of Leucite-Reinforced Ceramic Restorations. C. Kose[1,2], D. Oliveira[1], J.F. Roulet[1], P. Pereira [1], **M.G. Rocha[1*]** ([1] College of Dentistry, University of Florida, Gainesville, USA; [2] School of Dental Medicine, Tufts University, Boston, USA)

O7. Synthesis and Incorporation of Quaternary Ammonium Silane Antimicrobial into Self-Crosslinked Type I Collagen Scaffold: A hybrid formulation for 3D Printing. **U. Daood[1*]**, R.A. Bapat[1], S.K. Muthusamy[2], P. Sidhu[1], K.-K. Mak[3], A. Parolia[1], M.R. Pichika[3], L.L. Seow[1], T. Cao[2] ([1] School of Dentistry, International Medical University Kuala Lumpur, Kuala Lumpur, Malaysia; [2] Faculty of Dentistry, National University of Singapore, Singapore; [3] School of Pharmacy, International Medical University Kuala Lumpur, Kuala Lumpur, Malaysia)

O8. Controlled Drug Delivery in Metronidazole-Containing Bioactive Endodontic Cements. **G. De Souza Balbinot***, V.C.B. Leitune, K.C. Zatta, T. Benin, F. Visioli, S. Staniscauski Guterres, F.M. Collares (School of Dentistry, Universidade Federal Do Rio Grande Do Sul, Porto Alegre, Brazil)

O9. Fatigue Analysis of Restored Teeth Longitudinally Cracked Under Cyclic Loading. **F. Lin*[1]**, A. Fok[2], R. Ordinola-Zapata[2], N. Ye[2], Y.C. Heo[2] ([1] Department of Cariology and Endodontology, Peking University School and Hospital of Stomatology, Beijing, China; [2] School of Dentistry, University of Minnesota, Minneapolis, USA)

O10. Validation of Model Dental Restoration for Failure Prediction. **W. Aregawi***, A. Zhang, R. Chen, B. Lima, C. Aparicio, J. Rudney, A.S.L. Fok (School of Dentistry, University of Minnesota, USA)

List of Abstracts

1. 18-Month Clinical Evaluation of Universal Adhesive Applied in No-Waiting Technique. **RAM Almeida***, FSF Siqueira, A. Reis, MWC Ferreira, MC Bandeca, AFM Cardenas, AD Loguercio (Ceuma University, Dentistry, Sao Luis, Brazil).

2. The Wistar Rat: A Study Model for Dental Implant Biomaterials? **B.A. Akon-Laba***, K.A.P.Kouassi, J.A.L.Okon, G.T.Maroua, Y.S.I. Ohoukou (Universite Felix Houphouet Boigny, Abidjan, Ivory Coast)

3. General Knowledge of Light-Curing Units Among Dentists in Saudi Arabia. **H.M. Alhaddad***, D.E. Meisha, R.A. Al-Bukhary, A.O. Al-Zain (King Abdulaziz University, Faculty of Dentistry, Saudi Arabia)

4. Degree of Conversion of Resin-Based Luting Materials Containing Alternative Photoinitiators. **S.Amini***, P.Pereira, J.F.Roulet, D.Oliveira, M.G.Rocha (University of Florida, Restorative Dental Sciences Department, Florida, USA)

5. Effect of Roughness on Flexural Strength of Dental Lithium-Disilicate. **M.F.R.P. Alves*[1]**, B.G. Simba[2], M.H.V. Fernandes[1], C.N. Elias[3], J.E.V. Amarante[4], C. Santos[1,2] ([1] University of Aveiro, Department of Materials and Ceramic Engineering, Aveiro, Portugal; [2] State University of Rio De Janeiro, Materials and Processes Laboratory, Resende, Brazil; [3] Instituto Militar De Engenharia, Materials Science Department, Rio De Janeiro, Brazil; [4] Fluminense Federal University, Institute of Health of Nova Friburgo, Nova Friburgo, Brazil).

6. Ceramic-Dentin Cement Thickness: Bond Strength and Residual Stress. J.P.M. Tribst, G.C.Santos, L.S.S. Leite, L.R. Silva-Concilio, K. Baroudi, **M. Amaral*** (University of Taubate, Brazil).

7. Method for Detecting Calcium Phosphate Mineralization on Dental Composites. **K. Ames*** (Pulpdent Corporation, Watertown, USA).

8. Dentine Conditioners: Effect on Collagen Probed by Amide-III Peak Analysis. **K. Anastasiadis***, G. Eliades (Department of Biomaterials, School of Dentistry, National and Kapodistrian University of Athens, Athens, Greece).

9. The Effect of Yttria Content on The Bond-Strength to Zirconia. **Z. Badr*[1]**, B. Alsayed[2], B. Rodgers[2], T. Sulaiman[2] ([1] College of Dentistry, University of Nebraska Medical Center, Lincoln, USA; [2] Adams School of Dentistry, University of North Carolina, Chapel Hill, USA)

10. Functionalization of Restorative Dental Glass-Ceramics with Bactericidal Properties. **I.O. Baptista*[1]**, F.R. Gomes[2], S. Vieira[3], S. Ferreira[3], M.F.R.P. Alves[1], C. Santos[1,4], M.H.F. Fernandes[1] ([1] Department of Materials and Ceramic Engineering, University of Aveiro, Aveiro, Portugal; [2] Department of Physics, University of Aveiro, Aveiro, Portugal; [3] Department of Medical Sciences, University of Aveiro, Aveiro, Portugal; [4] Materials and Processes Laboratory, State University of Rio De Janeiro, Resende, Brazil).

11. Efficiency of Natural Ingredients in Teeth Whitening. **A Barbuzan-Caragyov***, T. Hajaj, A. C. Cojocariu, S. Christa, C. Sinescu (University of Medicine and Pharmacy Victor Babes Timisoara, Timisoara, Romania).

12. Structure-Property Relationships in Lithium-Based Glass-Ceramics. **R. Belli*[1]**, J. Lubauer[1], K. Hurle[2], H. Peterlik[3], U. Lohbauer[1] ([1] Dental Clinic, Friedrich-Alexander-Universität Erlangen-Nürnberg (Fau), Erlangen, Germany; [2] Department of Materials Science, Friedrich-Alexander- Universität Erlangen-Nürnberg (Fau), Erlangen, Germany; [3] Faculty of Physics, Universität Wien, Vienna, Austria).

13. Recycling of High-Viscosity Glass Ionomer Cement Plastic Capsules. **A Borges*[1]**, TFR Mota[1], EB Nascimento[1], DSS Padovini[2], FM Pontes[2] ([1] Bauru School of Dentistry, University of São Paulo - FOB/USP, Brazil; [2] School of Sciences, São Paulo State University, Brazil).

14. Systematic Review of In Vitro Enamel Wear Behavior Opposing Zirconia. **S. Butler*[1]**, Y. Torrealba[2], B. Linke[2], C. Flores-Mir[2], J.A. Nychka[2] ([1] Western University, Canada; [2] University of Alberta, Canada)

15. Characterization and Thickness Effect on Fatigue Strength of Translucent Zirconias. **LVC Arcila*[1]**, NC Ramos[2], TMB Campos[3], KS Dapieve[4], LF Valandro[4], RM Melo[1], MA Bottino[1] ([1] Institute of Science and Technology, Säo Paulo State University (Unesp), Brazil; [2] São Francisco University (USF), Brazil; [3] Technological Institute of Aeronautics, Brazil; [4] Federal University of Santa Maria (UFSM), Brazil)

16. Morphological and Functional Evaluation of Biogeneric and Human CAD-Designed Crown. **Y. Chen***, E.H.N Pow, J.K.H.Tsoi (Faculty of Dentistry, the University of Hong Kong, Hong Kong, China)

17. LC-MS/MS Analysis of Aged Dental Composites in Simulated Oral Environment. **C. Chen*[1]**, K. Mondal[1], P. Vervliet[1], A. Covaci[2], E.P. O'Brien[1], J.L. Drummond, K.J. Rockne[1], L Hanley[1] ([1] University of Illinois Chicago, USA; [2] University of Antwerp, Belgium)

18. The Effectiveness of Different Types of Varnishes in Preventing Erosion. T Kolus[1], **E Coban*[2]**, H Yalcinkaya[2], H. Esra Ulker[2], E Durmus[2], I Celik[2] ([1] Faculty of Dentistry, Karamanoglu Mehmetbey University; [2] Selcuklu, Turkey).

19. Root Dentin Conditioning with Self-Etch Primers Incorporated with Nanochitosan. **P.C. Dias***, I.B. Quero, J.J. Faraoni, R.G. Palma-Dibb (Department of Restorative Dentistry, University of Sao Paulo, Ribeirao Preto, Brazil)

20. Zirconia Strength Degradation Post Air-Abrasion of Veneering and Cementation Surfaces. S. Butler[1], B. Linke[2], **N.C.F. Moreira*[2]**, J.A. Nychka[3] ([1] Schulich School of Medicine & Dentistry, Western University, London, Canada; [2] School of Dentistry, University of Alberta, Edmonton, Canada; [3] Department of Chemical and Materials Engineering, School of Dentistry, University of Alberta, Edmonton, Canada)

21. Understanding Stress Development on Bilayer Lithium Disilicate Crowns. **C.S. Rodrigues*[1]**, S. Dhital[2], J. Kim[2], M.S. Wolff[3], L.G. May[4], Y. Zhang[3] ([1] Sao Paulo State University, Brazil; [2] University of Connecticut, USA; [3] University of Pennsylvania, USA; [4] Federal University of Santa Maria, Brazil)

22. Crystallization Effect on Biaxial Flexural Strength of Lithium Disilicate. **B.F. Vallerini*[1]**, A.T.H. Olivi[1], M.O.C. Villa-Boas[2], E.D. Zanotto[2], L.A.P. Pinelli[1] ([1] School of Dentistry, Sao Paulo State University, Araraquara, Brazil; [2] Materials Engineering, Federal University of Sao Carlos, Brazil)

23. Mechanical Strength Evaluation of a Printed Dental Space Maintainer. **B. Dragos*[1]**, C.S. Neagu[1], A.G. Balica[1], A.C. Cojocariu[1], A. Cernescu[2], D.C. Bratu[1], M.L. Negrutiu[1], C. Sinescu[1] ([1] Faculty of Dental Medicine, "Victor Babes" University of Medicine and Pharmacy, Timisoara, Romania; [2] Department of Mechanics and Strength of Materials, Faculty of Mechanics, Polytechnic University of Timisoara, Romania)

24. Mechanical Properties of Dental Composites Aged in Different Media. K. Mondal, E.P. O'Brien, C. Chen, **J.L. Drummond***, L. Hanley, K.J. Rockne (University of Illinois, Chicago, USA)

25. Analysis of Indirect Restorative Materials Submitted to Different Conditioning Protocols. **M.E. Queiroz[1]***, G.Q. Lima[1], H.B.S. Sahyon[1], A.T. Maluly-Proni[1], J.A. Delben[2], P.H. Dos-Santos[1]. ([1] Department of Dental Materials and Prosthodontics, State University of Sao Paulo "Julio De Mesquita Filho" (UNESP), Aracatuba, Sao Paulo; [2] Department of Dentistry, Western Parana, State University, Cascavel, Parana).

26. Coulometric Karl-Fischer-Titration of Water in CAD/CAM Chairside Composites. **A.L. Faria-E-Silva*[1,2]**, L. Heckel[2], R. Belli[2], U. Lohbauer[2] ([1] Federal University of Sergipe, Brazil; [2] Friedrich-Alexander University of Erlangen-Nurnberg, Germany)

27. Efficacy of Popular Natural Dental Bleaching Products on Dental Enamel. C.R.O. Maciel, **R.F.L. Oliveira***, A.A. Amorim, F.C.P. Pires-De-Souza (University of Sao Paulo, Ribeirao Preto, Brazil)

28. Spark Plasma Sintered Zirconia-Mica Glass-Ceramics for Dental Restorations. **S. Gali*[1]**, S. Gururaja[2], S. Srikari[1] ([1] M.S. Ramaiah University of Applied Sciences, India; [2] Auburn University, USA)

29. Influence of Bromelain and Biosilicate on Adhesive Bond Strength. **R Geng Vivanco***, FCP Pires-De-Souza (University of Sao Paulo, Brazil)

30. Clinical Efficacy of GIC in Treatment of Occlusal MIH Lesions. **R.G. Palma-Dibb*[1]**, L.A. Pion[1], J.J. Faraoni[1], I.B. Quero[1], D. Hesse[2], A.M. Queiroz[1], F.M. Carvalho[1] ([1] FORP/University of Sao Paulo, Brazil; [2] Academisch Centrum Tandheelkunde Amsterdam, Nederlands)

31. 18-Month Clinical Performance of a Bulk-Fill Composite Resin In NCCLS. **L. Guerra*[1]**, N.F. Coelho Neta[1], V.C. Ruschel[1], C. L. Baratieri[1], R. Walter[2], S. Monteiro Junior[1] ([1] Federal University of Santa Catarina, Brazil; [2] University of North Carolina, USA)

32. A New 3D Volume-Based Method for Assessing Composites Curing Depth. S. Gummadi*, J.-F. Roulet, M.G. Rocha (Department of Restorative Dental Sciences, University of Florida, Center of Dental Biomaterials, Gainesville, Fl, USA)

33. Colour Stability of Maxillofacial Silicone Mixed with Nano-Sized Anti-Microbials. **M.M. Hatamleh*** (Luminus Technical University College)

34. Experimental S-PRG-Filled Composites Prevent Secondary Caries: An In-Vitro Biofilm Model. **A. C. Ionescu*[1]**, F. I. Buhus[1], P. Delvecchio[2], V. Zambelli[2], G. Bellani[2], E. Brambilla[1] ([1] Surgical and Dental Sciences, Universita degli Studi Di Milano, Milan, Italy; [2] School of Medicine and Surgery, Universita degli Studi Di Milano Bicocca, Monza, Italy)

35. Battery Sustainability of Budget Light-Curing Units. **H.MH. Jamalellail*[1]**, I.M. Alshehri[1], R.B. Price[2], A.O. Al-Zain[1] ([1] Faculty of Dentistry, King Abdulaziz University, Saudi Arabia; [2] Dalhousie University, Canada)

36. Low Power Laser Debonding: Ceramic Thickness and Irradiation Time. **J.J. Ulloa***, S. Salazar Marocho (Department of Biomedical Materials Science, University of Mississippi Medical Center, USA)

37. Development of Antibacterial Resin Composites Containing a QAC-Based Monomer METAC. **T. Kohno***, R. Tsuboi, H. Kitagawa, S. Imazato (Osaka University Graduate School of Dentistry, Suita, Osaka, Japan)

38. Hydrofluoric-Acid Etching: Successful Pretreatment of Resin-Composite Block with Universal Adhesives. **M Koko*[1,2]**, J Tagami[1], A Abdou[3] ([1] Tokyo Medical and Dental University, Japan; [2] University of Dental Medicine, Myanmar; [3] Faculty of Dentistry, King Salman International University, El Tur, South Sinai, Egypt)

39. Properties of Printed Zirconia Using Suspension Enclosing Projection Stereolithography. **J. Lensing*[1]**, F. Fei[2], W. Pei[3], X. Song[2], E.C. Teixeira[1] ([1] Operative Dentistry, University of Iowa, Iowa City, USA; [2] Engineering, University of Iowa, Iowa City, USA; [3] Biostatistics, University of Iowa, USA)

40. Toughening Via Revitrification of Li2SiO3 Crystals in Obsidian. **J. Lubauer*[1]**, K. Hurle[2], M.R. Cicconi[3], A. Petschelt[1], U. Lohbauer[1], R. Belli[1] ([1] Dental Clinic 1, Friedrich-Alexander-Universitat Erlangen-Nurnberg (Fau), Germany; [2] Department of Mineralogy, Friedrich-Alexander-Universitat Erlangen-Nurnberg (Fau), Germany; [3] Department of Materials Science, Friedrich-Alexander-Universitat Erlangen-Nurnberg (Fau), Germany)

41. Effect of Polishing Technique on Flexural Strength of Glass-Ceramics. **E. Maier***, P. Gebler, P. Lammers, R. Belli, U. Lohbauer, M. Pelka (Dental Clinic 1, Friedrich Alexander University Erlangen-Nurnberg, Erlangen, Germany)

42. Fatigue Resistance of CAD/CAM and 3D-Printing Provisional Restorations. **G. Marchesi*[1]**, M. Buda[2], R. Di Lenarda[1], M Cadenaro[1], G Turco[1] ([1] University of Trieste; [2] Private Practice, Treviso, Italy)

43. Mechanical Properties and Ion-Release of Composites Containing Functionalized Calcium Phosphates. **B.M. Fronza***, R.A.A. Silva, B.F. Vela, M.D.S. Chiari, R.R. Braga (Department of Biomaterials and Oral Biology, University of Sao Paulo, Brazil)

44. Time-Lapse for Cutting Different Zirconia Thicknesses for Removal Purposes. **S.M. Salazar Marocho***, H. Raymond, L. R. Corby (University of Mississippi Medical Center, USA)

45. Resin-Cement Coating on Machined Glass-Ceramic: Effect on Flexural Fatigue Strength. M.M. May[1], **L.G. May*[1]**, R.V. Machry[1], S. Fraga[2], L.F. Valandro[1], G.S. Andrade[3], M.A. Bottino[3] ([1] Federal University of Santa Maria, Br; [2] Federal University of Rio Grande Do Sul, Br; [3] Sao Paulo State University, Br)

46. Optimal Intrusive Force for a Periodontally Compromised Tooth: A Finite Element Analysis Strategy. **O.M. Ugarte*[1]**, P.M. Cattaneo[2] , M.G. Roscoe[1], I.G. Onone[1], G.C. Dominguez[1] , J.B.C. Meira[1] ([1] University of Sao Paulo, Br; [2] Melbourne Dental School, Dentistry and Health Sciences, Au)

47. Effect of Sintering and Etching Protocols of Zirconia-Reinforced-Li_2O-SiO_2 on Bond-Strength. **M. Moeeduddin Ahmed***, D. Nathanson, F. Yuwei (Boston University Henry M Goldman School of Dental Medicine, Boston, USA)

48. Calcium Phosphate Nanoparticles Tested on Hydroxyapatite Discs as Remineralising Agent. **Z.H. Mok*[1]**, P. Mylonas[2], R. Austin[1], G. Proctor[1], N. Pitts[1], M. Thanou[1] ([1] King's College London, UK; [2] Cardiff University, UK)

49. Can S-PRG Fillers in Different Vehicles Act on Dentin Permeability? **V. Mosquim*[1]**, R.A. Caracho[1], L.S. Condi[1], G.S. Zabeu[1,2], G.A. Foratori-Junior[1], A.C. Magalhaes[1], L. Wang[1] ([1] Bauru School of Dentistry, University of Sao Paulo, Bauru, Brazil; [2] School of Dentistry, Unisagrado University Center, Bauru, Brazil)

50. Different Mechanical Properties of Sand Blasting on Co-Cr Alloys. **C. Mouchtaridi*[1]**, M. Munoz Hernandez[2], M.M. Multigner Dominguez[2], M.D. Escalera Rodriguez[2], J. Rams[2], T. Papadopoulos[1], I. Eleftheriadis[3] ([1] National and Kapodistrian University, Greece; [2] University Rey Juan Carlos, Spain; [3] Tver Medical State University, Russia)

51. Bonding Durability of Resin Cement to Lithium Disilicate Glass Ceramics. S**. Murakami***, K. Hirano, F. Fusejima (GC Corporation, Japan)

52. Fatigue of Ti6Al4V Dental Implants Produced by AM and Machining. **F. Oliveira***, C. Elias, A. Paula (Military Institute of Engineering (Ime), Rio De Janeiro, Brazil)

53. Use of EDTA on Bond of Adhesives to Fluorotic Enamel. **LP Muniz***, PHA Moreira, MWC Ferreira, A Reis, AFM Cardenas, AD Loguercio, FSF Siqueira (Centro Universitário Do Maranhao- Uniceuma, São Luis, Brazil)

54. Fracture Strength of CAD/CAM CROWNS after Enhancement of Occlusal Morphology. **L. Passos*[1]**, S. Butler[2], Y. Torrealba[3], B. Linke [3] ([1] School of Dentistry, Federal Fluminense University, Nova Friburgo, Brazil; [2] Schulich School of Medicine & Dentistry, Western University, London, Canada; [3] School of Dentistry, University of Alberta, Edmonton, Canada)

55. Dental Ceramic Surface Properties after Resin-Cement Removal by Burning Technique. **N. Pesun***, I.J. Pesun, B. Vallerini, R. Franca (University of Manitoba, Department of Restorative Dentistry, Winnipeg, Canada)

56. Reduction of EPS Formation in S. Mutans Biofilms. PMC Scaffa[1], MY Icimoto[2], A Kendall[1], APP Fugolin[1], X Cao, **CS Pfeifer*[1]** ([1] Oregon Health & Science University, Biomaterials & Biomechanics, Portland, USA; [2] Department of Biophysics, UNIFESP-EPM, Sao Paulo, Brazil)

57. Can Smoking affect Whiteness and Color Change after At-Home Bleaching? **R.R. Silva***, J.P De Carli, O.E. Pecho, K.F. Collares, A. Della Bona, J.R. Dieterich-Jnior, P. Benetti (Dental School, University of Passo Fundo, Passo Fundo, Brazil)

58. Experimental Silver-Infiltrated Glass on Biofilm Formation in Monolithic Zirconia. **R.M.M. Marinho[1]**, C.F. Sabino*[1], T.M.B. Campos[2], A.O.P. Ribeiro[1], A.C. Silva[1], F.C. Ribeiro[1] ([1] Department of Dental Materials and Prosthodontics, Sao Paulo State University, Sao Jose dos Campos, Brazil; [2] Aeronautics Institute of Technology, Department of Physics, Sao Jose dos Campos, Brazil)

59. Characterization of Experimental Short Fiber Reinforced Dual-Cure Core Build-Up Composites. **E. Sailynoja*[1,2]**, S. Garoushi[1], P. K. Vallittu[1], L. Lassila[1] ([1] University of Turku, Turku, Finland; [2] Stick Tech Ltd Member of GC Group, Turku, Finland)

60. Temporal Assessment of Remineralizing Demineralized Enamel Using Micro-Computed Tomography. **M. Salah*[1 2]**, T. Abdelrehim[1], K.A Nour[2], M.N Anwar[2], H.P Chew[1] ([1] University of Minnesota, USA; [2] Operative Dentistry, University of Ain Shams, Egypt)

61. Effect of Zinc Chloride on HOCl-Smear Layer Deproteinization. **K. Sanon*[1]**, T. Hatayam[1], K. Hosaka[2], Y Shimada[1], M Nakajima[1] ([1] Tokyo Medical and Dental University, Japan; [2] Tokushima University, Japan)

62. Compression Force Testing of Veneer-Retained Anterior Fixed Partial Dentures. **C. Serban*[1]**, C.C. Cotca[2], I.D. Bretean[1], C. Zaharia[1], M.L. Negrutiu[1], M. Rominu[1], L. Marsavina[3], C. Sinescu[1] ([1] Victor Babes University of Medicine and Pharmacy Timisoara, Romania; [2] Washington Institute of Dentistry and Laser Surgery, USA; [3] Polytechnic University of Timisoara, Romania)

63. Aesthetic Properties of New Hybrid Resin Block for CAD/CAM. **T. Shoji***, D. Machida, F. Fusejima, T. Kumagai (GC Corporation, Tokyo, Japan)

64. Ceramic Composites from Bovine Hydroxyapatite, ZrO_2@SiO_2, and Hydroxyapatite + 15%ZrO_2@SiO_2. **L.J. Azevedo-Silva*[1]**, D.S.S. Padovini[2], B.M Ferrairo[1], P.R. Minim[1], L.F. Pereira[1], R.S. Monteiro[1], C.A. Fortulan[3], P.N. Lisboa-Filho[4], A.F.S. Borges[1] ([1] School of Dentistry, University of Sao Paulo, Bauru, Brazil; [2] Department of Chemistry, Sao Paulo State University, Bauru, Brazil; [3] Department of Mechanical Engineering, University of Sao Paulo, Sao Carlos, Brazil; [4] Department of Physics, Sao Paulo State University, Bauru, Brazil)

65. Evaluating Boron-Doped Soda Lime Glass for Finishing Dental Zirconias. **A.C. Silva[1]***, C.S. Rodrigues[1], T.M.B. Campos[2], R.M.M. Marinho[1] ([1] Department of Dental Materials and Prosthodontics, Sao Paulo State University (Unesp), Sao Jose Dos Campos, Br; [2] Physics Departament, Aeronautics Technological Institute (Ita), Br)

66. Polyvinylsiloxane Impression Dimensional Stability after Immersed in Chloroxylenol 5% Solution. N. Mohamed Kutty, **W. Siswomihardjo***, S. Sunarintyas, D.A. Widyasrini (Department of Dental Biomaterial, Faculty of Dentistry, Universitas Gadjah Mada, Yogyakarta, Indonesia)

67. Development of a Magnetic Nanorod Reinforced Bulk Fill Composite. **Z.R. Skeete*[1]**, A.R. Ochoa A[2], J.P. Bequette[1], R.A. Brothers[1], T.T. Yuan A[2], Cdr N.J. Hamlin[3], Col W. Lien B[2], Lt T.A. Truong[3], Lcdr T.A. Sarwar[1], Dr. John W Simecek[1] ([1] Naval Medical Research Unit at San Antonio, Craniofacial Health and Restorative Medicine, USA; [2] United States Air Force 59Th Medical Wing, a Diagnostic and Therapeutic, B Dental Research and Consultation Service; [3] Naval Medical Leader & Professional Development Command, Research Department, USA)

68. Toothbrushing Duration Effect on Streptococcus Mutans Adherence to FRC. S. Vayravel, **S. Sunarintyas***, W. Siswomihardjo, D.A. Widyasrini (Department of Dental Biomaterial, Faculty of Dentistry, Universitas Gadjah Mada, Yogyakarta, Indonesia)

69. Wear Resistance Comparison of 3D-Printed Composite Resin Material. **D. Takada***, T. Kumagai, F. Fusejima, T. Ueno, S. Kariya (GC Corporation, Leuven, Belgium)

70. Effect of Synthesis Parameters on Calcium Phosphates Phases and Properties. **R.B. Trinca***, R.R. Braga (School of Dentistry, University of Sao Paulo, Sao Paulo, Brazil)

71. Biomimetic Approach to Evaluate Mineralization of BAG-Containing Resin Composite. J. Yun[1], K.-H. Tsui[1], Z. Fan[2], M.F. Burrow[1], J.P. Matinlinna[1], Y. Wang[3], **J.K.H. Tsoi*[1]** ([1] University of Hong Kong, Hong Kong; [2] Hong Kong University of Science and Technology, Hong Kong; [3] Sun Yat-Sen University, China)

72. Six-Year Bond Stability of Universal Adhesives with Alternative Dentin Treatments. **R.V. Rodrigues***, T. Al-Mosuli, R.M. Carvalho, A.P. Manso (Faculty of Dentistry, University of British Columbia, Vancouver, Canada)

73. Wear of Orthodontic Aligners Through Simulated Bruxing. **B. Van Heel***, A. Fok, (University of Minnesota, MDRCBB Minneapolis, USA)

74. CAD/CAM Fabricated Prosthetic Accuracies of Lithium Disilicate Glass Ceramic Block. **K. Yamamoto***, Y. Hokii, F. Fusejima (GC Corporation, Research & Development Department, Tokyo, Japan)

75. Bond Strength of Multi-Step Adhesive at Intraoral Repair. **M. Yamashita***, K. Hirano, F. Fusejima (GC Corporation, Tokyo, Japan)

76. Validation of Finite Element Models for Orthodontic Aligners. **N. Ye*[1]**, B.E. Brown[2], S.C. Mantell[1], A.S. Fok[3], Y.C. Heo[3], B.E. Larson[2] ([1] Mechanical Engineering, University of Minnesota, Minneapolis, USA; [2] School of Dentistry, University of Minnesota, Minneapolis, USA; [3] Minnesota Dental Research Center for Biomaterials and Biomechanics, University of Minnesota, Minneapolis, USA)

77. Polymerization Behavior of Composites at Top/Bottom of Cavity Using Different-Lights. **T. Yoshikawa*[1]**, A. Sadr[2] ([1] Tokyo Medical and Dental University, Japan; [2] University of Washington, USA)

78. Effect of Bevels on Load Capacity of Composite-Restored Incisors. **L. Zhang*[1,2]**, N. Ye[2], W.A. Aregawi[2], A. Fok[2] ([1] Wuhan University, China; [2] University of Minnesota, USA)

79. Designing Molecules for S. mutans Biofilm Inhibition. **A. J. Kendall***, P. M. C. Scaffa, M. Logan, S. Lewis, H. Wu, J. L. Merritt, J. Ferracane, and C. S. Pfeifer. (Oregon Health & Science University, Biomaterials & Biomechanics, Portland, USA)

80. Optimization of a NIR/Photo-rheometer for Measurement of Gel-Point Conversion in Dental Resins. **S. Lewis***, A. Tahayeri, J. Ferracane, C. Pfeifer (Oregon Health & Science University, Biomaterials & Biomechanics, Portland, USA)

81. Improvement of methacrylate-based polymer networks by introduction of catechol moieties. **D Fu***, CR Szczepanski (Chemical Engineering and Material Science. Michigan State University, Michigan, USA)

82. Evaluation of Different Coronal Sealing Materials on Endodontically Treated Teeth. **T. Hajaj***, M.L. Negrutiu, M. Rominu, A. Barbuzan, C. Sinescu (Victor Babes Medicine and Pharmacy University Timisoara, Timisoara, Romania)

83. Verification of Collagenase Production by Streptococcus Mutans. **A. Zhang***, B. Lima, R. Chen, W. Aregawi, J. Rudney, C. Aparicio, A. Fok (School of Dentistry, University of Minnesota, Minneapolis, USA)

Aims and Scope

The principal aim of *Dental Materials* is to promote rapid communication of scientific information between academia, industry, and the dental practitioner. Original manuscripts on clinical and laboratory research of basic and applied character which focus on the properties or performance of dental materials or the reaction of host tissues to materials are given priority for publication. Other acceptable topics include: application technology in clinical dentistry and dental laboratory technology. Comprehensive reviews written by experts on the topic and editorial commentaries on pertinent subjects will be considered. Only manuscripts that adhere to the highest scientific standards will be accepted.
The Academy's objectives are: (1) to provide a forum for the exchange of information on all aspects of dental materials; (2) to enhance communication between industry, researchers and practising dentists; and (3) to promote dental materials through its activities.
Annual meetings and scientific sessions are held in conjunction with other dental organizations. The Academy sponsors symposia and scientific programs in international meetings; recognizes scholarship at all levels from students to senior scholars; and elects Fellows in the Academy.
For a full and complete Guide for Authors, please go to http://www.elsevier.com/locate/dema

USA mailing notice: *Dental Materials* (ISSN 0109-5641) is published monthly by Elsevier Ltd. (The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, UK). Periodicals postage paid at Jamaica, NY 11431 and additional mailing offices.
USA POSTMASTER: Send change of address to *Dental Materials*, Elsevier Customer Service Department, 3251 Riverport Lane, Maryland Heights, MO 63043, USA.
AIRFREIGHT AND MAILING in USA by Air Business Ltd., c/o Worldnet Shipping Inc., 156-15, 146th Avenue, 2nd Floor, Jamaica, NY 11434, USA.

Publication information: *Dental Materials* (ISSN 0109- 5641). For 2022, volume 38 is scheduled for publication. Subscription prices are available on request from the Publisher or from the Elsevier Customer Service Department nearest you or from this journal's website (http://www.intl.elsevierhealth.com/journals/dema). Further information is available on this journal and other Elsevier products through Elsevier's website: (http://www.elsevier. com). Subscriptions are accepted on a prepaid basis only and are entered on a calendar year basis. Issues are sent by standard mail (surface within Europe, air delivery outside Europe). Priority rates are available upon request. Claims for missing issues should be made within six months of the date of dispatch.

Advertising Information: Advertising orders and enquiries can be sent to: **USA, Canada** and **South America:** Elsevier Inc., 360 Park Avenue South, New York, NY 10010-1710, USA: phone: (+1) (212) 633 3974. **Europe and ROW:** Sarah Ellis, Advertising Sales Executive, Elsevier Ltd, 32 Jamestown Road, London NW1 7BY, UK. Phone: +44 (0) 207 424 4538; fax: +44 (0) 207 424 4433; e-mail: s.ellis@elsevier.com

Orders, claims, and journal enquiries: Please visit our Support Hub page https://service.elsevier.com for assistance.

Author inquiries: You can track your submitted article at http://www.elsevier.com/track-submission. You can track your accepted article at http://www.elsevier.com/trackarticle. You are also welcome to contact Customer Support via http://support.elsevier.com

Funding body agreements and policies
Elsevier has established agreements and developed policies to allow authors whose articles appear in journals published by Elsevier, to comply with potential manuscript archiving requirements as specified as conditions of their grant awards. To learn more about existing agreements and policies please visit http://www.elsevier.com/fundingbodies

Illustration services
Elsevier's WebShop (http://webshop.elsevier.com/illustrationservices) offers Illustration Services to authors preparing to submit a manuscript but concerned about the quality of the images accompanying their article. Elsevier's expert illustrators can produce scientific, technical and medical-style images, as well as a full range of charts, tables and graphs. Image 'polishing' is also available, where our illustrators take your

For a full and complete Guide for Authors, please go to: http://www.elsevier.com/locate/dental

image(s) and improve them to a professional standard. Please visit the website to find out more.
♾ The paper used in this publication meets the requirements of ANSI/NISO Z39.48-1992 (Permanence of Paper)

The item fee code for this publication is 0109-66412/ $36.00

Printed by Henry Ling Ltd, The Dorset Press, Dorchester, UK.

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/dental

Abstracts of the Academy of Dental Materials Virtual Meeting, 07-09 October 2021

Regular Abstracts

1

18-Month Clinical Evaluation of Universal Adhesive Applied in No-Waiting Technique

RAM Almeida*, FSF Siqueira, A. Reis, MWC Ferreira, MC Bandeca, AFM Cardenas, AD Loguercio

Ceuma University, Dentistry, Sao Luis, Brazil
* *Corresponding author.*

Purpose/Aim: To evaluate the clinical behavior of a universal adhesive applied in the no-waiting technique in non-carious cervical lesions (NCCLs).

Materials and Methods: Forty-four patients participated in this study. One hundred and seventy-six restorations were assigned to four groups according to the adhesive system in the conditioning strategies and in the waiting time: Prime&Bond Active (PB), applied in the etch-and-rinse strategy (ER) and self-etch (SE) with 20 s application and Clearfil Universal Bond Quick (CQ), applied in the ER and SE strategy), in no-waiting technique. One experienced and calibrated operator made the restorations with (Filtek Z-350 XT) composite resin using the incremental technique. The restorations were evaluated at baseline and after 18 months using both the World Dental Federation (FDI) and the United States Public Health Service (USPHS) criteria. Statistical analyses were performed with Friedman repeated measures analysis of variance by rank and McNemar test for significance in each pair.

Results: Ten restorations (2 for PB-ER, 4 for PB-SE, and 4 for CQ-SE) were lost after 18 months. Had a retention rate of 95,45% for PB-ER, 90,9% for PB-SE, 90,9% for CQ-SE and 100% for CQ when using the ER adhesive strategy ($p > 0.05$ for either criterion). Seventeen restorations showed some discrepancies in marginal adaptation at the 18-month recall using the FDI criteria (2 for PB-ER, 2 for PB-SE, 4 for CQ-ER, and 9 for CQ-SE), but only three restorations were scored as bravo for marginal adaptation in the USPHS criteria (3 for CQ-SE; $p > 0.05$).

Conclusions: The clinical performance of the CQ adhesive in the "no waiting" technique was similar to the PB adhesive in conventional application (20 s), promoting very satisfactory results when applied in the ER or SE strategy, after 18 months of clinical evaluation in non-carious cervical lesions.

https://doi.org/10.1016/j.dental.2021.12.031

2

The Wistar Rat: A Study Model for Dental Implant Biomaterials?

B.A. Akon-Laba*, K.A.P. Kouassi, J.A.L. Okon, G.T. Maroua, Y.S.I. Ohoukou

Universite Felix Houphouet Boigny, Abidjan, Ivory Coast
* *Corresponding author.*

Purpose/Aim: Before marketing implants, osseointegration studies are necessary. Numerous studies in the search for perfect osseointegration of dental implants have been carried out on animals, but very few on alveolar bones, the site of dental implants.

Thus, the purpose of this study is to know the organization of the bone architecture of the alveolar bone tissue of the Wistar rat in order to use it as a study model for the osseointegration of implant biomaterials.

Materials and Methods: This is a descriptive histomorphological study under an optical microscope of the alveolar bone of the Wistar rat, involving 32 samples. Rats were fed over a period of 2 months. Then, 2 females underwent bilateral oophorectomy. Three groups of rats were made up G1 (young adults), G2 (old adults) and G3 (ovariectomized rats). Animals were sacrificed at 60 days. The dissected jaws underwent histological treatment and were stained with Masson's Trichrome.

Results: The histological constituents of human alveolar bone have been found in the alveolar bone of the wistar rat (Table 1). The different bone types of humans have been found but they had different locations in the wistar rat. Age has no impact on the bone microarchitecture of the Wistar rat. Oophorectomy changes the bone microarchitecture of the ovariectomized adult spleen from 2 weeks.

Table 1 – Summary table of the histological constituents of the alveolar bone of young and old adult rats.

PRESENT ELEMENTS	FORM	LOCALIZATION
Osteones	circular	Compact tissue
Havers or Walkman canal	Oval	Compact tissue
Interstitial system	Varied	Compact tissue
Cementing limit	Circular border	Surrounding the osteones of the compact tissue
Bone marrow	Varied	Spongy tissue
Bone spans	Varied	Spongy tissue
Blood cells	Reddish nucleus	Spongy tissue, Havers or Walkman canal
Osteoblast	cubic	osteoid, interstitial system, surface canal havers, bone span.
Osteocyte	Starry	osteoid, interstitial system, interior of havers canal, mineralized bone, bone span.
Bordering cell	elongated	osteoid, interstitial system, surface canal havers, spongy tissue bone span
Osteoclast (only in the elderly)	multinucleate	Les lacunes de Howship
Howship gap	oval	Osteone, interstitial system, bone span

Conclusions: In view of these results, we can validate the use of the Wistar rat as an osseointegration study model for dental implants that opens prospects.

https://doi.org/10.1016/j.dental.2021.12.032

3

General Knowledge of Light-Curing Units Among Dentists in Saudi Arabia

H.M. Alhaddad*, D.E. Meisha, R.A. Al-Bukhary, A.O. Al-Zain

King Abdulaziz University, Faculty of Dentistry, Saudi Arabia
* *Corresponding author.*

Purpose/Aim: Light curing a restorative material is an essential step that is typically downplayed. The knowledge about light-curing unit (LCU) types, curing technique, and parameters on which dentists select an LCU are necessary to maximize the restoration longevity and provide optimum dental care. Therefore, clinicians should have sufficient knowledge regarding LCUs. This study was conducted to explore the level of dentists' knowledge in Saudi Arabia regarding LCUs, current practice, and the parameters on which dentists choose to purchase them.

Materials and Methods: An electronic questionnaire was formulated. Face and content validation were performed. The questionnaire was piloted and sent to dentists in governmental and private universities and clinics in Saudi Arabia. The questionnaire included several domains: demographic information, knowledge about different LCU devices, LCU selection parameters, participants current light curing practice, monitoring and care of the LCUs. Chi-square tests were performed.

Results: A total of 292 respondents participated in this study. One-third of them were dental students, 35.6% were general dentists, and 27.8% were specialists or consultants. While 54.5% believed that they received sufficient undergraduate education regarding LCUs, 52.7% did not know the type of their LCU and 64% did not know their LCU irradiance. It was interesting that only 51.7% believed that increasing the curing time or light irradiance affects the pulp. Of the known consequences of inadequate polymerization, the least proportion of respondents believed that toxic reaction (13.4%) and allergic reaction (19.2%) were possible consequences. Moving the LCU tip during curing (51%), light-guide tip diameter (53.1%), and light-guide tip angulation (56.2%) were the least mentioned clinical factors to affect the quality of resin polymerization. The most important parameter in purchasing LCU for respondents was irradiance (14.9%), while the most important parameter when purchasing a composite was brand reputation (33.2%). When comparing LCU decision makers versus others, a higher proportion of decision-making dentists (by 60.4%) knew the irradiance of their LCU compared to non-decision makers ($p<0.0001$). Despite that, decision makers were not more knowledgeable regarding LCU optimum distance, factors affecting curing time, or adverse effects on pulp compared to non-decision makers.

Conclusions: Knowledge about LCUs needs to be reinforced in dental curricula so they would graduate knowing on what basis to purchase an LCU. Also, reinforcing dentists knowledge through continuous educational courses is recommended in an attempt to deliver high standard patient care.

https://doi.org/10.1016/j.dental.2021.12.033

4

Degree of Conversion of Resin-Based Luting Materials Containing Alternative Photoinitiators

S. Amini*, P. Pereira, J.F. Roulet, D. Oliveira, M.G. Rocha

University of Florida, Restorative Dental Sciences Department, Florida, USA
* *Corresponding author.*

Purpose/Aim: Evaluate the degree of conversion (DC) of pre-heated composites, light- and dual-cured resin cements containing alternative photoinitiators under lithium disilicate ceramic with different thicknesses light cured using single-peak and dual-peak light curing units (LCUs).

Materials and Methods: Thirty rectangular (12 ×14 mm; n= 5) lithium disilicate ceramic (IPS e.max CAD MT A2) specimens in six different thicknesses (0.5, 1.0, 1.5, 2.0, 2.5 and 3.0 mm) were cut using a precision saw machine. The spectral irradiance ($mW/cm^2/nm$) of a single-peak (SmartLite Pro Cure) and a dual-peak (SmartLite Pro Polycure) LCUs and the light transmittance through the ceramic with different thicknesses were evaluated using a spectrophotometer (MARC Light Collector). LCU beam profile was also evaluated (ZWO ASI). The DC of a pre-heated dental composite (TPT,

Tetric Prime T using the CalSet at 68 C), a light-cured resin cement (VLC, Variolink LC) and a dual-cured resin cement (VDC, Variolink DC) was evaluated using FTIR spectroscopy. The luting agents were light cured with no ceramic interposed for 10 s and 40 s and through the ceramics with different thicknesses for 10 s using both LCUs. Statistical analyses were performed according to the different experimental designs with a level of significance of α= 0.05.

Results: The single-peak LCU emitted an irradiance of 1335 7 mW/cm2 with 98.4% of the irradiance within the blue spectrum. The dual-peak emitted an irradiance of 1192 4 mW/cm2 with 72.6% of the irradiance within the blue spectrum and 27.4% within the violet spectrum. The ceramic thickness has an exponential effect on the decrease of the light transmitted. VLC had a higher DC when using dual-peak and presented a maximum DC ratio above 80% up to 2 mm of ceramic thickness; VLC DC with single-peak LCU only cured efficiently up to 1 mm of ceramic thickness. There were no significant differences on the VDC DC when light cured with both LCUs at any thickness and VDC cured above the 80% of the maximum DC in all conditions, except for the single-peak LCU with a 3 mm thick ceramic. No differences were found for the TPT using both LCUs and TPT can be efficiently cured through a ceramic with up to 1 mm thickness.

Conclusions: Dual-peak LCUs were more efficient than single-peak on curing light- and dual-cured resin cements containing alternative photoinitiators, but there is no difference on the DC of pre-heated composites light cured with single- or dual-peak LCUs.

https://doi.org/10.1016/j.dental.2021.12.034

5

Effect of Roughness on Flexural Strength of Dental Lithium-Disilicate

M.F.R.P. Alves [1,*], B.G. Simba [2], M.H.V. Fernandes [1], C.N. Elias [3], J.E.V. Amarante [4], C. Santos [1,2]

[1] *University of Aveiro, Department of Materials and Ceramic Engineering, Aveiro, Portugal*
[2] *State University of Rio De Janeiro, Materials and Processes Laboratory, Resende, Brazil*
[3] *Instituto Militar De Engenharia, Materials Science Department, Rio De Janeiro, Brazil*
[4] *Fluminense Federal University, Institute of Health of Nova Friburgo, Nova Friburgo, Brazil*
[*] *Corresponding author.*

Purpose/Aim: A common process in dental clinics is to perform small fitting adjustments of dentures after testing in the patient's mouth using the micro-grinding tool. This procedure promotes a local roughness increase and can lead to the formation of microcracks on the prosthesis surface. The aim of this work was to investigate the benefits of a post-finishing heat treatment on the surface roughness smoothing and crack healing of lithium disilicate dental glass ceramics, and its effect on the flexural strength.

Materials and Methods: Commercially available lithium metasilicate, Li_2SiO_3 (IPS e-maxCAD), samples were heat treated at 840C-7min. The material was characterized by X-ray diffraction, Scanning Electron Microscopy, Vickers hardness, Youngs modulus and fracture toughness. One of the surfaces of the samples was machined, aiming to simulate the fitting procedure of dentures in the dentist's laboratory, generating a rough surface. Half of the samples were tested by biaxial flexural testing (3B-P) and the other half were submitted to a rapid heat treatment (840C-3min) and later tested by biaxial strength, with statistical analysis by Weibull. The Roughness parameters (Ra, PV and Rz) were measured using Zygo New View 7100 Optical Profiler.

Results: After the crystallization heat-treatment protocol suggested by the manufacturer, the formation of elongated lithium disilicate crystals, $Li_2Si_2O_5$, with 36% residual amorphous phase was observed. In addition, the Vickers hardness of 6.1±0.3 GPa, fracture toughness of 1.90± 0.2 MPa.m1/2 and modulus of elasticity values of 91 ±2 GPa were obtained. The samples from the group without rapid heat-treatment showed bending strength of 203.5 ±33 MPa, with roughness values of Ra=0.6 ±0.2 μm, Rz=22 ±6 μm and PV=28 ±7 μm. After the rapid heat treatment, the roughness parameters Ra, Rz and PV were 0.3 ±0.2 μm, 9 ±6 μm and 5 ±4 μm, respectively. With this reduction in roughness, the flexural strength increased by 65%, with mean values of 336.6 ±32 MPa. Weibull modulus values were in the order of 5 for both groups.

Conclusions: In the need for finishing machining of lithium disilicate-based glass-ceramic dental prostheses, the use of a rapid heat treatment at 840 C allows considerable gains in flexural strength. Increasing the service life of the prosthesis, due to a reduction on the surface roughness, promoted by the softening of the remaining amorphous phase in the glass-ceramic.

https://doi.org/10.1016/j.dental.2021.12.035

6

Ceramic-Dentin Cement Thickness: Bond Strength and Residual Stress

J.P.M. Tribst, G.C. Santos, L.S.S. Leite, L.R. Silva-Concilio, K. Baroudi, M. Amaral [*]

University of Taubate, Brazil
[*] *Corresponding author.*

Purpose/Aim: This study aimed to test whether three different cement layer thicknesses (60, 120 and 180 μm) would provide the same bonding capacity between adhesively luted lithium disilicate and human dentin.

Materials and Methods: Ceramic blocks were cut with a low-speed diamond saw with water cooling into 20 blocks, which were cemented to human flat dentin with adhesive protocol. The assembly was sectioned into 1 mm^2 cross-section beams composed of ceramic/cement/dentin. Cement layer thickness was measured, and three groups were formed. Half of the samples were submitted to aging simulation and the other half was immediately tested to evaluate the long-term bond strength. The microtensile test was performed in a universal testing machine. Bond strength (MPa) was calculated. The fractured specimens were examined under stereomicroscopy. Applying the finite element

method, the residual stress of polymerization shrinkage according to cement layer thick-ness was also calculated using First Principal Stress as analysis criteria.

Results: ANOVA showed that the cement layer thickness factor significantly influenced the bond strength results for the aged samples (p=0.040) without difference between the groups for the immediately tested groups (p=0.772). The higher the cement layer thickness the higher the residual stress generated at the adhesive interface due to cement polymerization shrinkage.

Conclusions: In conclusion, the cement layer thickness does not affect the immediate bond strength in lithium disilicate restorations; however, thinner cement layers are most stable in long-term showing constant bond strength and lower residual stress.

https://doi.org/10.1016/j.dental.2021.12.036

7

Method for Detecting Calcium Phosphate Mineralization on Dental Composites

K. Ames *

Pulpdent Corporation, Watertown, USA
* *Corresponding author.*

Purpose/Aim: The purpose of the study is to develop a procedure for determining the in-vitro calcium phosphate mineralization potential of dental composites.

Materials and Methods: A dental material containing Methacrylate-Functionalized Calcium Phosphate (MCP), was studied to determine a procedure to identify and quantify its capacity to create calcium phosphate mineralization. This study used Activa Presto, a dental composite containing 3 wt.% MCP (3MCP), and a control with the same chemical formulation as Presto, but without MCP (0MCP).

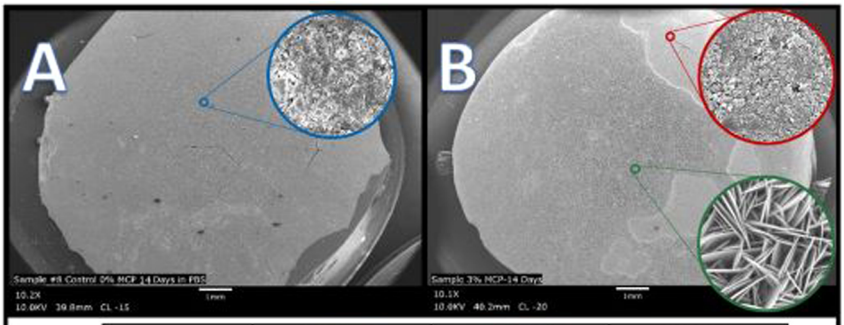
Using ISO 23317:2007 as a guideline, six cylindrical samples were created with an approximate diameter of 9.5 mm and height of 4 mm. Each sample was fabricated with an embedded nylon thread, which was used to suspend each sample in 25 mL of phosphate buffered saline (PBS) in individual plastic bottles. The samples were stored in a 37 C incubator for time periods of one, two and four weeks, and the PBS solution was replaced twice weekly. Once the designated time period elapsed, the samples were removed from the solution, placed back in the 37 C incubator and desiccated for scanning electron microscopy (SEM) with energy dispersive spectroscopy (EDS) evaluation.

Results: The SEM of the 0MCP sample was uniform throughout. At 3000x magnification the surface was granular and showed no sign of crystal formation. All the SEMs of the 3MCP samples had areas of crystal formation and areas where crystals had not yet formed (nucleation areas). The nucleation areas on the 3MCP sample looked granular, like the control, but EDS revealed a different surface composition.

Conclusions: The EDS shows that the 0MCP sample had minimal calcium and phosphorus, elements essential for mineralization. This sample had a high amount of silicon, which comes from the silica inherent in dental composites.

The nucleation area of the 3MCP sample had over five times the amount of calcium and phosphorus compared to the control, which indicates that there is an increase in potential for mineralization. The crystal area of the 3MCP sample shows about three times the amount of calcium and phosphorus when compared to the nucleation area, these values confirm the surface has been mineralized. Additionally, silicon was not detectable in this area, which suggests that the crystals are dense, and completely cover the underlying silica in the composite. The results of this study confirm that this procedure is suitable to determine the in-vitro mineralization potential of dental composites.

https://doi.org/10.1016/j.dental.2021.12.037



C

Element	0% MCP *Control*	3% MCP *Nucleation Area*	3% MCP *Crystal Area*
Calcium	0.6%	6.7%	24.6%
Phosphorus	1.4%	7.0%	20.9%
Silicon	15.4%	13.0%	0.0%

*Figure 1: **A:** SEM of the 0MCP sample at 14 days at 10x, with insert at 3000x magnification. **B:** SEM of the 3MCP sample at 14 days at 10x, with inserts at 3000x magnification of the nucleation area (top), and the apatite crystal area (bottom). **C:** Element composition of each of the 3000x magnifications described above.*

8

Dentine Conditioners: Effect on Collagen Probed By Amide-III Peak Analysis

K. Anastasiadis *, G. Eliades

Department of Biomaterials, School of Dentistry, National and Kapodistrian University of Athens, Athens, Greece
* *Corresponding author.*

Purpose/Aim: To assess the extent of demineralization and changes in the collagen type I structure of dentine conditioned with various acids, by using the amide-III peak for analysis, which is not affected by the presence of water, as opposed to the commonly used Amide-I peak.

Materials and Methods: Coronal dentin specimens (n=10/group) were analyzed by ATR-FTIR spectroscopy before and after conditioning (15 s for all) with 32% phosphoric acid (PA), 3% nitric acid (NA), 20% phytic acid (PT), 20% citric acid (CT) and 17% neutral EDTA (ED). The extent of demineralization (DM%) was measured from the PO_4 (1185-885 cm^{-1}) / Amide-III (1370-1150 cm^{-1}) peak area ratios, normalized against the native dentine specimens. The Amide-III peak was curve-fitted in four components assigned to α-helix (1285-1275 cm^{-1}), β-turns (1255-1245 cm^{-1}), random coils (1220-1210 cm^{-1}) and β-sheets (1210-1200 cm^{-1}) and the percentage subpeak areas were calculated relative to the total Amide-III peak. Statistical analysis was performed by one-way ANOVA (DM%) and t-test/Wilcoxon signed rank test for the curve-fitted components (α=0.05)

Results: The results of DM% were (mean/sd): PA: 89(3), NA: 95(2), PT:71(7), CT: 58 (8), ED: 25 (9) with a ranking of significant differences NA,PA>PT,CT>ED. Curve-fitting of the Amide- III peak revealed the following significant differences: Reduction in -helices and β-turns (PA); reduction in α-helices, β-turns and increase in β-sheets (NA); reduction in α-helices, β-turns and increase in random coils (PT); reduction in β-turns and an increase in β-sheets and random coils (CT) and increase in β-sheets and α-helices (ED)

Conclusions: Amide-III peak may provide important information for the extent of demineralization and the collagen type I structure of acid etched dentine, without the water interferences considered in Amide-I analysis. The inorganic and phytic acids, with the highest demineralization, disorganized the α-helix and β-turn structures, citric acid adversely affected only b-turns, whereas ED was the least aggressive treatment.

https://doi.org/10.1016/j.dental.2021.12.038

9

The Effect of Yttria Content on The Bond-Strength to Zirconia

Z. Badr [1,*], B. Alsayed [2], B. Rodgers [2], T. Sulaiman [2]

[1] *College of Dentistry, University of Nebraska Medical Center, Lincoln, USA*
[2] *Adams School of Dentistry, University of North Carolina, Chapel Hill, USA*
* *Corresponding author.*

Purpose/Aim: Various types of dental zirconia are commercially available. These zirconias contain varying amounts of yttria, which affects their chemical, mechanical, and optical properties. The aim of this study is to investigate the effect of ytrria content on the shear-bond strength between zirconia and a light-curing resin-cement.

Materials and Methods: A total of 20 zirconia disks with a thickness of 1.5 mm were prepared. A 3-mol% yttria zirconia block was used to make ten disks (Katana HTML, Kuraray Noritake Dental). The other ten disks were made of a 5-mol percent yttria zirconia block (Katana STML, Kuraray Noritake Dental). The samples were air particles abraded with 50μm aluminum oxide for 15 s at a distance of 10 mm at 2 Bar pressure. An adhesive phosphate monomer containing adhesive (Scotchbond Universal, 3 M) was applied and followed by a light-curing resin-cement (RelayX veneer, 3 M). The shear-bond strength of the resin cement and zirconia in each group was assessed at a speed of 0.5 mm/s using a universal testing machine. A light microscope, under to 200 times magnification, was used to examine the mode of failure. The data was analyzed using an unpaired t test with a significance level of 0.05.

Results: Table 1 shows the mean shear-bond strength between zirconia and resin-cement. The yttria content had a statistically significant effect on the shear-bond strength between zirconia and resin-cement (p=0.029). The mean bond strength between the resin cement and 5 mol% yttria zirconia (38.96 MPa, SD= 12.9) was significantly higher when compared the mean bond strength between the resin cement and 3 mol% yttria zirconia (28.18 MPa, SD=11.0).

The mode of failure was within the adhesive layer in all of the specimens renegades of their yttria concentration.

Conclusions: The yttria content of zirconia directly affected the bond strength between zirconia and the resin-cement. Lowering the yttria content decreased the shear bond strength to zirconia.

Yttria Content	Sample Size	Mean Shear-Bond Strength in MPa (SD)
3 mol%	10	28.2 (11.0)
5 mol%	10	38.9 (12.9)

https://doi.org/10.1016/j.dental.2021.12.039

10

Functionalization of Restorative Dental Glass-Ceramics with Bactericidal Properties

I.O. Baptista [1,*], F.R. Gomes [2], S. Vieira [3], S. Ferreira [3], M.F.R.P. Alves [1], C. Santos [1,4], M.H.F. Fernandes [1]

[1] *Department of Materials and Ceramic Engineering, University of Aveiro, Aveiro, Portugal*
[2] *Department of Physics, University of Aveiro, Aveiro, Portugal*
[3] *Department of Medical Sciences, University of Aveiro, Aveiro, Portugal*
[4] *Materials and Processes Laboratory, State University of Rio De Janeiro, Resende, Brazil*
[*] *Corresponding author.*

Purpose/Aim: Clinically, the periodontitis is related with the dental plaque, a biofilm of microorganisms, growth on the gum line and on the tooth interface. Therefore, a strategy to minimize this condition is the functionalization of the dental prosthesis, usually in contact with the gum, with antibacterial properties. The purpose of this study was to investigate the bactericidal potential of some commercial restorative glass-ceramic materials and to functionalize a commercial dental porcelain with antibacterial properties.

Materials and Methods: Commercially available restorative glass-ceramics in powder (IPS d.SIGN), or as monolithic (IPS E.max Press e GC Initial LiSi Press) were used as control samples, and characterized by X-ray diffraction (XRD), Rietveld refinement, differential thermal analysis and particle size distribution. The IPS d.SIGN glass-ceramic was selected for functionalization with nanostructured β-$AgVO_3$ that was synthetized by a hydrothermal route, using $AgNO_3$ and NH_4VO_3 as precursors, and characterized by XRD and Scanning Electron Microscopy (SEM). The glass-ceramic material was mixed with different percentages (1%, 2%, 4% or 6%wt) of β-$AgVO_3$, uniaxially pressed at 50 MPa, and thermally treated at 900 C for 5 min, as indicated by the manufacturer. The functionalized glass-ceramics was characterized by XRD, Rietveld refinement, SEM, Vickers Hardness and Vickers indentation fracture toughness. The three commercial glass-ceramics, IPS d. SIGN, IPS E.max Press and GC Initial LiSi Press as well as the functionalized samples were evaluated for its bactericidal potential against model bacteria (Escherichia coli and Staphylococcus aureus).

Results: The as-received control samples presented leucite ($KAlSi_2O_6$) as the only detectable crystalline phase, 62% wt of amorphous phase and a median particle size (D50) of 25.5 m in IPS d.SIGN. The product of the hydrothermal synthesis was characterized as pure needle like shaped β-$AgVO_3$ crystals. The heat-treated control samples still presented $KAlSi_2O_6$ as the only detectable crystalline phase. However, a secondary feldspar ($KAlSi_3O_8$) phase could be detected in the functionalized samples, which turns to be the main crystalline phase as a function of the increase in the β-$AgVO_3$ concentration. None of the commercially available samples showed antibacterial activity, but the IPS d.SIGN samples functionalized with 2%wt or more of β-$AgVO_3$ presented a clear inhibition halo, from 12, 70, 3 mm to 15, 50, 1 mm, suggesting bactericidal activity against both model bacteria.

Conclusions: Preliminary, in vitro results indicated that the analyzed commercial dental glass ceramics demonstrated no antibacterial activity. Nevertheless, the functionalization of a commercially available veneering glass-ceramic with at least 2%wt of β-$AgVO_3$ can induce bactericidal activity against gram-positive and gram-negative bacteria.

https://doi.org/10.1016/j.dental.2021.12.040

11

Efficiency of Natural Ingredients in Teeth Whitening

A Barbuzan-Caragyov [*], T. Hajaj, A.C. Cojocariu, S. Christa, C. Sinescu

University of Medicine and Pharmacy Victor Babes Timisoara, Timisoara, Romania
[*] *Corresponding author.*

Purpose/Aim: Whitening or bleaching is a procedure that improves the colour of the teeth and has an important role in the aesthetic look of the patient. It is known that standard materials used for whitening (hydrogen peroxide and carbamide peroxide) can have harmful effects on the tooth structure so in the recent years, emphasis has been put on using natural ingredients. Studies are being carried to see the efficacy of these natural products.

Materials and Methods: The authors have reviewed the information available from a number of 12 studies that had the objective to demonstrate the efficacy of the natural ingredients on teeth whitening. The studies have been separated in 3 groups: group A baking soda, group B charcoal and group C citric acid. Each of them consists of 4 studies.

Results: In all cases, the colour of the teeth has been improved. Some studies showed that the natural ingredients don't have a higher abrasivity than the toothpastes and are safe for use. Baking soda has an antibacterial role, has a low abrasivity and is compatible with the sodium

fluoride found in toothpastes. Charcoal has a good whitening potential, but it is recommended to be used carefully because it cand induce enamel lesions. The citric acid has an antibacterial and anti-inflammatory role and the best concentration for teeth whitening is the 5% one. None of the studies showed great damage of the enamel and dentin structure. All the natural ingredients had similar esthetic results with the synthetic products but none of them had a greater effect regarding tooth substance loss.

Conclusions: It has been demonstrated that natural ingredients have a good capacity of teeth whitening and some of them can reduce the plaque accumulation and increase the gum health. Whether they are used in a pure form or as ingredients in different gels or toothpaste, their good aesthetic results and reduced side effects recommend them in the bleaching procedure. Further studies should be carried to find the best formula for a natural whitening product.

https://doi.org/10.1016/j.dental.2021.12.041

12

Structure-Property Relationships in Lithium-Based Glass-Ceramics

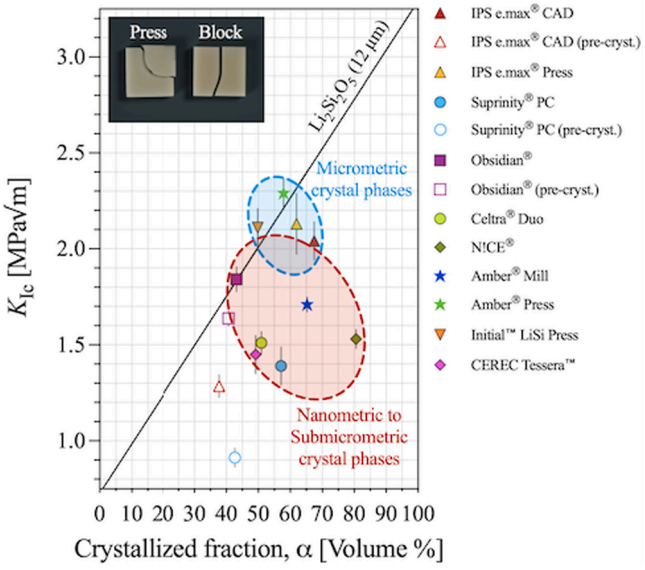
R. Belli [1,*], J. Lubauer [1], K. Hurle [2], H. Peterlik [3], U. Lohbauer [1]

[1] *Dental Clinic, Friedrich-Alexander-Universität Erlangen-Nürnberg (Fau), Erlangen, Germany*
[2] *Department of Materials Science, Friedrich-Alexander- Universität Erlangen-Nürnberg (Fau), Erlangen, Germany*
[3] *Faculty of Physics, Universität Wien, Vienna, Austria*
* *Corresponding author.*

Purpose/Aim: Lithium-based glass-ceramics are currently dominating the landscape of dental restorative ceramic materials, with new products taking the market by storm in the last years. Though, the difference among all these new and old products is not readily accessible for the practitioner, who faces the dilemma of reaching a blind choice or trusting manufacturers marketing brochures. To add confusion, new compositions tend to wear material terminologies inherited from vanguard dental lithium disilicates, disregarding accuracy. Here we aim to characterize such materials for their microstructure, crystalline fraction, glass chemistry and mechanical properties.

Materials and Methods: Ten commercial dental lithium-based glass ceramics were evaluated: IPS e.max CAD, IPS e. max Press, Celtra Duo, Suprinity PC, Initial LiSi Press, Amber Mill, Amber Press, N!CE, Obsidian and CEREC Tessera. The chemical composition of their base glasses measured by X-Ray Fluorescence Spectroscopy (XRF) and Inductive Coupled Plasma Optical Emission Spectroscopy (ICP-OES), as well as the composition of their residual glass by subtracting the oxides bound in the crystallized fraction, characterized by X-Ray Diffraction (XRD) and Rietveld refinement, and quantified accurately using the G-factor method (QXRD). The crystallization behavior is revealed by differential scanning calorimetry (DSC) curves. Elastic constants are provided from Resonant Ultrasound Spectroscopy (RUS) and the fracture toughness measured by the Ball-on-Three-Balls method (B3B-KIc). The microstructure is revealed by field-emission scanning electron microscopy (FE-SEM).

Results: The base glasses showed a wide range of SiO_2/Li_2O ratios, from 1.5 to 3.0, with the degree of depolymerization dropping from to 2/3 of the initial connectivity. Materials contained Li_2SiO_3+Li_3PO_4, Li_2SiO_3+Li_3PO_4+$Li_2Si_2O_5$, $Li_2Si_2O_5$+Li_3PO_4+Cristobalite and/or Quartz and $Li_2Si_2O_5$+-Li_3PO_4+$LiAlSi_2O_6$, in crystallinity degrees from 45 80 vol%. Crystalline phases could be traced to their crystallization peaks on the DSC curves. Pressable materials and IPS e. max CAD were the only ones showing micrometric phases, with N!CE showing solely nanometric crystals, with the rest presenting a mixture of submicrometric and nanometric particles (Fig. 1). Fracture toughness from 1.45 to 2.30 MPa.m^1/2 were measured, with the correlation to crystalline fraction breaking down for submicrometric and nanometric crystal phases.



Conclusions: Dental lithium-based silicate glass-ceramics cannot be all put in the same bag, as differences exist in chemical composition, microstructure, crystallinity and mechanical properties. Pressable materials still perform better mechanically than CAM/CAM blocks, which loose resistance to fracture when crystal phases enter the submicrometric and nanometric range.

https://doi.org/10.1016/j.dental.2021.12.042

13

Recycling of High-Viscosity Glass Ionomer Cement Plastic Capsules

A Borges [1,*], TFR Mota [1], EB Nascimento [1], DSS Padovini [2], FM Pontes [2]

[1] *Bauru School of Dentistry, University of São Paulo - FOB/USP, Brazil*
[2] *School of Sciences, São Paulo State University, Brazil*
[*] *Corresponding author.*

Purpose/Aim: This study aimed to show the chemical recycling process of glass ionomer cement capsules (Chemfil Rock, Dentsply).

Materials and Methods: The process included acetone to attack polystyrene, separation of the dye (Rhodamine B) inside the polymer, and photodegradation by TiO_2 nanoparticles. The chemical reaction of the acetone solvent with the polystyrene degraded the material as power, but with the dye. The centrifugation technique separated the polystyrene from Rhodamine B dissolved in acetone. After that, the mixture was placed on the stove to evaporate the acetone and the dye was mixed with water and 10 mg of TiO_2 nanoparticles. The solution was exposed to UV radiation for 1 hour.

Results: Discoloration of the solution showed that Rhodamine B was degraded by TiO_2 nanoparticles. XRD confirmed the presence of crystalline anatase TiO_2. FTIR analysis confirmed the existence of polystyrene organic groups in the powder resulting from centrifugation.

Conclusions: This process was a feasible possibility to decrease the plastic residues of dental material capsules.

https://doi.org/10.1016/j.dental.2021.12.043

14

Systematic Review of In Vitro Enamel Wear Behavior Opposing Zirconia

S. Butler [1,*], Y. Torrealba [2], B. Linke [2], C. Flores-Mir [2], J.A. Nychka [2]

[1] *Western University, Canada*
[2] *University of Alberta, Canada*
[*] *Corresponding author.*

Purpose/Aim: The aim of this systematic review was to assess enamel wear on teeth opposing zirconia restorations and to evaluate factors related to the wear of natural teeth opposing zirconia restorations.

Materials and Methods: Five electronic databases were searched through July 2021 without limitations. Terms antagonist*, enamel, wear and zirconia* were used. All titles revealed by the electronic search were screened according to the following inclusion criteria: 1. In vitro studies; 2. Use of Y-TZP ceramic; 3. Evaluation of the antagonists enamel. In addition to the inclusion criteria the following exclusion criteria were applied: 1. Veneered zirconia specimens; 2. Absence of enamel wear evaluation; 3. Enamel of primary teeth. Study selection: Titles and abstracts were initially screened, and those that fulfilled the inclusion criteria were selected for a full-text assessment. Studies which evaluated only the material wear were not included. The studies were analyzed regarding the wear mimicking device and wear method, its testing parameters, ceramic preparation, finishing technique, antagonists enamel wear and zirconia wear. When information was unavailable or limited, authors were contacted in order to obtain missing information.

Results: The database search strategy retrieved 1326 potentially eligible studies. After removing the duplicate studies, 324 studies were obtained. Titles and abstracts that fulfilled the inclusion criteria were selected for a full-text assessment (49). Eighteen laboratory studies met the inclusion criteria. Additionally, reference lists from the finally selected studies were also screened.

Conclusions: There was a large variation in relation to wear test method quantifi- cation, applied force, lateral movement, number and frequency of cycles, number of specimens, and enamel specimen preparation. In all studies, enamel wear rates were lower against polished zirconia. Differences in the test methods did not allow for comparisons of wear rates among the studies. Clinical Significance: Polishing the surface is recommended for a full-contour zirconia restoration because polished zirconia presents favorable wear behavior opposing natural teeth. (Table 1)

https://doi.org/10.1016/j.dental.2021.12.044

Table 1 – Search strategy.

Database	Dates of coverage	Keywords
MEDLINE (OvidSP)	1950 - July/2021	"antagonist*" OR "enamel" AND "wear" AND "zirconi*"
[1]PubMed (NLM)	1950 - July/2021	Same search strategy as MEDLINE (OvidSP). MeSH terms: dental enamel, tooth wear, zirconium dioxide
EMBASE (OvidSP)	1974 - July/2021	Same search strategy as MEDLINE (OvidSP)
Cochrane (Wiley)	1996 - July/2021	Same search strategy as MEDLINE (OvidSP)
Scopus (Elsevier)	1960 - July/2021	"antagonist*" OR "enamel" AND "wear". Within results, "zirconi*" was added.

[1]The search terms were related to the MeSH terms.

15

Characterization and Thickness Effect on Fatigue Strength of Translucent Zirconias

LVC Arcila [1,*], NC Ramos [2], TMB Campos [3], KS Dapieve [4], LF Valandro [4], RM Melo [1], MA Bottino [1]

[1] *Institute of Science and Technology, Säo Paulo State University (Unesp), Brazil*
[2] *Säo Francisco University (USF), Brazil*
[3] *Technological Institute of Aeronautics, Brazil*
[4] *Federal University of Santa Maria (UFSM), Brazil*
[*] *Corresponding author.*

Purpose/Aim: To characterize the microstructure, hardness, and fracture toughness of yttria-partially stabilized zirconia ceramics and to evaluate the effect of thickness on their biaxial flexural strength (quasi-static and fatigue tests).

Materials and Methods: Disc-shaped specimens (12 mm in diameter, 1.2 mm-thick) were obtained from 3Y-TZP (Vita YZ HT), 4Y-PSZ (Vita YZ ST), and 5Y-PSZ (Vita YZ XT) ceramics. The samples had their crystalline phases, microstructure and composition analyzed with X-ray diffraction (XRD), Scanning Electron Microscopy (SEM), and Energy-dispersive X-ray spectroscopy (EDX). A microhardness tester was used to assess the Vickers hardness and fracture toughness of each material. Thinner discs were also prepared to evaluate the thickness effect (0.7 or 1.2 mm) on the biaxial flexural strength. The monotonic biaxial flexural strength tests were performed according to ISO 6872/2015. The same test set up was used to perform fatigue tests (incremental steps of 25 MPa for 10,000 cycles starting from 400 MPa).

Results: SEM images revealed surface defects on 4Y-PSZ and 5Y-PSZ samples, while 3Y-TZP exhibited greater grain uniformity. All ceramics showed similar chemical compositions. The main difference was the amount of yttria, which was higher in 5Y-PSZ, followed by 4Y-PSZ, and 3Y-TZP. The same trend was observed regarding the amount of cubic phase (5Y-PSZ > 4Y-PSZ > 3Y-TZP). 5Y-PSZ and 3Y-TZP presented the highest hardness values (1529.8 152.6 and 1421.5 109.7, respectively). The highest fracture toughness was observed in 3Y-TZP (5.66 0.56), while 4Y-PSZ (4.44 0.58) and 5Y-PSZ (4.29 0.38) showed similar values. The lowest flexural fatigue strength was observed in 5Y-PSZ (0.7 mm: 376.7 MPa and 60.3 ×103 cycles for failure, 1.2 mm: 440 MPa and 73 ×103 CFF), while 3Y-TZP and 4YSZ were statistically similar (3Y 0.7 mm: 520 MPa and 89 ×103 CFF, 1.2 mm: 516.7 MPa and 88.3 ×103 CFF, 4Y 0.7 mm: 603.3 MPa and 105.6 ×103 CFF, 1.2 mm: 546.6 MPa and 94.3 ×103 CFF). Comparing the monotonic and fatigue tests, 3Y-TZP suffered the highest (1.2 mm: 47.04%) and lowest (0.7 mm: 29.85%) percentage of degradation. 5Y-PSZ degraded more than 4Y-PSZ (5Y 0.7: 46.38%, 1.2: 41.38%, 4Y 0.7: 35.19%, 1.2: 38.52%).

Conclusions: Despite the microstructural differences, 4Y-PSZ and 3Y-TZP had similar fatigue behavior regardless of thickness. 5Y-PSZ had the lowest mechanical performance.

https://doi.org/10.1016/j.dental.2021.12.045

16

Morphological and Functional Evaluation of Biogeneric and Human CAD-Designed Crowns

Y. Chen [*], E.H.N Pow, J.K.H. Tsoi

Faculty of Dentistry, the University of Hong Kong, Hong Kong, China
[*] *Corresponding author.*

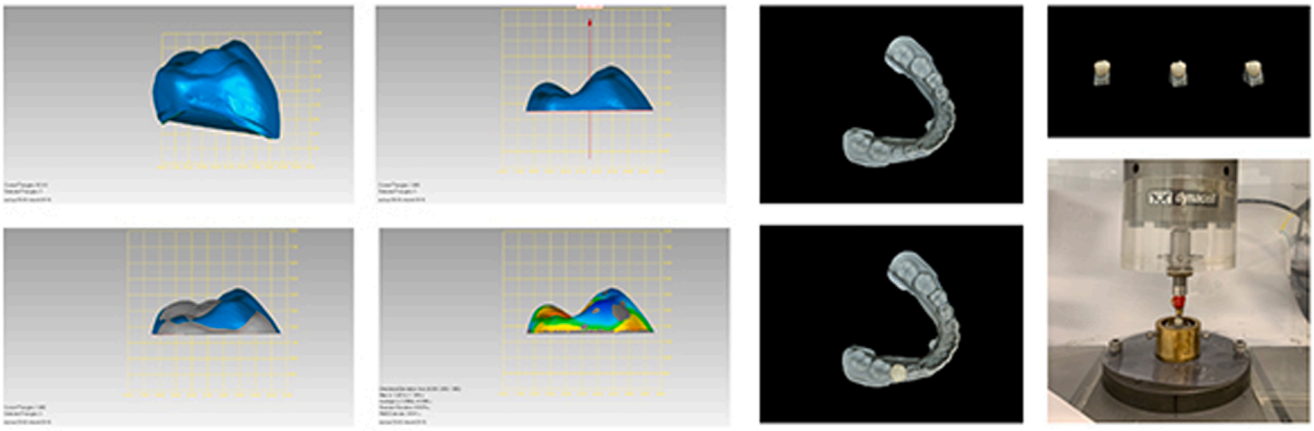
Purpose/Aim: This study aimed to evaluate single crown restorations generated by CEREC biogeneric function, designed by experienced dental technician, and designed by dental student using a dental CAD software. Occlusal morphological parameters were evaluated by superimposing and analyzing the digital datasets, while fracture resistance was assessed via load-to-fracture tests of milled restorations.

Materials and Methods: Digital datasets of models were obtained and 3D-printed, teeth #45 were prepared, and models were scanned again (n=12). For each model, three crown designs were accomplished by the CEREC biogeneric function (group BI), by an experienced technician using CAD software (Zfx Manager 2.0)(group TD), and by two dental students after 3-hour standard training using the same CAD software (group AD). The original tooth morphology and crown designs were superimposed (Geomagic Control 14.0), and occlusal morphological parameters, including average positive and negative profile discrepancy, standard deviations (SD), estimated root mean square (RMSestimate), volume discrepancy, volume/area profile discrepancy, and cusp angle, were analyzed. Fracture resistance was determined using compressive load-to-fracture test (Instron E3000, crosshead speed 0.5 mm/min) on monolithic lithium disilicate (IPS e.max CAD) whereas the crowns were milled, sintered, and adhesively luted to 3D-printed dies. The failure mode of the specimens was recorded and examined using polarized light microscopy, while representative samples were examined using SEM. Repeated measurements of ANOVA, Kruskal-Wallis test, Pearsons correlation coefficient, paired t-test, and chi-square exact test were used in statistical analysis (? = 0.05).

Results: Significant differences were detected among three groups in occlusal morphological analysis. Groups BI and AD have significantly higher average positive profile discrepancies than group TD ($p<0.05$). Group BI were significantly higher than TD in SD, RMSestimate, and average absolute profile discrepancy ($p<0.05$). Cusp angle values were significantly different in all groups except group BI and TD. No significant difference was found in fracture loads, while group BI has a significantly higher percentage of restorable substrate damage ($p<0.05$).

Conclusions: Discrepancies in occlusal morphology exist between biogeneric and human CAD-designed crowns, as the latter showed higher similarities to the

original teeth. Both biogeneric and human-designed crowns can achieve clinically acceptable fracture resistance. To compare different restoration designs, multiple measuring parameters to assess both morphological and functional aspects would be essential and recommended.



Morphological evaluation using profile discrepancy, volume discrepancy and cusp angle

Functional evaluation using load-to-fracture test and failure mode analysis

https://doi.org/10.1016/j.dental.2021.12.046

17

LC-MS/MS Analysis of Aged Dental Composites in Simulated Oral Environment

C. Chen [1,*], K. Mondal [1], P. Vervliet [2], A. Covaci [2], E.P. O'Brien [1], J.L. Drummond [1,2], K.J. Rockne [1], L Hanley [1]

[1] *University of Illinois Chicago, USA*
[2] *University of Antwerp, Belgium*
[*] *Corresponding author.*

Purpose/Aim: Resin-based composites have replaced traditional amalgam as dental restorations. Most resins consist of organic compounds such as Bisphenol A diglycidyl dimethacrylate (BisGMA), triethylene glycol dimethacrylate (TEGDMA), ethoxylated bisphenol A dimethacrylate (BisEMA), and diurethane dimethacrylate (UDMA). These monomers polymerize upon the light curation during the dental restoration process, but saliva induces hydrolysis and enzyme catalysis which degrades the polymeric matrix over time. This study developed an analytical method to determine the effect of static aging of resin-based dental restorative composites in simulated oral environments. Commercial composites Filtek Supreme Ultra and Bisco Aelite were aged in artificial saliva, both with and without added esterase enzyme, then the leaching solutions were sampled by liquid chromatography tandem mass spectrometry (LC-MS/MS).

Materials and Methods: Two dental composites, Filtek Supreme Ultra and Bisco Alelite, were aged separately in artificial saliva with and without esterase enzyme for up to six months. Each aging media was sampled at four-, five- and six-month time points, extracted with ethyl acetate, and analyzed with LC-MS/MS. Agilent MassHunter software was used for suspect screening via comparison of experimental MS/MS with known mass spectra. Monomers associated with dental composite degradation products are not available in standard MS libraries, so a database developed at the University of Antwerp supplemented with an in-house library created with available analytical standards was used in the identification workflow. To avoid false-positive identification, compounds identified by the software were screened manually along with the collection of analyte and instrumental blanks.

Results: Unaged methanol extracts from composites as well as artificial saliva exposed to composites for up to six months were analyzed by LC-MS/MS. A total of 24 and 13 compounds were identified in unaged extracts and aged leaching solutions, respectively. Most compounds identified in unaged extracts are intact monomers or monomers

Table 1 – Compounds identified in each aging solution.

Bisco in AS+enzyme														
4-months	x	x	x					x				x		
5-months	x	x	x	x	x			x				x		
6-months	x	x	x					x				x		
Bisco in AS														
4-months	x	x	x	x									x	
5-months	x	x	x	x									x	
6-months	x	x	x	x				x					x	
Filtek in AS+enzyme														
4-months	x	x	x	x	x	x	x	x			x	x		
5-months	x	x	x	x	x	x	x	x		x	x	x		
6-months	x	x	x	x	x	x	x	x		x	x			
Filtek in AS														
4-months	x	x	x	x	x	x	x	x	x	x				
5-months	x	x	x	x	x	x	x	x		x				
6-months	x	x	x	x	x	x	x	x	x	x				
	BisEMA-04-Degr	BisEMA-07-Degr	BisEMA-08-Degr	BisEMA-09-Degr	BisEMA-10-Degr	BisEMA-11-Degr	BisEMA-12-Degr	BisHPPP	UDMA-Degr1	UDMA-Degr2	UDMA-Degr4	TEG	TEGDMA	

that lost only one methacrylate group. Only two intact monomers were identified in the aged leaching solutions along with various degradation products.

Conclusions: An analysis workflow has been developed to identify the organic monomers leached from resin-based dental composites using LC-MS/MS. Data shows that artificial saliva and esterase enzyme not only cause the elution of monomers, but can also chemically degrade the monomers. (Table 1)

https://doi.org/10.1016/j.dental.2021.12.047

18

The Effectiveness of Different Types of Varnishes in Preventing Erosion

T Kolus [1], E Coban [2], H Yalcinkaya [2], H. Esra Ulker [2], E Durmus [2], I Celik [2]

[1] *Faculty of Dentistry, Karamanoglu Mehmetbey University*
[2] *Selcuklu, Turkey*

Purpose/Aim: The aim of this in vitro study is to evaluate the effect of fluoride varnish, bioactive glass varnish, eggshell powder and sodium tri-metaphosphate treated eggshell membrane powder containing varnish against erosion.

Materials and Methods: 27 teeth were cut with a water-cooled low-speed diamond separator. Two 2×3 mm windows were created in the middle three of the buccal surfaces of the specimens and the remaining parts were covered with acid-resistant nail polish. Fluoride varnish (FV), Bioactive glass varnish (BV), STMP treated eggshell and eggshell membrane containing varnish (EV) were applied to one of the two windows in each tooth sample, the other window was used as a control. Using separate containers, samples were immersed in cola drink (6 ml/sample, p H 2.6, Coca-Cola, Ankara, Turkey) gentle shaking (Duomax 1030, Heidolph) at room temperature for 2 minutes. Then the samples were kept in 0.4 ml artificial saliva for 2 minutes. This pH cycle was repeated 4 times. The surface properties of the samples were examined in a scanning electron microscope, the Ca, P, F, Mg, K and Na ratios were determined, and the Ca/P ratio was calculated.

Results: The Ca/P ratio in the area where FV is applied is 1.56, which is lower than 1.61, the stochiometric ratio in human enamel. This ratio is 1.50 in the FV control group. The Ca/P ratio of the BV group was 1.63 and 1.51 in the BV control group, 1.63 in the EV group and 1.52 in the EV control group. No statistical difference found among groups. Also, on the enamel surface treated with BV and EV, a protective layer observed.

Conclusions: Against dental erosion, BV and EV can be used as an alternative to fluoride varnishes.

https://doi.org/10.1016/j.dental.2021.12.048

19

Root Dentin Conditioning with Self-Etch Primers Incorporated with Nanochitosan

P.C. Dias *, I.B. Quero, J.J. Faraoni, R.G. Palma-Dibb

Department of Restorative Dentistry, University of Sao Paulo, Ribeirao Preto, Brazil
* *Corresponding author.*

Purpose/Aim: This study aimed to evaluate different experimental self-etch primers (EP) incorporated with nanochitosan gel (NC gel) on the surface of the radicular dentin of bovine incisor teeth.

Materials and Methods: Sections with 3x3mm dimension of bovine radicular dentin were flattened, and the smear layer formed and standardized with #600 sandpaper. Then the sections (n=5) were treated with different primers: C Clearfil (control), P1 EP without NC gel, P2 EP with 5% NC gel, P3 EP with 10% NC gel, and P4 EP with 15%

NC gel. Primers were actively applied and left on the surface for 20 s. After this, surfaces were analyzed under confocal laser scanning microscopy, obtaining images (x2160) to assess the degree of surface modification and dentinal tubule alteration. The relation total/open tubules after primer application (%) were evaluated, in addition to the tubular area and perimeter. Data were analyzed by ANOVA and Fisher test ($p<0.05$).

Results: Morphologic analysis showed similar alterations on the dentin surface among the evaluated groups. It can be observed the same pattern of demineralization on the intertubular and peritubular dentin. The number of open tubules was similar for all groups; however, it presented more alteration of perimeter and area for P2 and P3, and statistically significant difference for the control group ($p<0.05$).

Conclusions: The addition of NC gel (5 and 10%) into the experimental primers interfered in the dentin surface modification promoted by the self-etch primers but not exposed more tubules. (Table 1)

Table 1 – Effect of different primers on tubules present in root dentin (mean ± standard deviation).

Groups	Tubules (%)*	Perimeter (%)*	Area (%)*
C	57.23±10.74a	73.14±7.42bc	56.16±9.49b
P1	61.88±12.49a	70.89±8.27c	53.52±10.43b
P2	73.43±5.66a	84.42±2.84a	71.42±3.96a
P3	62.11±10.42a	82.58±10.66ab	71.38±16.86a
P4	62.87±17.44a	80.72±5.41ab	63.75±8.83ab

* Column comparison – same letters are statistically similar ($p>0.05$).

https://doi.org/10.1016/j.dental.2021.12.049

20

Zirconia Strength Degradation Post Air-Abrasion of Veneering and Cementation Surfaces

S. Butler [1], B. Linke [2], N.C.F. Moreira [2,*], J.A. Nychka [3]

[1] *Schulich School of Medicine & Dentistry, Western University, London, Canada*
[2] *School of Dentistry, University of Alberta, Edmonton, Canada*
[3] *Department of Chemical and Materials Engineering, School of Dentistry, University of Alberta, Edmonton, Canada*
[*] *Corresponding author.*

Purpose/Aim: This study evaluated how the flexural strength of a zirconia-based ceramic (Y-TZP) was affected by air abrasion with 30 μm SiO on both zirconia surfaces: the cementation surface, and the veneering surface.

Materials and Methods: Translucent Y-TZP ceramic bars, for four-point bend testing, were prepared and divided considering the compressive (surface treatment for cementation) and tensile surfaces (surface treatment for veneering). Sandblasting was performed or not for each compressive and tensile surfaces. The specimens from all experimental conditions were analysed by SEM. All specimens were tested in four-point bending. Data were statistically analysed using one-way ANOVA and Post Hoc tests ($\alpha= 0.05$). A Weibull analysis was used to analyse the strength reliability.

Results: According to the results of this investigation, the flexural strength was significantly affected by sandblasting on both surfaces: for veneering ($P < 0.001$) and for cementation ($P < 0.001$).

Conclusions: Sandblasting the veneering surface, to improve bonding of the veneer to Y-TZP, negatively impacted strength reliability. Sandblasting the cementation surface decreased the flexural strength while increasing the strength reliability.

https://doi.org/10.1016/j.dental.2021.12.050

21

Understanding Stress Development on Bilayer Lithium Disilicate Crowns

C.S. Rodrigues [1,*], S. Dhital [2], J. Kim [2], M.S. Wolff [3], L.G. May [4], Y. Zhang [3]

[1] *Sao Paulo State University, Brazil*
[2] *University of Connecticut, USA*
[3] *University of Pennsylvania, USA*
[4] *Federal University of Santa Maria, Brazil*
[*] *Corresponding author.*

Purpose/Aim: Despite the high survival rates, bilayer lithium disilicate crowns mostly fail due to major porcelain chipping or bulk fracture. Therefore, this study aimed to understand the stress development in porcelain-veneered lithium disilicate (PVLD) crowns with different veneer/core thickness ratios and cooling rates. Design guidelines and understanding of clinical fractures were provided with the aid of Viscoelastic Finite Element Method (VFEM).

Materials and Methods: The VFEM was validated by comparing the predicted residual stresses with experimental measurements in flat PVLD samples. As an excellent agreement was obtained, the model was used to predict transient and residual stresses in bilayer crowns. Models with two different veneer/core thickness ratios were prepared (2:1 and 1:1) and two cooling protocols were simulated (Fast: ~300 C/min, Slow: ~30 C/min) using a heat transfer, followed by stress analysis in ABAQUS. The coefficient of thermal contraction, thermal conductivity, specific heat, density, and elastic modulus were experimentally determined from lithium disilicate and porcelain samples at different temperatures. Thus, the physical properties used for the simulations were simulated as a function of temperature.

Results: Fast cooling led to higher residual stress values and abrupt stress magnitude changes in both porcelain and framework layers. The 1:1 thickness ratio slightly increased the residual stresses in the porcelain layer when fast cooling was applied. The maximum tensile stresses were in the central fossa, which together with the low stress magnitude (Table 1), does not facilitate crack propagation to the peripheral areas of the crowns.

Table 1 – Maximum tensile residual stresses observed in porcelain and framework layers of PVLD crowns after simulation of different thickness ratios and cooling rates.

		2:1	1:1
Fast cooling	Porcelain	19 MPa	24 MPa
	Framework	10 MPa	9 MPa
Slow cooling	Porcelain	12 MPa	12 MPa
	Framework	8 MPa	6 MPa

Therefore, any occlusal contact-induced crack would have to propagate a longer distance in order to fracture. However, once it happens, major chipping is formed.

Conclusions: Slow cooling is preferable, mainly due to its effect on the transient stresses. The thickness ratio does not play an important role in stresses development once a slow cooling protocol is applied. The stress distributions in PVLD crowns might be related to the failure modes reported in clinical studies.

https://doi.org/10.1016/j.dental.2021.12.051

22

Crystallization Effect on Biaxial Flexural Strength of Lithium Disilicate

B.F. Vallerini [1,*], A.T.H. Olivi [1], M.O.C. Villa-Boas [2], E.D. Zanotto [2], L.A.P. Pinelli [1]

[1] *School of Dentistry, Sao Paulo State University, Araraquara, Brazil*
[2] *Materials Engineering, Federal University of Sao Carlos, Brazil*
[*] *Corresponding author.*

Purpose/Aim: Glass-ceramics destined for dental prostheses have evolved over the years allowing reaching ceramics materials with high quality, lithium disilicate is one of the most used materials due to its wide range of indications. Appropriate mechanical analyses of dental ceramics require a suitable biaxial flexural strength. The aim of this work was developed a composition of a lithium disilicate glass and evaluated the effect of different nucleation heat treatments on the biaxial flexural strength.

Materials and Methods: Discs (12 mm diameter x 1.2 mm thickness) of LS2 experimental and IPS e.max CAD (C, control group n=15) were made. LS2 experimental discs were annealed at 380 C/2 h followed by different nucleation heat treatments in which time and temperature were varied composing 4 groups (n=15): T1 (1h30/500 C), T2 (3 h/500 C), T3 (6 h/500 C) and T4 (6 h/480 C). X-ray diffraction (XRD) with Rietveld refinement was performed to analyze the crystalline phases. The characterization of the crystals was performed for all samples using a scanning electron microscope (SEM). Quantification of the crystalline fraction (CF) was performed using the Image J software, obtaining the estimated percentage for the glass and the crystalline phase. The biaxial flexural strength (BFS) was evaluated by the biaxial piston-on-three balls. The XRD, SEM, and CF data were analyzed descriptively. The BFS were statistically analyzed by one-way non-parametric ANOVA (Kruskal-Wallis test) with post hoc all pairwise. (α=0.05).

Results: XRD analysis showed peaks of lithium disilicate for all groups. The morphology of crystals was in an acicular and homogeneous format for all groups. The mean values for CF (%) were: T1= 59.31; T2 = 61.73; T3 = 60.13; T4 = 55.51 and C = 57.52. The mean values for BFS (MPa) were: T1= 399.32; T2 = 357.86; T3 = 224.83; T4 = 492.65 and C = 337.34.

Conclusions: It was concluded that the time and temperature of nucleation influenced the crystals morphology, crystals size, and the crystalline fraction, impacting the properties assessed; the group was that presented the best result was that received treatment for 6 hours at 480 C.

https://doi.org/10.1016/j.dental.2021.12.052

23

Mechanical Strength Evaluation of a Printed Dental Space Maintainer

B. Dragos [1,*], C.S. Neagu [1], A.G. Balica [1], A.C. Cojocariu [1], A. Cernescu [2], D.C. Bratu [1], M.L. Negrutiu [1], C. Sinescu [1]

[1] *Faculty of Dental Medicine, "Victor Babes" University of Medicine and Pharmacy, Timisoara, Romania*
[2] *Department of Mechanics and Strength of Materials, Faculty of Mechanics, Polytechnic University of Timisoara, Romania*
[*] *Corresponding author.*

Purpose/Aim: Due to the latest progress of 3D scanning and printing technology in the medical field, attempts have been made to apply this technology also in preventive orthodontics in order to obtain an aesthetic dental space maintainer. The aim of this study is to observe the mechanical load distribution on a SLA band and loop space maintainer in order to develop a high-precision aesthetic dental space maintainer using computer-aided design (CAD) / computer-aided manufacturing (CAM) and 3D printing by resin-based additive technique.

Materials and Methods: On account of increasing aesthetic requirements, an initiative was made to replace the classic band and loop space maintainer with a metal-free appliance, using an innovative technique for creating the esthetic design of the space maintainer. Four band and loop space maintainers were achieved through stereolithography (SLA). After scanning the dental cast, a 3D software Exocad was used to establish the design of the dental space maintainer. They were manufactured using two different 3D printers, two with Formlabs form2 using C&B Micro Filld Hybrid (MFH) resin and two with Creality using NextDent SG resin. After printing, all samples were placed in an isopropyl alcohol bath to clean them of residues and resin excess, then placed in the UV oven for drying. Shortly afterwards processing they were subjected to the mechanical strength test by compression using the Zwick/ Roell Z005 device. For the fulfillment of the mechanical resistance tests, the dental cast made by the classic plaster technique was used as support.

Results: Following mechanical tests, it was observed that these devices yielded to the action of a vertical force between 16-31 N. There were no significant differences between the two materials, but the highest resistance was observed in the C&B Micro resin Filld Hybrid (MFH) using Formlabs form2 printer which is consistent with the minimum masticatory forces developed in mixed dentition 26.21-41.5 N for males and 8.05-12.61 for females.

Conclusions: Given the importance of dental aesthetics nowadays, 3D printing offers the possibility to manufacture an aesthetic dental space maintainer device with a better adaptation to the clinical situation. The mechanical properties being closely related to the object design, it is important to ensure a sufficient thickness of the device to prevent fractures under the masticatory forces.

https://doi.org/10.1016/j.dental.2021.12.053

24

Mechanical Properties of Dental Composites Aged in Different Media

K. Mondal, E.P. O'Brien, C. Chen,
J.L. Drummond *, L. Hanley, K.J. Rockne

University of Illinois, Chicago, USA
* *Corresponding author.*

Purpose/Aim: Resin based dental composite materials have become the most commonly used restorative material due to their biocompatibility, mechanical properties, and excellent aesthetics. However, exposure to different corrosive constituents of saliva and mechanical loading, limit their service life in the oral cavity The objective of this project was to investigate the effect of long-term ageing of resin based dental composites in different in vitro solutions for different time periods.

Materials and Methods: Mechanical properties: diametral tensile strength (DTS), push-out strength (POS), and stiffness(S) were measured for a micro-hybrid composite (Alelite, Bisco, USA) following ageing in four different environmental conditions (air (A), artificial saliva(AS), esterase enzyme in artificial saliva(Enz +AS), and deionized water (DI) for three different aging times (120, 150, and 180 days). The composite (0.25 gr were light cured in an epoxy ring, (6.3 mm diameter x10 mm length) simulating an occlusal restoration.

Results: DTS decreased in all the liquid media whereas the opposite trend was found for POS. ANOVA analysis, media versus time, showed a significant difference for DTS and POS, but no difference in S. The absorption of water explains and shrinkage the effect on DT and POS from the air control.

Conclusions: Aging in in vitro media effects the mechanical properties of resin based composite restorative materials. Additional studies are being done on the potential leaching of polymers in the different solutions.

Acknowledgments: Funding was provided by NIH/NIDCR (Grant R01-DE027596).

https://doi.org/10.1016/j.dental.2021.12.054

Table 1. Means (SD) of diametral tensile strength, stiffness, and push-out strength

Diametral Strength (MPa)	120 Days	150 Days	180 Says
Air	57.68 (3.31)	53.85 (6.00)	50.12 (7.94)
AS	46.16 (9.38)	36.24 (4.17)	43.25 (5.50)
Enz +AS	43.48 (5.51)	40.21 (4.08)	40.68 (8.47)
DI	48.07 (8.22)	40.58 (6.20)	45.77 (8.70)
Stiffness (GPa)	120 Days	150 Days	180 Days
Air	1.35 (0.20)	1.40 (0.25)	1.37 (0.20)
AS	1.33 (0.34)	1.14 (0.18)	1.38 (0.14)
Enz +AS	1.34 (0.21)	1.21 (0.19)	1.33 (0.29)
DI	1.13 (0.12)	1.10 (0.15)	1.20 (0.18)
Push-out Strength (MPa)	120 Days	150 Days	180 Dys
Air	0.86 (0.12)	0.90 (0.24)	0.71 (0.37)
AS	0.86 (0.20)	1.60 (0.50)	1.01 (0.35)
Enz +AS	1.31 (0.31)	1.60 (0.53)	1.22 (0.24)
DI	1.37 (0.62)	1.84 (0.58)	1.23 (0.35)

25

Analysis of Indirect Restorative Materials Submitted to Different Conditioning Protocols

M.E. Queiroz [1,*], G.Q. Lima [1], H.B.S. Sahyon [1], A.T. Maluly-Proni [1], J.A. Delben [2], P.H. Dos-Santos [1]

[1] *Department of Dental Materials and Prosthodontics, State University of Sao Paulo "Julio De Mesquita Filho" (UNESP), Aracatuba, Sao Paulo*
[2] *Department of Dentistry, Western Parana, State University, Cascavel, Parana*
[*] *Corresponding author.*

Purpose/Aim: The aim of this study was to evaluate the influence of hydrofluoric acid application time and concentration on bond strength and surface morphology of three indirect restorative materials.

Materials and Methods: Samples measuring 4x4x0.8 mm were obtained from three materials (lithium monosilicate reinforced by zirconia - Celtra Duo, nanoceramic resin - Lava Ultimate and hybrid ceramic - Vita Enamic). These materials were conditioned with hydrofluoric acid at concentrations of 5% or 10% for 20, 40, 60 or 90 seconds. In addition, a control group was adopted, in which no conditioning was performed, totaling 9 groups for each material. The analysis of bond strength was performed using the microshear test (n=6). For this purpose, cylinders of Variolink Esthetic LC resin cement were made on the conditioned samples, using a silicone matrix. The test was performed in a mechanical testing equipment, in which the samples were fixed and with the aid of an orthodontic wire, tension was applied to the cylinders. Bond strength data were submitted to two-way ANOVA and Tukey's test (α=0.05). The surface microstructure of each material was observed through images obtained by the technique of scanning electron microscopy (SEM) (n=2).

Results: Celtra Duo presented better bond strength values when subjected to etching with 10% hydrofluoric acid for 40, 60 and 90 seconds. For Lava Ultimate, better results were obtained with application of 10% acid concentration for 20 and 40 s, while Vita Enamic showed better results after application of 5% hydrofluoric acid for 40 and 90 seconds and at 10% for 20 and 40 s. Through the images obtained by the technique of scanning electron microscopy (SEM) it was possible to observe the appearance of irregularities on the surface of each material evaluated after conditioning.

Conclusions: The evaluated restorative materials showed different behaviors after conditioning protocols with hydrofluoric acid, therefore, the professional must adopt the best hydrofluoric acid concentration and time protocol for each specific material in order to obtain a satisfactory and effective adhesive procedures.

https://doi.org/10.1016/j.dental.2021.12.055

26

Coulometric Karl-Fischer-Titration of Water in CAD/CAM Chairside Composites

A.L. Faria-E-Silva [1,2,*], L. Heckel [2], R. Belli [2], U. Lohbauer [2]

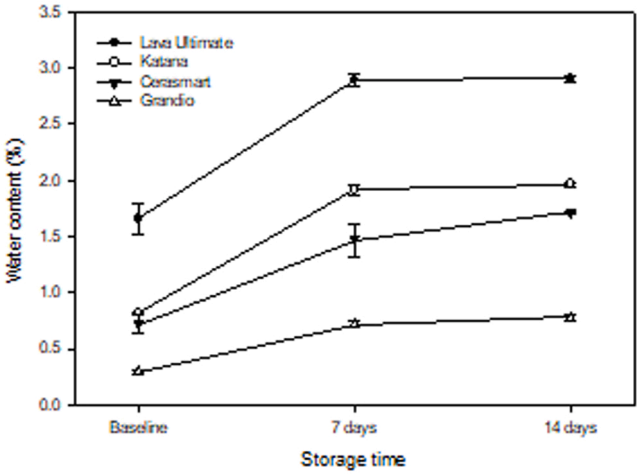
[1] *Federal University of Sergipe, Brazil*
[2] *Friedrich-Alexander University of Erlangen-Nurnberg, Germany*
[*] *Corresponding author.*

Purpose/Aim: This study aimed to evaluate the water sorption of CAD/CAM chairside composites over 21 days using coulometric Karl-Fischer (KF) titration

Materials and Methods: Rectangular plates (10 ×10 x 1 mm of thickness) were cut from the blocks of composites Cerasmart 270 (CS), Katana Avencia Block (KA), Grandio Blocs (GB) and Lava Ultimate (LU) (n = 15). Five specimens of each material were evaluated without any water storage, and the remaining was stored in distilled water for 7 or 21 days at 37 C. Coulometric KF titration of evaporated water content from specimens heated at 200 C (Isothermal) was carried out to measure the water content. The water vapor was transferred to a methanol solution in the Coulometer throughout a nitrogen gas flow. The mass of extracted water was measured in real-time until reach a drift of 5 g/min. Data were analyzed by 2-way ANOVA and Tukey`s post hoc test (α = 0.05).

Results: The water content of non-stored specimens ranged from 0.29 0.01% (7.1 0.3 μg/mm^3) to 1.66 0.14% (33.9 2.3 μg/mm^3) for GB and LU, respectively. The water content increased for all materials after 7 days (ranged from 0.72 0.03% to 2.90 0.06%) in water but storing the specimens for further 14 days only increased the content for CS (from 1.47 0.15% to 1.71 0.01%). After 21 days in water, the lowest water sorption was observed for GB (10.9 μg/mm^3) and the other materials absorbed approximately 20.0 μg/mm^3. The variation coefficient of readings reduced from the non-stored specimens (4.9-11.8%) toward specimens stored for 21 days (0.8-3.1%).

Conclusions: Chairside composites present some base water content that is not measured by ISO 4049. KF titration demonstrates to be a reliable method to measure the water sorption of composites, including their base content. Further studies are required to determine the effect of water sorption on hydrolytic expansion and expansion stress of these materials.



https://doi.org/10.1016/j.dental.2021.12.056

27

Efficacy of Popular Natural Dental Bleaching Products on Dental Enamel

C.R.O. Maciel, R.F.L. Oliveira *, A.A. Amorim, F.C.P. Pires-De-Souza

University of Sao Paulo, Ribeirao Preto, Brazil
* *Corresponding author.*

Purpose/Aim: The aim of this study was to evaluate the effect of natural products used empirically for dental bleaching on the color alteration (ΔE00), whitening index for dentistry (WID), surface gloss and microhardness of dental enamel.

Materials and Methods: For this study 70 fragments of bovine teeth (6x6x2mm) were obtained and separated in five groups (n=14), according to the product used for the treatments: G1 (conventional toothpaste), G2 (charcoal), G3 (curcumin), G4 (banana peel) and G5 (16% carbamide peroxide gel). Initial color (Easyshade, VITA), surface gloss (Micro-Gloss 45, BYK Gardner), and microhardness (Micro Hardness Tester HMV-2, Shimadzu) readings were performed. For G1 to G4, treatments were performed using a simulated toothbrushing machine where the samples were brushed for 560 cycles (14 day of brushing T1) and 1200 cycles total (simulating 30 days of brushing T2). New readings were obtained after T1 and T2. For the G5 group, the treatment with carbamide peroxide gel were submitted on the fragments during 4 hours/day for 14 days, and then final readings were obtained.

Results: Regarding EΔ00, only G5 showed difference from other groups ($p>0.5$). For the WID analysis, after 14 days G3 (curcumin) showed lower whitening efficacy ($p>0.5$), and after 30 days there was no difference between groups ($p<0.5$) except for the carbamide peroxide group. Banana peel, curcumin and carbamide peroxide caused a decrease in the enamel gloss values after T1, different ($p>0.5$) from the charcoal and toothpaste groups. Charcoal resulted in the higher gloss values in T2, different ($p>0.5$) from all groups, except toothpaste. Carbamide peroxide showed the lower microhardness values, similar ($p<0.5$) to the banana peel and curcumin groups.

Conclusions: Considering the results found, it can be concluded that natural products that have been used for dental bleaching purposes did not present effectiveness on the enamel color alteration. Furthermore, banana peel and curcumin caused a decrease in microhardness similar to carbamide peroxide.

https://doi.org/10.1016/j.dental.2021.12.057

28

Spark Plasma Sintered Zirconia-Mica Glass-Ceramics for Dental Restorations

S. Gali [1,*], S. Gururaja [2], S. Srikari [1]

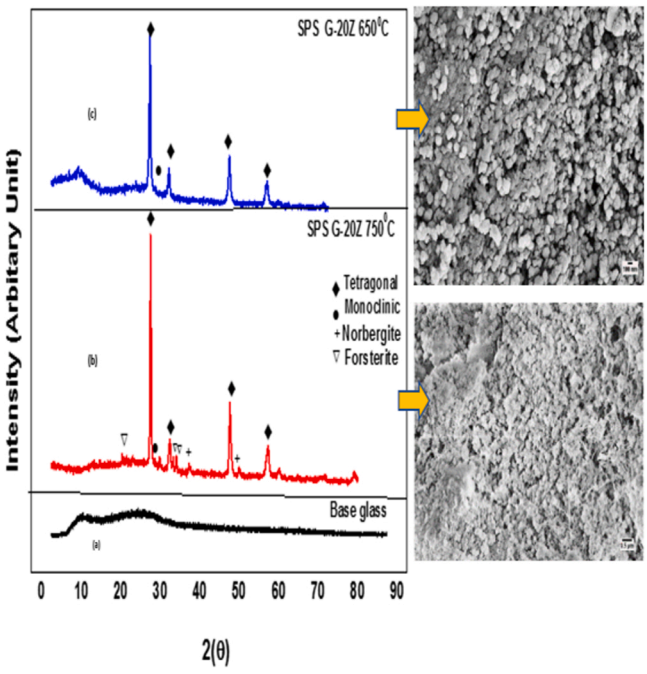
[1] *M.S. Ramaiah University of Applied Sciences, India*
[2] *Auburn University, USA*
* *Corresponding author.*

Purpose/Aim: Prospects of a dental restorative material are dictated by clinically relevant properties such as mechanical properties, wear behaviour, chemical solubility, thermal properties, cytocompatibility and optical properties. Preliminary studies on 20 wt.% zirconia reinforced mica glass-ceramics processed using conventional sintering technique have shown good machinability, cytocompatibility, chemical durability and optimal fracture toughness. Use of conventional sintering technique, however had limitations of porosity, low density and low coefficient of thermal expansion with long heat treatment schedules. Spark plasma sintering (SPS) technique is a pressure assisted sintering method that uses pressure, temperature and current simultaneously to densify ceramics. SPS has advantages of reduced sintering temperature, faster heating rates and shorter holding times. The key goal of the project is to develop a spark plasma sintered ceramic composite consisting of 20 wt.% zirconia-mica glass-ceramics for dental restorations.

Materials and Methods: Precursor powders of mica base glass composition (44.5 SiO_2-16.7 Al_2O_3-9.5 K_2O-14.5 MgO_8.-5 B_2O_3-6.3 F (wt.%)) were ball milled in a zirconia jar with ethanol as milling medium at 300 rpm for 6 h to ensure homogenous mixing. The ball milled glass powder was remelted thrice in a platinum crucible and quenched in cool, deionised water to obtain the glass frit. The glass frit powder was further ball milled with 20 wt.% of 3 mol% yttria stabilized zirconia (YSZ) for homogeneity. The mixture was subjected to SPS under 50 MPa compressive stress with a heating rate of 1000 C/min and holding at sintering temperatures of 6500 and 7500 C for 5 min, to promote densification and mica crystal growth. Phase analysis of sintered samples using X-ray Diffraction (XRD) and microstructural characterisation using Scanning Electron Microscopy (SEM) was carried out to determine morphology and major phases.

Results: Amorphous hump in XRD confirms the base glass nature of mica. At 6500 C, glassy amorphous phase

with tetragonal and monoclinic peaks of zirconia were observed. At 7500 C, minor peaks of norbergite and forsterite with tetragonal and monoclinic phases of zirconia, were observed (Fig. 1). SEM images revealed distinct spherical particles at 6500 C and fused glass matrix at 7500 C (Fig. 1). Density of sintered ceramics at 7500 C (2.75 g/cc) was higher than 6500 C (2.25 g/cc).



Conclusions: SPS of 20 wt.% zirconia-mica glass-ceramics requires high temperature (>7500 C) to initiate fluorphlogopite crystals and obtain higher densification. Effect of SPS on porosity of sintered ceramics using Micro-CT, microhardness and indentation fracture toughness of 20 wt.% zirconia-mica glass -ceramics will be further investigated.

https://doi.org/10.1016/j.dental.2021.12.058

29

Influence of Bromelain and Biosilicate on Adhesive Bond Strength

R Geng Vivanco*, FCP Pires-De-Souza

University of Sao Paulo, Brazil
** Corresponding author.*

Purpose/Aim: This study evaluated the effect of bromelain associated with Biosilicate on the bond strength (BS) of composite restorations to sound and caries-affected dentin.

Materials and Methods: 360 sound human molars were selected, and occlusal cavities (6 mm×6 mm x 3 mm) were prepared using carbide burs. Half of them were submitted to cariogenic challenge with Streptococcus mutans strain ATCC25175. All the teeth were separated into nine groups (n = 20), according to the treatment received before the adhesive system (Single Bond Universal, 3 M ESPE): Control group Adhesive System (two coats in self-etch mode); CHX group 0,12% chlorhexidine; NaOCl group 5% sodium hypochlorite; Bio group 10% Biosilicate; Br5 group - 5% bromelain; Br10 group - 10% bromelain; Br5Bio group 5% bromelain + 10% Biosilicate; Br10Bio group 10% bromelain + 10% Biosilicate; NaOClBio group 5% sodium hypochlorite + 10% Biosilicate. After restorative procedures (Filtek Z350XT, 3 M ESPE), the samples were sectioned into sticks, separated, and stored in distilled water at 37 C for 24 h. After that, the sticks were submitted to microtensile test (0.5 mm/min). Data were analyzed using 2-way ANOVA and Bonferronis test ($p < .05$). The fracture pattern was observed with digital microscope (VH-M100).

Results: The caries-affected dentin presented higher BS ($p < .05$) than the sound substrate under control conditions and when the surface was treated with Biosilicate. Among the sound samples, there was no difference ($p > .05$), regardless of the treatment employed. In the caries-affected samples, Control and Br10 groups resulted in higher ($p < .05$) BS than Br5Bio group, with no difference ($p > .05$) between them. Br10 group also demonstrated higher values ($p < .05$) than Br10Bio group. The other groups showed no difference ($p > .05$). Both substrates presented higher incidence of non-adhesive fractures irrespective of the treatment.

Conclusions: The pre-treatments with bromelain and bioactive glass-ceramic can affect the bond strength of composite restorations to sound and caries-affected dentin.

https://doi.org/10.1016/j.dental.2021.12.059

30

Clinical Efficacy of GIC in Treatment of Occlusal MIH Lesions

R.G. Palma-Dibb[1], L.A. Pion[1], J.J. Faraoni[1], I.B. Quero[1], D. Hesse[2], A.M. Queiroz[1], F.M. Carvalho[1]

[1] *FORP/University of Sao Paulo, Brazil*
[2] *Academisch Centrum Tandheelkunde Amsterdam, Nederlands*

Purpose/Aim: The aim of this study was to evaluate clinical efficacy of glass ionomer cement (Equia Forte - GC) in the treatment of hypomineralized occlusal lesions in enamel on permanent first molars affected with HMI as a sealant.

Materials and Methods: It conducted standardized clinical study approved by the ethics committee of the institution. Children were selected (6-10 years) with clinical diagnosis of MIH and with involvement of the first permanent molars with hypomineralized lesion in enamel (without involvement of dentin). After parental consent, the teeth were isolated, cleaned and sealed with the Equia Forte (GC) following the manufacturer's instructions. Then the teeth were evaluated at baseline (immediately) and after 1, 6, 12, 18 and 24 and 30 months. As outcome was assessed the presence of caries, the sealing and our

Table 1 – Percentual the survivor of glass ionomer sealant over time and caries lesion presence.

	Sealant presence	Partial sealant presence	Sealant absent	caries lesion
Initial	100%	0%	0%	0%
1st month	93.33%	6.67%	0%	1.67%
6th month	79.63%	20.37%	0%	0%
12th month	85.71%	14.29%	0%	0%
18th month	54.55%	45.45%	0%	9.09%
24th month	80%	20%	0%	0%
30th month	62.5%	31.25%	16.25%	0%

maintain, and dental sensitivity over time. Data analysis was descriptive, as the over time analysis (after 12 months) was affected by the pandemic.

Results: Thirty-one patients were selected, and 65 teeth were evaluated, however, over time, there were significant sample losses, and after 1 year it was not possible to evaluate all patients due to the pandemic. By the 6th month, 90% of the volunteers returned with 100% of total or partial retention of the sealant. After 12 months, we had inconsistent returns, and after 30 months only 16 restorations could be evaluated, with 83.75% of partial or total retention of the sealant. Dental sensitivity was reduced after tooth sealing and practically became very low over time. Only 2 tooth presented recurrent caries.

Conclusions: It is concluded that the use of high viscosity glass ionomer cement can be a viable alternative to be used in hypomineralization occlusal lesion in enamel due to MIH. (Table 1)

Support by FAPESP 2019/06978-9.

https://doi.org/10.1016/j.dental.2021.12.060

31

18-Month Clinical Performance of a Bulk-Fill Composite Resin In NCCLS

L. Guerra [1,*], N.F. Coelho Neta [1], V.C. Ruschel [1], C.L. Baratieri [1], R. Walter [2], S. Monteiro Junior [1]

[1] *Federal University of Santa Catarina, Brazil*
[2] *University of North Carolina, USA*
[*] *Corresponding author.*

Purpose/Aim: To evaluate the clinical performance of a bulk-fill composite resin in the restoration of non-carious cervical lesions (NCCLs) during 18 months of clinical service, and to compare its performance to other commercially available materials.

Materials and Methods: Eighteen subjects in need of 143 restorations participated in the study. NCCLs were randomly assigned to three groups to be restored with 1) Durafill VS (Heraeus Kulzer); 2) Z100 (3 M Oral Care); or 3) SureFil SDR flow + (Dentsply Sirona). The internal aspect of the NCCLs were roughened with a diamond and Clearfil SE Bond 2 was applied following the selective etching protocol. Durafill VS and Z100 were inserted in increments that were up to 2 mm in thickness. The bulk-fill composite resin SureFil SDR flow + was applied in a single increment of up to 4 mm. Materials were light-activated according to the manufacturers recommendations and finished/polished immediately after placement. Restorations were performed by a single operator and were evaluated immediately after completion, and after 18 months by two independent evaluators. The clinical characteristics evaluated using the modified USPHS assessment criteria were retention, marginal adaptation, marginal discoloration, second caries, shade match, and texture.

Results: All subjects were available for the 18-month evaluation. No restoration failed (no Charlie score) during the 18 months of clinical service. All restorations scored Alfa for retention and secondary caries. For marginal adaptation, the percentage of Alfa scores at 18 months was 77% (33/43) for DuraFill VS, 71% (37/52) for Z100, and 73% (35/48) for SureFil SDR flow +. In regard to marginal discoloration, 53% (23/43) of the Durafill VS restorations, 71% (37/52) of the Z100 restorations, and 65% (31/48) of the SureFil SDR flow + restorations were able to maintain the Alfa score during the 18-month evaluation. For shade match and texture, respectively, percentages of Alfa score at 18 months were 74% (32/43) and 58% (25/43) for Durafill VS; 73% (38/52) and 56% (29/52) for Z100; and 79% (38/48) and 58% (28/48) for SureFil SDR flow +.

Conclusions: Restorations placed with Durafil VS, Z100, and SureFil SDR flow + showed acceptable clinical performance as no restoration failed during 18 months of clinical service. The implication of the Bravo scores during the first 18 months of clinical service in the longevity of the restorations at this time is unknown.

https://doi.org/10.1016/j.dental.2021.12.061

32

A New 3D Volume-Based Method for Assessing Composites Curing Depth

S. Gummadi [*], J.-F. Roulet, M.G. Rocha

Department of Restorative Dental Sciences, University of Florida, Center of Dental Biomaterials, Gainesville, Fl, USA
[*] *Corresponding author.*

Purpose/Aim: Develop a new method to evaluate the curing depth of conventional and bulkfill composites based on the total volume of cure (VOC) and compare to the ISO 4049 depth of cure standard (DOC) with different mold diameters.

Materials and Methods: A total of 100 samples were made from 2 bulkfill composites and 2 conventional

resin-based composites, 25 samples for each material, with 5 samples per diameter of 10 mm, 8 mm, 6 mm, 4 mm, and 2 mm using stainless steel molds of 10 mm length. An individually designed 3D printed frame was attached to a metal plate using stainless steel screws in order to secure a fixed position of the molds in relation to the Valo cordless LED LCU which was clamped to the metal plate with an adjustable arm. ISO DOC was measured according to ISO 4049. Then the domed cylinders were scanned and the VOC % was measured in the Autodesk Meshmixer software using the STL files obtained from the scanned data using a E4D planmeca scanning device. Geomagic software was used for 3D comparison of curing profiles of 10 mm diameter samples. Two-way analysis of variance (ANOVA) and Tukeys test for pairwise comparison was used to analyze the data. A difference plot assembled in the geomagic software was used for 3D comparison of curing profiles

Results: ISO 4049 method that measures the center of the specimen does not represent the full potential of the LCU. With a 10 mm ⌀ window of the LCU, 10 mm, 8 mm and 6 mm molds give identical results for DOC and VOC%. The difference between the bulkfill and regular composites was significant ($p<0.05$); bulkfill DOC was between 1.9x (Filtek) and 2.4x (Tetric) higher than for the regular composites. DOC and VOC% are both negatively influenced by smaller mold diameter ($p<0.05$). The non-homogenous nature of the LCU did not influence the VOC% and DOC. The non-homogenous nature beam profile of the LCU unit had an influence on the 3D curing profiles of the specimen, which can be explained with the higher absorption of the violet light from the composite

Conclusions: Most of contemporary LCUs have diameters of the light exiting window >4 mm. since there were significant differences in DOC between ⌀ 6 mm and ⌀ 4 mm molds. ISO 4049 under-represents the DOC. The influence on the LCUs curing profile on ⌀ 6 mm molds should be investigated in the future. The experiment should be repeated with other LCUs than the one used in this study.

Results for the ISO DOC and volume of cure percent (VOC %) for different mold diameter samples for 4 materials Filtek Bulkfill one(FBO), Tetric Powerfill(TPF), Filtek Supreme (FS), and Tetric Prime(TP).

https://doi.org/10.1016/j.dental.2021.12.062

Ø	Filtek Bulkfill One (FBO)						Tetric Powerfill (TPF)						Filtek Supreme (FS)						Tetric Prime (TP)					
	ISO DOC			ISO DOC			ISO DOC			VOC%			ISO DOC			VOC%			ISO DOC			VOC%		
	Avg	SD	Tuk	Avg	SD	Tuk	Avg	SD	Tuk	Avg	SD	Tuk	Avg	SD	Tuk	Avg	SD	Tuk	Avg	SD	Tuk	Avg	SD	Tuk
10 mm	4.1	0.0	Aa	74.8	0.8	Ba	4.1	0.1	Aa	72.9	1.2	Ba	2.1	0.0	Ba	92.9	2.6	Aa	1.7	0.0	Ca	68.1	2.1	Bb
8 mm	4.1	0.0	Aa	73.6	1.0	Ba	4.0	0.1	Ab	73.5	1.2	Ba	2.1	0.0	Ba	92.9	1.0	Aa	1.7	0.0	Ca	71.9	1.6	Ba
6 mm	3.9	0.0	Ab	71.3	1.3	Ba	3.8	0.0	Bc	68.6	1.6	Bb	2.1	0.0	Ca	93.9	2.9	Aa	1.7	0.0	Da	72.0	1.2	Ba
4 mm	3.2	0.1	Ac	62.3	2.7	Bb	3.0	0.1	Bd	61.6	1.7	Bc	1.9	0.1	Cb	85.2	0.9	Ab	1.6	0.0	Db	66.1	1.7	Bb
2 mm	2.1	0.1	Ad	41.4	3.2	Cc	2.2	0.2	Ae	57.3	6.0	Bd	1.3	0.0	Bc	66.9	7.1	Ac	1.2	0.1	Cc	54.1	3.6	Bc

2way ANOVA and Tukeys test for pairwise comparison - $p< 0.05$. Statistically, smaller case letters compare means within the columns (diameter) and capital letters compare means within the rows (RBC materials).

33

Colour Stability of Maxillofacial Silicone Mixed with Nano-Sized Anti-Microbials

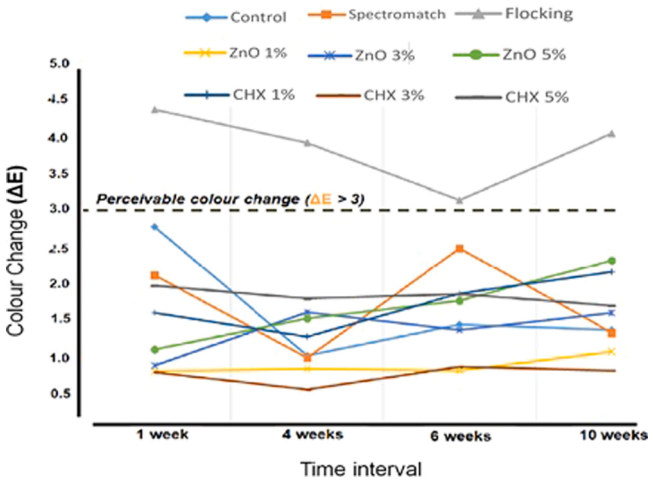
M.M. Hatamleh

Luminus Technical University College

Purpose/Aim: Maxillofacial prostheses in clinical service become contaminated by oral and skin microflora, thus requiring replacement after only a short period. Our earlier work showed mixing silicone with anti-microbial additives such as Chlorohexidine diacetate Salt (CHX) or ZnO has beneficial antibacterial/fungal effects. However, their effect on silicone colour stability and longevity is unknown. This study aimed to investigate the effect of two different anti-microbial additives (ZnO and CHX) at three difference concentrations (1, 3, and 5%) on the colour stability of maxillofacial silicone elastomer.

Materials and Methods: A commonly used maxillofacial silicone elastomer (M511, Technovent, UK) was mixed with nano-particulate additives: ZnO and CHX at 1, 3 and 5% concentrations (w/w). Specimens were packed inside disc-shaped steel moulds (40 mm diameter and 0.5 mm height). The materials were cured for 1 h at 100 °C. Smaller silicone discs (10 mm diameter) were also produced and incubated at 37 °C. Additional test groups were produced from digitally recorded silicone (Spectromatch System Ltd, London, UK), and manually mixing silicones with colour flocking. Ten specimens per concentration were produced and colour measurements were conducted using colorimeter (Minolta Chroma Meter CR-221, Osaka, Japan) according to the CIELAB coordinates with a D65 standard light source. They were performed at 0, 1, 4, 6, and 10 weeks. One way ANOVA and Tukey post-hoc test were followed to detect statistical significances in colour change (ΔE) ($p<0.05$).

Results: Significant colour differences were present among the groups over the time interval ($p<0.05$). However, the changes in colour among the two inserts at the three different concentrations were the same ($p>0.05$) and were within the perceivable accepted range (ΔE <3) as shown in Fig. 1.



Conclusions: Current study showed that maxillofacial silicone elastomer mixed with nano-sized anti-microbials up to %5 (by weight) showed acceptable colour stability after 10 weeks.

NA

https://doi.org/10.1016/j.dental.2021.12.063

34

Experimental S-PRG-Filled Composites Prevent Secondary Caries: An In-Vitro Biofilm Model.

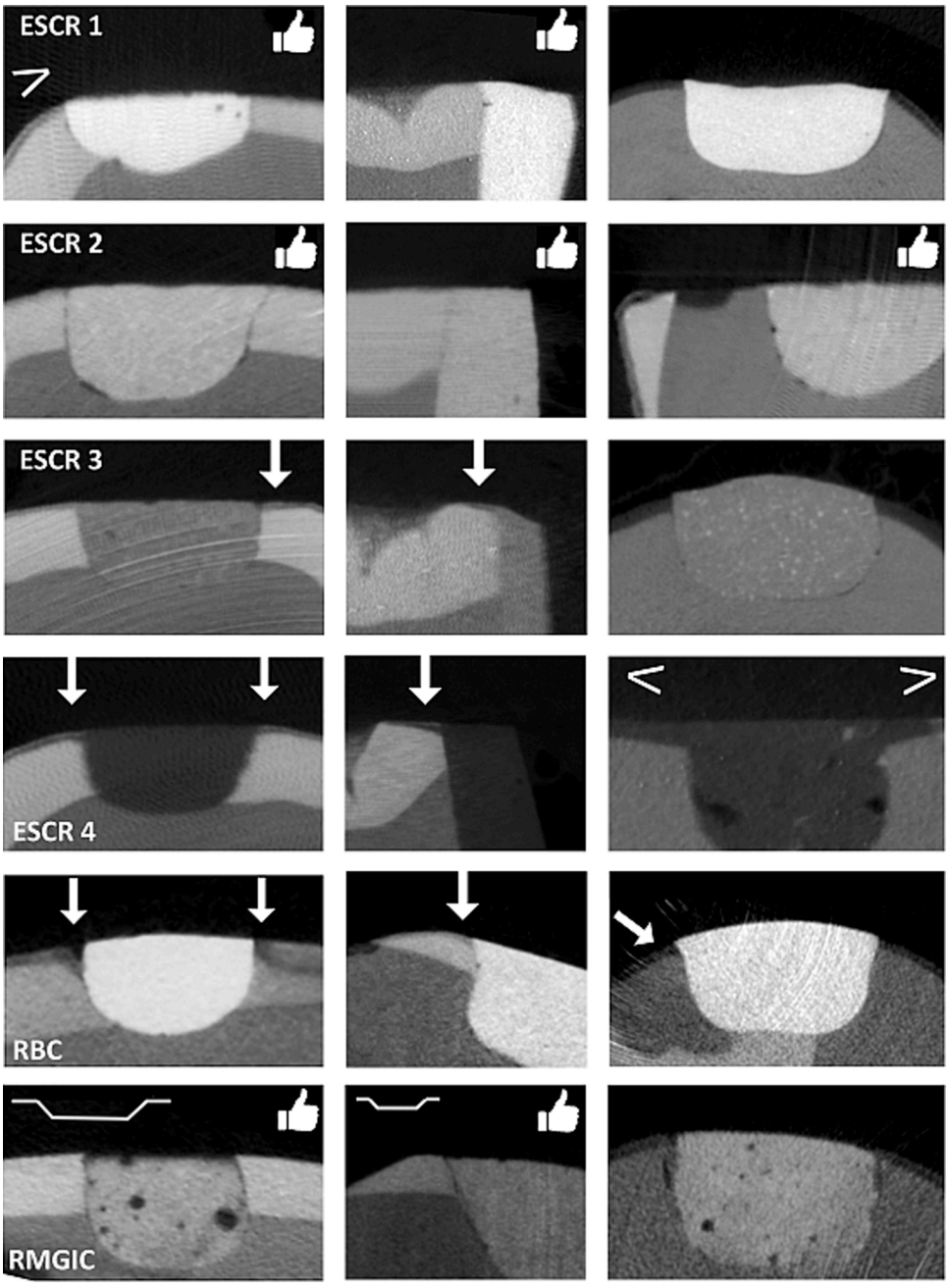
A.C. Ionescu [1,*], F.I. Buhus [1], P. Delvecchio [2], V. Zambelli [2], G. Bellani [2], E. Brambilla [1]

[1] *Surgical and Dental Sciences, Universita degli Studi Di Milano, Milan, Italy*
[2] *School of Medicine and Surgery, Universita degli Studi Di Milano Bicocca, Monza, Italy*
[*] *Corresponding author.*

Purpose/Aim: Secondary caries (SC) are still the main challenge restorative materials have to face. Conventional resin-based composites (RBC) express non-buffering surfaces that increase the risk of developing SC. Bioactive restorative materials may help preventing SC by active interaction with tooth tissues and oral biofilms. This study aimed to evaluate the ability of experimental RBCs containing different amounts of surface pre-reacted glass-ionomer fillers (S-PRG) to prevent SC. An in vitro model of accelerated cariogenic biofilm challenge was used.

Materials and Methods: Sixteen Class-I restorations (3 mm wide, 3 mm deep) were obtained in each of 6 bovine incisors. Nine sound human molars had their root removed 3 mm apical to cemento-enamel junction, and the pulp chamber filled (Filtek Supreme XTE, 3M-ESPE, USA). Four standardized Class-II cavities were made in each tooth having cervical margin in dentin. Cavities were randomly filled with experimental RBCs (ESCR) having BisGMA-TEGDMA resin blend and 70 wt% filler made of either 100% S-PRG (ESCR-1), 65% S-PRG, 35% SiO2 (ESCR-2), 35% S-PRG, 65% SiO_2 (ESCR-3), or 100% SiO2 (ESCR-4). A conventional RBC (Filtek) and resin-modified glass ionomer cement (RMGIC, Ionolux, VOCO GmbH, Germany) served as negative and positive controls. Restorations were finished, specimens were sterilized and stored in artificial saliva (one week). S. mutans biofilm formation on the specimens surfaces was obtained in a continuous flow bioreactor (37 C, 20 ml/h) incubating in 1:25 diluted brain-heart infusion + 5 wt% sucrose for two weeks. pH values of the culture broth and absence of contamination were checked daily. Before and after microbiological procedures, specimens were scanned using micro-CT (Skyscan 1176, 9 m resolution, 80KV, 300 mA). Image reconstruction was performed, and demineralization depths (m) were evaluated at the margins and 1.0 mm from the margins.

Results: pH values stayed constant (4.150.1), and no contamination was observed throughout the incubation time. In bovine enamel, ESCR-1, ESCR-2, and RMGIC showed good protection from demineralization of enamel until ~1 mm distance from the interface. RMGIC showed initial acid erosion. ESCR-3, ESCR-4, and RBC showed secondary caries development that reached maximum lesion depth close to control RBC. All materials displayed the same behavior when placed in human enamel. ESCR-1 and especially ESCR-2 protected from dentine demineralization. ESCR-3 and RMGIC did not protect nor promote dentine demineralization. ESCR-4 and RBC promoted secondary caries on dentine (Fig. 1).


ESCR 1
ESCR 2
ESCR 3
ESCR 4
RBC
RMGIC

Conclusions: S-PRG prevented enamel and dentine demineralization when present in at least 47 wt%. The bioreactor model displayed secondary caries formation in a similar way as in vivo.

https://doi.org/10.1016/j.dental.2021.12.064

35

Battery Sustainability of Budget Light-Curing Units

H.MH. Jamalellail [1,*], I.M. Alshehri [1], R.B. Price [2], A.O. Al-Zain [1]

[1] *Faculty of Dentistry, King Abdulaziz University, Saudi Arabia*
[2] *Dalhousie University, Canada*
[*] *Corresponding author.*

Purpose/Aim: Light-emitting-diode budget light-curing units (LCUs) are classified as medical devices in most countries. These LCUs are required almost every day in most dental offices. Budget LCU manufacturers claim to offer high-quality LCUs that are equivalent to more expensive LCUs, but at a much lower cost. This study assessed the battery performance and the power, irradiance, and radiant exposure values from different budget LCUs over one fully charged battery cycle compared to a more expensive LCU from 3 M.

Materials and Methods: Two types of budget LCUs were purchased over the internet; two (LY-A180, NSKI Cordless LCU, China), two (LED Curing Light, BoNew Cordless LCU, China), and compared to a control LCU (Elipar DeepCure-S, 3 M, USA). All LCUs were fully charged, and their power, irradiance, and radiant exposure were measured with a spectrometer [Managing Accurate Resin Curing-Light Collector (MARC-LC), BlueLight Analytics Inc., Canada] over one entire battery life cycle until the battery ran out. The position of each LCU guide tip was standardized over the MARC-LC top sensor at a 0-mm distance. The measurements were collected over a 10 s exposure time with a 30-second interval between each subsequent exposure cycle. The mean values and percent decrease in values were measured. Data were analyzed using two-way ANOVA followed by Tukey post hoc test (p=0.05).

Results: The mean power, irradiance, and radiant exposure values from the budget LCUs showed fluctuating readings and an overall decrease in output throughout the battery life compared to the 3 M LCU. The budget LCUs measurement values in the first cycle measured mean power values from 205-444 mW, mean irradiance from 533-1154 mW/cm^2, mean radiant exposure 5.3-11.5 J/cm^2. The total number of exposure cycles from the budget LCU ranged from 326-764 cycles. The decrease in mean power, irradiance, and radiant exposure from the budget LCUs ranged from 24-81%. The control 3 M LCU delivered 906.3 mW, 1427.9 mW/cm^2, and 14.3 J/cm^2 in the first cycle and completed 959 exposures cycles. There was a slight 4.9% increase in mean power, irradiance and no changes in its radiant exposure values. Significant differences in measurements were observed among all the budget units except between one NSKI Cordless and one BoNew Cordless LCU.

Conclusions: The light output from the budget LCUs tested from the same and from different manufacturers was inconsistent. These lights were unable to sustain their power, irradiance, and radiant exposure output values. These values were significantly lower than the control LCU.

https://doi.org/10.1016/j.dental.2021.12.065

36

Low Power Laser Debonding: Ceramic Thickness and Irradiation Time

J.J. Ulloa [*], S. Salazar Marocho

Department of Biomedical Materials Science, University of Mississippi Medical Center, USA
[*] *Corresponding author.*

Purpose/Aim: To evaluate the effect of irradiation time, for debonding purposes, on the shear bond strength of yttria-stabilized zirconia (YSZ) irradiated by an erbium-based laser at low power output under body temperature conditions.

Materials and Methods: YSZ square-shaped slices of 0.5 mm, 2 mm, and 3 mm thicknesses were tribochemical silica-coated and cemented to resin composite cylinders with a resin-based cement. Five groups of specimens were tested, one served as the control group (non-irradiated) and the other four were submitted to laser irradiation for 30 s, 60 s, 90 s, and 120 s. After water storage for 24 h, the control and the irradiated group were subjected to shear bond strength (SBS) test. Both, the testing and the irradiation were performed at body temperature. For irradiation, an erbium, chromium: yttrium-scandium-gallium-garnet (Er,Cr:YSGG) laser was used with the following parameters: 1 W, 20 Hz, and 1% of air spray. Optical microscope and scanning electron microscope were used for failure analysis. SBS data were analyzed using two-way ANOVA and Tukey post hoc test to determine significant differences.

Results: Data for irradiated groups are shown in the table. The control group (9.22.4) showed only significant differences with the 0.5 mm group at 30 ($p<0.001$), 60 ($p<0.001$), 90 ($p<0.001$), and 120 s ($p<0.001$). No statistical differences were found between the 2 and 3 mm groups at any irradiation time. The 0.5 mm group presented significantly low bond strength in comparison with the other groups. For the 0.5 mm group, the SBS values were significantly different after 30 and 120 s of irradiation ($p=0.018$), while all the other irradiation times had similar values. All the failures were classified as mixed.

Conclusions: Zirconia SBS in the thickest groups (2 and 3 mm) was not affected by any of the irradiation times tested. Longer irradiation times might reduce the SBS of

thicker zirconia for debonding purposes. For the thin group, any irradiation time decreased the bond strength to the resin cement.

YSZ thickness	Irradiation time	Bond strength in MPa (SD)	n	Time of failure		
				pF	F	D
0.5 mm	30	3.08 (0.96)	15	0	0	0
	60	3.02 (1.54)	13	1	3	1
	90	4.21 (1.87)	13	2	1	1
	120	1.07 (1.27)	13	1	0	9
2 mm	30	9.7 (3.13)	16	0	1	0
	60	9.38 (2.09)	10	0	1	0
	90	10.33 (2.17)	10	0	0	0
	120	9.44 (2.54)	10	0	0	0
3 mm	30	10.02 (3.31)	14	0	0	0
	60	9.91 (1.52)	10	0	0	0
	90	9.75 (3.45)	10	0	3	0
	120	9.18 (2.43)	10	0	1	0

n= sample size, pF= pre-test failure, F= failed during test, D= debonded while irradiating.

https://doi.org/10.1016/j.dental.2021.12.066

37

Development of Antibacterial Resin Composites Containing a QAC-Based Monomer METAC

T. Kohno *, R. Tsuboi, H. Kitagawa, S. Imazato

Osaka University Graduate School of Dentistry, Suita, Osaka, Japan
* *Corresponding author.*

Purpose/Aim: It has been reported that an adhesive resin or resin sealants containing a quaternary ammonium compound (QAC)-based monomer 2-(methacryloyloxy) ethyl]trimethylammonium chloride (METAC) demonstrated contact inhibition of Streptococcus mutans on their surfaces. In this study, resin composites incorporating METAC was newly fabricated, and the antibacterial and anti-biofilm effects were evaluated by in vitro and in situ tests.

Materials and Methods: An experimental resin composites (EX) was prepared by adding 6 wt% of METAC to a commercialized Bis-MEPP-based resin composites (GRACEFIL ZeroFlo, GC; GZ). To evaluate the antibacterial effects in vitro, 50 μL of S. mutans NTCT10449 or S. sobrinus ATCC 33478 suspension at 1.0 × 10^5 CFU/mL was inoculated on the disc-shaped cured specimen, and the number of viable bacteria was determined after 24 hours incubation by colony counting. To evaluate inhibitory effects against biofilm formation in situ, the specimens were fixed in the region of upper premolars and molars of 4 volunteers using a custom-made acrylic splint. The specimens were collected after 24 hours, and the biofilm formed on the surface was observed and analyzed by using a confocal laser scanning microscopy with LIVE/DEAD staining. GZ was used as a control.

Results: For both S. mutans and S. sobrinus, the numbers of surviving cells on EX (mean values; 1.3 × 10^2 CFU and 2.3 × 10^2 CFU, respectively) were significantly smaller than those on GZ (mean values; 9.3 × 10^5 CFU and 4.0 × 10^4 CFU, respectively) ($p < 0.05$, Student's t-test, $n = 3$), and less than the initial bacterial amount (5.0 × 10^3 CFU). The thickness of biofilm formed in situ on EX (17.2 μm) was significantly smaller than that on GZ (30.5 μm) ($p < 0.05$, Students t-test, $n = 4$). Additionally, the volume fraction of bacteria with intact cell membrane in the biofilms formed on EX was 20% and significantly less than GZ which showed 67% ($p < 0.05$, Students t-test, $n = 4$).

Conclusions: The newly fabricated resin composites containing the QAC-based antibacterial monomer METAC exhibited the bactericidal effects against oral bacteria on its surface. Moreover, due to such contact killing effects, the experimental composites could inhibit biofilm formation in the oral environment.

https://doi.org/10.1016/j.dental.2021.12.067

38

Hydrofluoric-Acid Etching: Successful Pretreatment of Resin-Composite Block with Universal Adhesives

M Koko [1,2,*], J Tagami [1], A Abdou [3]

[1] *Tokyo Medical and Dental University, Japan*
[2] *University of Dental Medicine, Myanmar*
[3] *Modern University for Information and Technology, Egypt*
* *Corresponding author.*

Purpose/Aim: The purpose of this study was to evaluate the effect of different surface treatments on micro-shear bond strength of a computer-aided design/computer-aided manufacturing resin-composite block (RCB) after 24 hours and thermocycling when the bonding surface pretreated using hydrofluoric acid (HF) compared to Monobond Etch & Prime (MEP) with different universal adhesives.

Materials and Methods: Dispersed filler (DF-RCB) slaps (Estelite-P, Tokuyama Dental) were polished with 600-grit SiC paper, water rinsed and dried. The RCB slaps were then divided into two groups based on surface treatment: (A) those treated with 9.6% HF (Porcelain Etchant, Bisco) for 20 s and then rinsed off under running water for 60 s; (B) those treated with Monobond Etch & Prime (Ivoclar Vivadent) for 20 s and then rinsed off with water for 60 s. Afterwards, the adherend surfaces were treated with the four universal adhesives (Adhesive Universal, Ivoclar Vivadent; ADU), (Beautibond Universal, Shofu; BBU), (Optibond Universal, Kerr; OBU), (Prime&Bond Universal, Dentsply;

PBU) according to manufacturers instructions. Subsequently, a resin cement (Panavia V5, Kuraray Noritake Dental) was filled into Tygon tube (a diameter of 1 mm and a height of 2 mm) and adhered to the surface at seven or eight different spots on each RCB slap. Micro-shear bond strength (μSBS) test was performed after 24 hours (24 h) and 10,000 thermocycling (TC) process. A scanning electron microscope (JM-IT100, JEOL Ltd) at 90x magnification was used to examine the failure surface following μSBS measurement. Parametric survival regression with Weibull distribution were used to evaluate the effect of different parameters on μSBS data.

Results: The use of HF as surface pretreatment significantly improved the μSBS ($p < .001$) while thermo-cycling decreased μSBS significantly ($p < .001$). On the other hand, there was no significant difference in adhesives ($p = .071$). There was no difference between HF and MEP for different adhesives tested before and after TC except with BBU, where HF showed higher μSBS after TC. In the failure mode analysis, there was no difference between tested groups; the adhesive failure was predominant at 24 h while the mixed failure increased for all groups after TC. The Weibull plots of shear bond strength data of universal adhesives between HF and MEP at 24 h and TC are shown in Fig. 1.

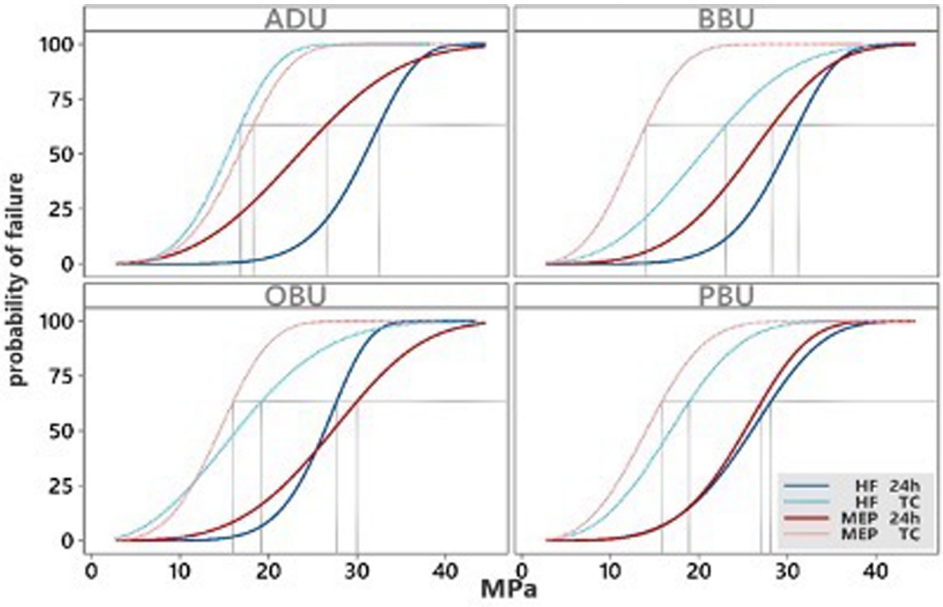


Figure 1: The Weibull survival graphs of the microshear bond strength (MPa) of the different groups after 24h and after thermocycling (TC). A reference line at 63.2% probability of failure, which was used to compare the characteristic strengths of the groups intersecting with probability plots for tested groups.

Conclusions: The surface of DF-RCB pretreated with 9.5% hydrofluoric acid is better than MEP. Different universal adhesives with various formulations were successfully achieved a consistent bond strength.

https://doi.org/10.1016/j.dental.2021.12.068

39

Properties of Printed Zirconia Using Suspension Enclosing Projection Stereolithography

J. Lensing [1,*], F. Fei [2], W. Pei [3], X. Song [2], E.C. Teixeira [1]

[1] *Operative Dentistry, University of Iowa, Iowa City, USA*
[2] *Engineering, University of Iowa, Iowa City, USA*
[3] *Biostatistics, University of Iowa, USA*
[*] *Corresponding author.*

Purpose/Aim: To evaluate the feasibility of using suspension enclosing projection stereolithography (SEPS) in printing zirconia dental restorations. Different from most AM processes, this technique is capable of printing overhanging shapes without the need of support structures.

Materials and Methods: A zirconia material (3 M Lava Esthetic, 5%mol zirconia), commonly used to mill zirconia dental restorations, and two experimental printed zirconia groups were analyzed regarding flexural strength, hardness, and microstructure. Thirty-two bar-shaped (n=16) specimens were printed using SEPS from 5% mol yttria zirconia powder (Zpex-Tosoh, Japan) and a photopolymerizable resin from an STL file, at a 70:30, and at a 75:25 ratio. Specimens were cured for 10 minutes, then debinded and sintered. Sixteen specimens were sectioned from zirconia pucks (control) and sintered using a heating, holding, and cooling cycle. Three-

point bending test was performed for all 48 specimens using a universal testing machine at 0.5mmm/min cross-head speed. Knoop hardness measurements were performed, using a load of 200 g for 15 s for both groups (n=8). The average of two measurements was recorded.

Results: An Independent-Samples Kruskal-Wallis Test was performed to test the flexural strength among the groups. A statistically significant difference was observed for the milled group($p<0.003$). The microhardness was not significantly different among groups ($p= 0.29$, One-way ANOVA).

Conclusions: SEPS showed to be a feasible technique to produce zirconia specimens. SEPS produced zirconia showed favorable microhardness properties for dental application. However, SEPS specimens had significantly reduced flexural strength when compared to the control, in particular for the 75% group. Further research is necessary to optimize the debinding and sintering settings when using SESP to print zirconia structures.

	Control	SEPS 70%	SEPS 75%
Flexural Strength (MPa)	417.2 (55.4) *	70.4 (28.7)	25.3 (33.2)
Microhardness (Knoop)	56.9 (17.3)	50.6 (5.9)	50.3 (10.0)

https://doi.org/10.1016/j.dental.2021.12.069

40

Toughening Via Revitrification of Li_2SiO_3 Crystals in Obsidian

J. Lubauer [1,*], K. Hurle [2], M.R. Cicconi [3], A. Petschelt [1], U. Lohbauer [1], R. Belli [1]

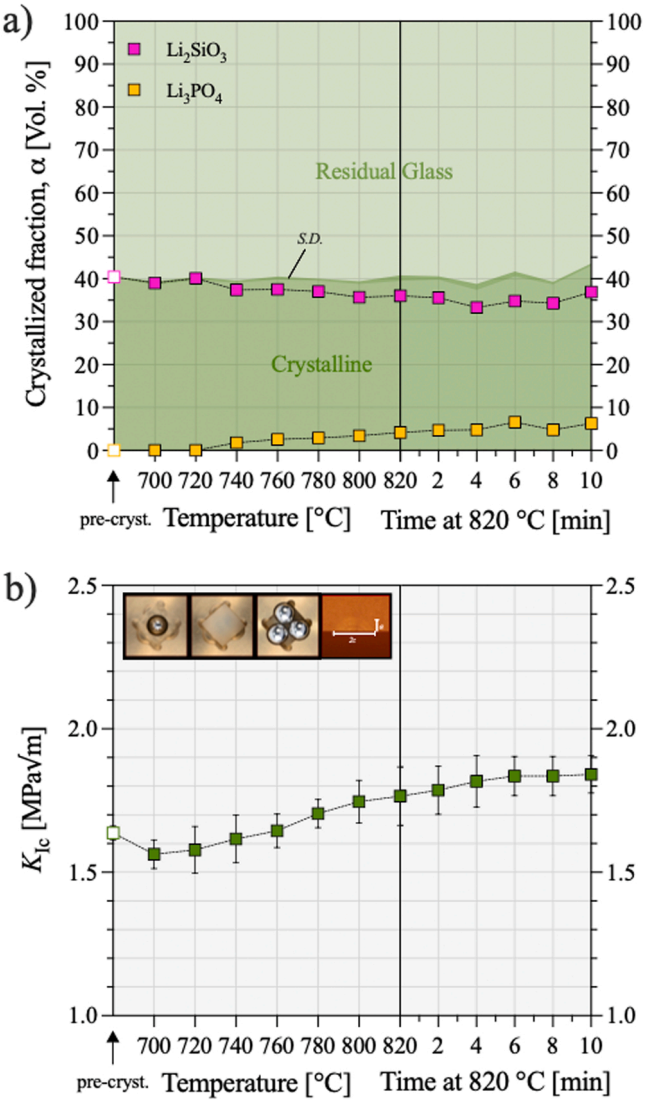
[1] *Dental Clinic 1, Friedrich-Alexander-Universitat Erlangen-Nurnberg (Fau), Germany*
[2] *Department of Mineralogy, Friedrich-Alexander-Universitat Erlangen-Nurnberg (Fau), Germany*
[3] *Department of Materials Science, Friedrich-Alexander-Universitat Erlangen-Nurnberg (Fau), Germany*
[*] *Corresponding author.*

Purpose/Aim: The aim of this study was to illustrate the microstructural and compositional evolution of a lithium silicate glass-ceramic and to draw conclusions about its mechanical behaviour.

Materials and Methods: Blocks of Obsidian (Glidewell Laboratories, USA) were processed into slices measuring 12x12x1.5mm3 for special heat treatment. The heating ramp was interrupted at temperatures between 700 C and 820 C (dwell time at 820 C between 0 min and 10 min) in order to freeze the respective microstructural state. The crystallization peaks of the base and the pre-crystallized glass were detected by DSC. The coefficient of thermal expansion and Tg were derived from DTA. XRD was performed to quantify and characterize the crystal phase fraction, whose microstructural changes were visualised using FE-SEM. The ball on three balls surface crack in flexure method was used to record the development of fracture toughness.

Results: The microstructural evolution during crystallization firing revealed the progressive revitrification of the original Li_2SiO_3 crystals at the boundaries of nanometric single coherent scattering domains (CSD) starting at 740 C and extending throughout the isothermal stage. The crystal fraction decreased monotonically from 41vol.% of 5 m-sized poly-crystals to 35vol.% 0.5m-sized single-crystals, in opposite trend to the CSD sizes. The KIc accompanied the reverse trend of crystallinity, departing from 1.63±0.02 MPa ↔ m at the pre-crystallized stage to 1.84±0.06 MPa↔m after 10 min at 820 C in a sigmoidal shape. Toughening appeared counter-intuitive in view of the decreasing crystal fraction and size, to rather relate to the relaxation of the residual stresses in the interstitial glass, as let suggest from the disappearance of the extensive microcracking. During heat-treatment, the CTE decreased from 13.7×10-6 K-1 to 12.8×10-6 K-1.

Conclusions: Toughening of Obsidian occurs via revitrification and isotropization of Li_2SiO_3 crystals and consequent relaxation of anisotropic mismatch in coefficient of thermal expansion between crystal and glass, despite decrease in crystallinity and crystal size.



https://doi.org/10.1016/j.dental.2021.12.070

41

Effect of Polishing Technique on Flexural Strength of Glass-Ceramics

E. Maier*, P. Gebler, P. Lammers, R. Belli, U. Lohbauer, M. Pelka

Dental Clinic 1, Friedrich Alexander University Erlangen-Nurnberg, Erlangen, Germany
* *Corresponding author.*

Purpose/Aim: Aim of the study was to evaluate the influence of polishing on the flexural strength of dental glass-ceramic materials performed according to chairside techniques, laboratorial procedures or glazed.

Materials and Methods: Specimens were produced of two dental ceramics (IPS e.max CAD/IPS e.max Press, both Ivoclar Vivadent, Schaan, Liechtenstein) as bars of 4 ×3 x 25 mm. Specimens were grinded wet with a rough diamond-copper wheel (D19) to standardize a rough surface (served as negative control, group 5). To simulate chairside conditions students of the 10th semester polished one side of the bars with either Diapro (two-step system, group 1) or Diapol (three-step system, group 2) (both from EVE Ernst Vetter GmbH, Keltern, Germany) dry with a KAVO handpiece. The positive control (group 3) was polished in laboratory with an automatic polishing machine (Buehler) with SiC papers up to 4000 grit under water-cooling. Group 4 was glazed (Crystal/Glaze Spray, Ivoclar) following manufacturers intructions. Afterwards all specimens were tested for flexural strength in a four-point-bending test. Stress at fracture was analyzed using Weibull statistics.

Results: The unpolished negative control group 5 showed the lowest mean flexural strength values for both materials. The chairside polishing groups (1/2) showed the highest mean flexural strength values. For e.max CAD those were significantly higher than in group 3 (lab polish), for e.max Press no significant difference between those groups could be found. Group 4 (glaze) reached similar mean flexural strength values to lab polishing (3) for e.max CAD; for e.max Press the values were significantly lower than in all polished groups (1-3).

Conclusions: Polishing of dental ceramics increases flexural strength, independent if done dry chairside or in laboratory under water-cooling. Glazing can increase strength depending on material but is not more effective than polishing.

https://doi.org/10.1016/j.dental.2021.12.071

42

Fatigue Resistance of CAD/CAM and 3D-Printing Provisional Restorations

G. Marchesi[1], M. Buda[2], R. Di Lenarda[1], M Cadenaro[1], G Turco[1]

[1] *University of Trieste*
[2] *Private Practice, Treviso, Italy*

Purpose/Aim: 3D-printed provisional restorations can be fabricated using additive manufacturing (AM) technologies. However, little information about their performance is available. The aim of this study was to compare the fatigue resistance of 3-teeth provisional resin restorations obtained by 3D printing with those made from polymethylmethacrylate (PMMA) blocks using a CAD/CAM system.

Materials and Methods: A titanium master model for 3-teeth fixed dental prostheses (FDPs) (abutment teeth 45 and 47) was prepared. The master model was scanned and 14 provisional FDPs were produced using respectively: group 1 (N=7): CAD/CAM + BreCAM HIPC-Bredent (BH); group 2 (N=7): 3D printing + NextDent (ND). The FDPs were cemented on the titanium master model with a provisional cement (Temp Bond, Kerr) and submitted to a 5-step incremental cyclic isometric loading: step 1: 5.000 cycles at 10 Hz with 200 N compressive load; steps 2 to 5: 30.000 cycles at 3 Hz with a compressive load respectively of 400 N, 600 N, 800 N and 950 N. Group 1 and 2 were compared using the life table survival analysis and t-test.

Results: In group 1 (BH), only 5 specimens endured the entire fatigue process, while 2 specimens failed at 950 N. In group 2 (ND), 1 specimen failed at 400 N, 5 specimens (ND) failed at 600 N) and 1 specimen failed at 800 N.

Conclusions: PMMA CAD/CAM provisional FDPs showed higher fatigue resistance when compared to the ones made via 3D printing.

https://doi.org/10.1016/j.dental.2021.12.072

43

Mechanical Properties and Ion-Release of Composites Containing Functionalized Calcium Phosphates

B.M. Fronza*, R.A.A. Silva, B.F. Vela, M.D.S. Chiari, R.R. Braga

Department of Biomaterials and Oral Biology, University of Sao Paulo, Brazil
* *Corresponding author.*

Purpose/Aim: To evaluate the effect of functionalized dicalcium phosphate dihydrate (DCPD) particles on degree of conversion (DC), flexural strength (FS) and modulus (FM), and ion-release of resin-based composites, at different CaP:glass ratios.

Materials and Methods: Two series of composites were manipulated with 50 vol% inorganic content at various CaP:barium glass ratios (100:0, 75:25, 50:50, 25:75, and 0:100). In one series, the CaP particles were synthesized in the presence of a phosphoric acid ester (methacryloyloxyethyl phosphate/MOEP @2 mol%). The other series used non-functionalized CaP. A composite containing 50 vol% of glass was used as control. Materials were tested for DC (FTIR), FS, and FM (biaxial strength test) after 24-hours. Calcium release was evaluated after 7-days using ICP-OES. Data were subjected to ANOVA/Tukey test (DC, ion release and FM), Kruskal-Wallis test (FS) and regression analysis (FS and ion release, alpha: 5%).

Results: Results are presented in Table 1. In order to verify the effect of functionalization, the effective CaP content in composites containing functionalized CaP was

Table 1 – Experimental composites' nominal and effective calcium phosphate (CaP) content, degree of conversion (DC), flexural strength (FS), flexural modulus (FM), and calcium release.

Composite	CaP nominal content (vol%)	CaP effective content (vol%)	DC (%)	FS (MPa)	FM (GPa)	Calcium release (ppm)
CaP:glass 0:100	0	0	76,4±1,6 A	200,7±35,0 A	13,5±2,2 A	0,3±0,0 D
CaP:glass 25:75	25	25	75,6±1,1 A	118,0±10,8 BC	11,8±1,0 A	5,0±3,8 CD
CaP:glass 50:50	50	50	79,5±1,5 A	111,9±12,7 BC	13,2±2,0 A	3,9±0,4 CD
CaP:glass 75:25	75	75	79,0±1,6 A	99,0±13,4 BCD	14,0±2,1 A	7,3±0,3 BC
CaP:glass 100:0	100	100	80,8±2,8 A	58,6±6,7 D	9,0±2,4 B	16,9±5,7A
MOEP:glass 25:75	25	20	75,9±3,1 A	132,5±15,3 AB	12,4±1,5 A	2,5±0,2 CD
MOEP:glass 50:50	50	40	78,4±3,9 A	130,5±13,2 AB	13,1±0,9 A	4,2±1,8 CD
MOEP:glass 75:25	75	60	78,6±4,3 A	105,8±7,5 BCD	11,8±2,6 A	7,4±0,6 BC
MOEP:glass 100:0	100	80	79,7±0,6 A	89,3±6,8 CD	12,8±1,3 A	12,0±0,3 AB

calculated based on particles densities (CaP 2,6 g/cm3, and CaP-MOEP 2,3 g/cm3). DC was similar among composites ($p>0.05$). Composites containing CaP-MOEP at 25:75 and 50:50 ratios had FS similar to the control composite ($p>0.05$). A strong negative correlation between FS and CaP effective content was observed for both series of composites, but the angular coefficient was slightly smaller for CaP-MOEP series (-0.8+-0.1) than for the series containing non-functionalized CaP (-0.9+-0.2), suggesting a positive effect of the functionalization. FM was similar among groups, with exception of CaP:glass 100:0 that presented statistically lower values ($p<0.05$). A strong positive correlation between calcium-release and CaP effective content was observed ($r=0.9$). For both series, composites containing only CaP released statistically higher calcium concentrations than composites with 25:75 and 50: 50 CaP:glass ratios ($p<0.05$).

Conclusions: Particle functionalization with MOEP showed a positive effect on composite strength in formulations with 25:75 and 50:50 CaP:glass ratios in relation to the use of non-functionalized particles. However, the compromise between strength and remineralization potential of CaP-containing composites was evident.

Funding FAPESP2019/01701-9.

https://doi.org/10.1016/j.dental.2021.12.073

44

Time-Lapse for Cutting Different Zirconia Thicknesses for Removal Purposes

S.M. Salazar Marocho *, H. Raymond, L.R. Corby

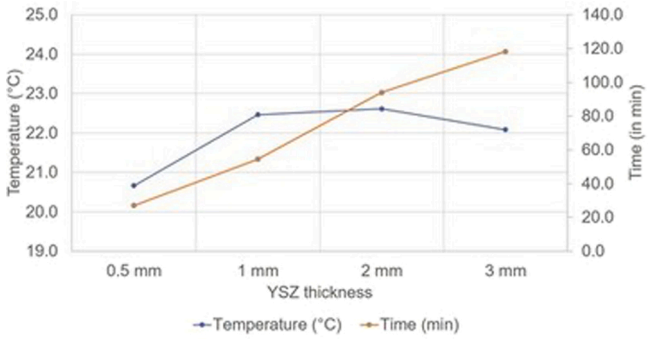
University of Mississippi Medical Center, USA
* *Corresponding author.*

Purpose/Aim: To determine time and heat produced during cutting off through yttria-stabilized zirconia (YSZ) ceramic slices of varying thicknesses.

Materials and Methods: Four groups (6 samples per group) of 0.5, 1, 2, and 3 mm YSZ sintered slices (e.max ZirCAD, Ivoclar Vivadent) were cut off completely using coarse diamond burs on a high-speed handpiece under irrigation. A type K thermocouple was placed under the YSZ slice during the cutting-off procedure, lined up with the position of the diamond bur so that the temperature could be accurately recorded. Each sample was held in place in a customized device. Cutting off total time, base temperature, and final maximum temperature during the cutting process was recorded for each group sample. Interaction effects, temperature, and cut-off time were analyzed using one-way ANOVA.

Results: Data is shown in the Figure. There was no significant difference in temperature among the different YSZ thicknesses during the cutting-off process. However, there was a significant difference in time ($p < 0.001$). The thickest samples took around 120 min to slice through fully.

Conclusions: Thicker YSZ restorations take a longer time to cut through than thinner YSZ restorations; however, regardless of the time spent during the cutting-off process, the temperature through the ceramic remains similar. Time plays an important role in clinical practice, therefore is important to reconsider if rotary mechanical instrumentation is the best route clinician could take to remove high-strength ceramic structures.



https://doi.org/10.1016/j.dental.2021.12.074

45

Resin-Cement Coating on Machined Glass-Ceramic: Effect on Flexural Fatigue Strength

M.M. May [1], L.G. May [1,*], R.V. Machry [1], S. Fraga [2], L.F. Valandro [1], G.S. Andrade [3], M.A. Bottino [3]

[1] *Federal University of Santa Maria, Br*
[2] *Federal University of Rio Grande Do Sul, Br*
[3] *Sao Paulo State University, Br*
[*] *Corresponding author.*

Purpose/Aim: To assess the effect of resin cement coating with high and low viscosities on the flexural fatigue strength of machined vs. polished lithium disilicate glass-ceramic.

Materials and Methods: Disc-shaped samples were prepared (IPS e.max CAD) and divided according to surface condition (polishing P and machining M), resin cement coating (yes or no) and cement viscosity (high and low). Surface roughness was measured on a contact profilometer. Cement-coated specimens received primer application (Monodond Etch & Prime) followed by resin cement (Variolink N high and low viscosities), which was pressed over an insulated glass sheet and photopolymerized. Biaxial flexural fatigue strength was evaluated on a piston-on-three-ball set by the step-test method (n = 15) (initial stress of 60 MPa; incremental steps of 20 MPa; 10,000 cycles per step, at 20 Hz). Weibull statistics was used for analysis of the flexural fatigue strength, and ANOVA/Tukey post hoc test (α= 5%) to compare roughness between M and P conditions. Contact angle analysis on goniometer, topographic and fractographic analysis on scanning electron microscope were also performed.

Results: Machining produced higher roughness and lower contact angle than polishing, as well a significant deleterious effect on the characteristic flexural fatigue strength ceramic fatigue behavior (M: 247.2 vs P: 337.4 MPa). However, machined and coated groups presented similar fatigue behavior to the polished and coated ones, irrespective of the cement viscosity.

Conclusions: Cement coating was able to revert the impact of machining on the fatigue strength of lithium disilicate glass-ceramic. High and low viscosity cements behave similarly on the improvement of CAD-CAM lithium disilicate fatigue strength.

https://doi.org/10.1016/j.dental.2021.12.075

46

Optimal Intrusive Force for a Periodontally Compromised Tooth: A Finite Element Analysis Strategy

O.M. Ugarte [1,*], P.M. Cattaneo [2], M.G. Roscoe [1], I.G. Onone [1], G.C. Dominguez [1], J.B.C. Meira [1]

[1] *University of Sao Paulo, Br*
[2] *Melbourne Dental School, Dentistry and Health Sciences, Au*
[*] *Corresponding author.*

Purpose/Aim: The present study evaluated the optimal force for orthodontic intrusive mechanics of a tooth with different levels of periodontal support reduction using a finite element analysis (FEA) approach.

Materials and Methods: An anatomical 3D model was constructed representing a second unirradicular premolar inserted into a maxillary bone segment. Based on the control model, three horizontal bone resorption conditions were simulated with alveolar bone height loss of 2 mm, 4 mm, and 6 mm (R2, R4, and R6, respectively). An 25 cN intrusive force was used for the two simulated mechanics: bilateral mini-implant intrusion and conventional intrusion. A root resorption risk index (RRRi) was calculated by dividing the maximum compressive hydrostatic stress in the periodontal ligament by the hydrostatic stress of the capillaries (4.7 kPa). It was assumed that the optimal intrusive force of reduced periodontal premolars was reached when the compressive hydrostatic stress distributions pattern of the reduced models was similar to those found in the control models of the corresponding mechanics. The FEA optimal force values for each model were compared with those obtained by the analytical formula (Force = stress x area).

Results: A linear trendline was observed between the control force reduction percentage and the bone loss height for both mechanics. For each millimeter of bone height loss, the control force had to be reduced by 9% for conventional intrusion, and by 8% for bilateral mini-implant intrusion. The root resorption risk index and the optimal intrusive force depends not only on the remaining root area with ligament support, but also on the intrusive mechanics used. The use of bilateral mini-implants in orthodontic intrusion reduced the external apical root resorption risk index and increased the optimal intrusive force.

Conclusions: The proposed FEA strategy provided an easy, precise and feasible approach to suggest the optimum force in a clinical situation.

https://doi.org/10.1016/j.dental.2021.12.076

47

Effect of Sintering and Etching Protocols of Zirconia-Reinforced-Li2O-SiO2 on Bond-Strength

M. Moeeduddin Ahmed*, D. Nathanson, F. Yuwei

Boston University Henry M Goldman School of Dental Medicine, Boston, USA
* *Corresponding author.*

Purpose/Aim: The optimal tensile bond strength of zirconia reinforced lithium-disilicate after multiple glazing firing protocols, different etching time and etchant concentration needs to be evaluated. Purpose of this study was to evaluate the effect of different firing cycles and etching condition on resin cement tensile bond strength of zirconia reinforced lithium disilicate system glass ceramics to titanium.

Materials and Methods: Square-shaped specimens (N=53) were prepared from blocks of zirconia reinforced lithium silicate glass ceramics (CeltraDUO) with 12.5 mm×14 mm rectangular tiles of 2 mm thickness. The specimens were subjected to different firing cycles and etching conditions. They were cemented onto titanium rods (Grade V Ti-alloy, 4.8 mm in diameter, and 1 inch in length) with a resin cement (Theracem), and then tested for tensile bond strength. Least square mean linear regression model was used to analyze the effects on tensile bond strength data using JMP Pro 13.2, followed by the post hoc Tukey tests and tests (α= 0.05).

Results: The tensile bond strength was significantly affected by etching duration ($p<0.001$) and firing cycles ($p<0.001$), but not significantly affected by etchant concentration ($p=0.31$). The highest load to failure was observed at 30-60 seconds of etching time and the least load to failure was observed at 20 seconds of etching time. In terms of firing cycles, 1 firing cycle provided the highest load to failure in contrast to least load to failure observed with no firing.

Conclusions: Changes in etching time and firing condition of the specimens had a significant effect on the resin cement tensile bond strength of zirconia reinforced lithium disilicate. On the other hand etching the specimens under different concentrations of 5 and 9.6% did not differ statistically in terms of resin cement tensile bond strength.

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Etching time(20,80)	1	1	6.163	32.639	<.0001*
Firing cycle	2	2	2.711	7.179	0.0040*
Etchant	1	1	0.053	0.281	0.6012
Etching time*Firing cycle	2	2	0.190	0.503	0.6117
Etching time*Etchant	1	1	0.165	0.876	0.3596
Firing cycle*Etchant	2	2	0.101	0.266	0.7696

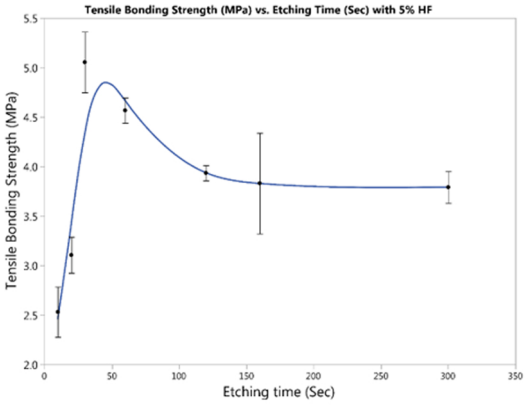


Figure: Bivariate plot of tensile bond strength and etching time after one firing cycle and 5% HF etching

https://doi.org/10.1016/j.dental.2021.12.077

48

Calcium Phosphate Nanoparticles Tested on Hydroxyapatite Discs as Remineralising Agent

Z.H. Mok[1,*], P. Mylonas[2], R. Austin[1], G. Proctor[1], N. Pitts[1], M. Thanou[1]

[1] *King's College London, UK*
[2] *Cardiff University, UK*
* *Corresponding author.*

Purpose/Aim: To investigate the remineralisation properties of novel calcium phosphate nanoparticles (CPNPs) on hydroxyapatite (HA) discs as an alternative substrate model to enamel at different pH levels.

Materials and Methods: Colloidally stable CPNPs (2% w/v) were prepared via co-precipitation of calcium chloride

and sodium phosphate, and sodium citrate (100 mM) added post-precipitation as the capping agent. Particle size and morphology were characterised with dynamic light scattering and scanning electron microscopy (SEM). Crystallinity was assessed with Fourier-transform infrared spectroscopy, Raman spectroscopy and X-ray diffraction, and the Ca/P ratio with inductively coupled plasma mass spectroscopy and total reflection X-ray fluorescence spectroscopy. HA discs were eroded in acetate buffer (0.5 M; pH 4.0) at various timepoints (1, 5, 10, 30 min, and 2, 4 h) to produce a suitably eroded substrate for remineralisation. Their physical differences compared to enamel, together with remineralisation outcome at different pH levels were assessed by Knoop microhardness, surface roughness and step height by a profilometer, SEM and light microscope.

Results: Colloidally stable CPNPs of 60 nm, zeta potential -23.3 1.3 mV, with high HA crystallinity and a Ca/P ratio of 1.54 had been produced. HA discs eroded for 2 h showed a 2 m step height and were deemed suitable to be used as a demineralised artificial substrate model for remineralisation. It was established that CPNPs were heterogeneously deposited on the HA discs at pH 9.2, whereas newly precipitated minerals from CPNPs were potentially formed at pH 6.2.

Conclusions: Citrate-stabilised CPNPs with high HA crystallinity showed detectable surface remineralisation properties on HA discs.

https://doi.org/10.1016/j.dental.2021.12.078

49

Can S-PRG Fillers in Different Vehicles Act on Dentin Permeability?

V. Mosquim [1,*], R.A. Caracho [1], L.S. Condi [1], G.S. Zabeu [1,2], G.A. Foratori-Junior [1], A.C. Magalhaes [1], L. Wang [1]

[1] *Bauru School of Dentistry, University of Sao Paulo, Bauru, Brazil*
[2] *School of Dentistry, Unisagrado University Center, Bauru, Brazil*
[*] *Corresponding author.*

Purpose/Aim: The exposure of dentin to the oral environment often leads to the development of dentin hypersensitivity (DH) partially due to the permeability of this mineralized tissue. Among the strategies to relief its symptoms, ions that minimize demineralization and reinforce mineralized tissues are often employed. Recently, one light-curing varnish containing surface pre-reacted glass (S-PRG) fillers (PRG Barrier Coat) was developed with this purpose. Furthermore, it presents aluminum, which is attributed to the clinical relief of DH. However, due to the presence of these fillers in a light-curing resinous matrix, the effect of the matrix cannot be disregarded. Therefore, the aim of this study was to investigate the effect of a S-PRG-based varnish, a toothpaste containing 30 wt.% of S-PRG fillers, a resin infiltrant (Icon) and a NaF-based varnish (Duraphat) on the dentin permeability in vitro.

Materials and Methods: The permeability of the dentin disks (1.0 0.2 mm) was evaluated using Flodec. The specimens were distributed in 4 groups (n=8) and the minimum (pMin, with smear layer) and maximum (pMax, without smear layer) were recorded. Thereafter, each specimen was treated with one of the designated product and the permeability after treatment (pTreat) was recorded. Then, specimens were subjected to a 1-min erosive challenge and the final permeability (pEro) was recorded. The data was transformed in Log10 and analyzed using 2-way repeated measures ANOVA (alpha=0.05).

Results: The results evidenced no difference between groups for the pMin and pMax values, assuring a standardized baseline for all tested conditions. There was no difference in pTreat when comparing the two S-PRG-based vehicles. For pTreat and pEro, the lowest permeability was seen for the group treated with the resin infiltrant, reaching values closest to pMin. Likely, its homogeneous TEGDMA layer constituted a mechanical barrier. NaF varnish also effectively reduced dentin permeability after treatment.

Conclusions: Therefore, it can be concluded that S-PRG-based products vehicle did not reduce the dentin permeability in vitro, so its effective action for DH might be attributed to other mechanisms rather than by an obliterating process.Support FAPESP #2019/21128-1.

https://doi.org/10.1016/j.dental.2021.12.079

50

Different Mechanical Properties of Sand Blasting on Co-Cr Alloys

C. Mouchtaridi [1,*], M. Munoz Hernandez [2], M.M. Multigner Dominguez [2], M.D. Escalera Rodriguez [2], J. Rams [2], T. Papadopoulos [1], I. Eleftheriadis [3]

[1] *National and Kapodistrian University, Greece*
[2] *University Rey Juan Carlos, Spain*
[3] *Tver Medical State University, Russia*
[*] *Corresponding author.*

Purpose/Aim: The purpose of this in study was to determine the influence of the sand blasting on the microstructure and the mechanical properties of cobalt chromium alloys.

Materials and Methods: Thirty Co-Cr metal substrates were fabricated according to ISO 9693-1, by Direct Melting Laser Sintering fabricating technique. One group of ten were sandblasted with 50μm Zinc oxide nanopowder, another group of ten were sandblasted with 250μm and one more group group of ten substrates were left as received without sandblasting at all. On the two fist groups a feldspathic porcelain was placed. Then the specimens were tested for metal-ceramic bond strength with 3-point bend test. The fractured specimens were observed with an optical and scanning electron microscopy in order to define the mode of failure. Also, X-ray diffraction spectroscopy was conducted to determine changes in crystalline phases after fabrication and the 3-point bend test.

Results: The first group of the 250μm gave more plasticity to the substrates and observed as more eslastic than th other two groups. The groups with the ceramic coating revealed cohesive bond strength. The metallographic analysis of the after porcelain firing, the after 3-point bend test specimens and the as-received revealed changes in microstructure. Regarding the crystallographic microstructure, the patterns had minor changes among the groups. The profilometry also indicated that the bigger the gridblasting particles made the surface of the substrates smother.

Conclusions: The adhesion between the metal substrate and the ceramic layer is not affected by the sandblasting. All of the techniques showed similar results and the modulus of elasticity revealed that the bigger the particle of the sandblasting is the higher the mechanical properties are.

https://doi.org/10.1016/j.dental.2021.12.080

51

Bonding Durability of Resin Cement to Lithium Disilicate Glass Ceramics

S. Murakami *, K. Hirano, F. Fusejima

GC Corporation, Japan
* *Corresponding author.*

Purpose/Aim: To obtain reliable adhesion of resin cement to glass ceramics, it is generally known that it is important to apply a silane coupling agent to glass ceramics surface to make its surface has chemically bonding ability. Currently, there are several types of commercial resin cement system with different approach to provide silane coupling agent, such as, prosthesis primer, mixed in bonding agent, or compounded in cement paste. The purpose of this study is to evaluate the bond durability of several resin cement systems to lithium disilicate glass ceramics (LDS) to find reliable system with silane coupling ability.

Materials and Methods: 3 resin cement systems, G-CEM ONE (GO, GC Corporation) with G-Multi Primer (GMP, GC Corporation) which is prosthesis primer included silane coupling agent, PANAVIA SA Cement Universal (PSU, Kuraray) which compounded silane coupling agent in cement paste, and RelyX Universal (RXU, 3 M) with Scotchbond Universal Plus Adhesive(SBU+, 3 M) which is bonding agent mixed silane coupling agent in it were examined. Initial LiSi Block (LiSi, GC Corporation) was used as LDS in this study.

LiSi were embedded with acrylic resin. Adhesive surface was finished with 600-grit SiC paper (#600) or hydrofluoric acid (HF)[BISCO PORCELAIN ETCHANT 9.5% HF]. Bonding area(3.0mm-diameter) and cement thickness(0.1mm-thickness) were defined by plastic-tape. Stainless-steel rod was bonded against the bonding area by each resin cement system according to manufacturers instruction in self-curing mode. Bonded specimens were stored in 37 C distilled water for 24 hours(24 h). In case of thermocycling, they were placed under thermocycling condition(5-55 C for 5000cycles:TC5000). Shear Bond strength was tested with universal test equipment (SHIMADZU AG-IC, crosshead-speed 1 mm/min, N=5). Data were statistically analyzed by Tukey-Krame.

Results: In case of GO with GMP, there were no significant differences of SBS between 24 h and TC5000 regardless of surface finish (#600 and HF). On the other hand, in case of PSU and RXU with SBU+, SBS of TC5000 on surface finish of #600 significantly decreased compared with SBS of 24 h.

Conclusions: From the results, GO with GMP showed high bond strength and bonding durability regardless of surface finish. In case of #600, its finished surface was relatively smooth and mechanical retention would not be expected, but GO with GMP showed the equivalent bonding durability on #600 compared with HF. It might indicate silane coupling ability in GMP was properly functioned and separate prosthesis primer system can be effective. It is expected that better long term bonding durability to lithium disilicate glass ceramics may be achieved by G-CEM ONE system.

products	G-CEM ONE		PANAVIA SA Cement Universal		RelyX Universal	
conditions	#600	HF	#600	HF	#600	HF
24 h	64.3 (2.5)a	62.9 (7.0)a	48.1 (3.7)B	59.5 (3.7)A	54.3 (9.9)B*	66.5 (3.1)A*
TC5000	61.9 (10.8)a	68.6 (6.0)a	1.5 (0.3)C	46.3 (1.8)B	1.0 (0.2)C*	70.8 (5.0)A*

https://doi.org/10.1016/j.dental.2021.12.081

52

Fatigue of Ti6Al4V Dental Implants Produced by AM and Machining

F. Oliveira *, C. Elias, A. Paula

Military Institute of Engineering (Ime), Rio De Janeiro, Brazil
* *Corresponding author.*

Purpose/Aim: The general objective of the present work is to compare the fatigue life of dental implants produced by additive manufacturing (selective laser fusion) of the Ti6Al4V alloy (Grade V) in contrast to those manufactured by machining (Grade IV).

Materials and Methods: The materials to be studied consist of samples of dental implants produced by additive manufacturing (selective laser melting) of the Ti6Al4V alloy (Grade V) and samples of dental implants manufactured by machining, of Grade IV titanium. The parameters used both in the additive manufacturing production process and in the machining process were not disclosed by the manufacturer as they are confidential. The fatigue tests were carried out in an INSTRON brand servo-hydraulic testing machine, model 8872, with a 15 kN load cell. The tests were conducted in accordance with the ISO 14801:2016 standard, where the initial load applied was 80% of the force obtained in the compression test.

Table 1 – Results of testing dental implants manufactured by machining.

Sample	Number of cycles		
	Range 1	Range 2	TOTAL
01	500.000	162.476	662.476
02	326.682	-	326.682
03	500.000	137.619	637.619
	Average		542.259
	Standard deviation		152.742
	Result		542.259 ± 152.742

Note: Range 1 = 40 to 400 N; Range 2 = 50 to 500 N.

Results: In the fatigue test of machined implants, the initial load applied was 400 N and every 500,000 cycles there was an increase of 100 N and, as an average result (Table 1), the test had a value of 542,259 152,742 cycles, with a cyclic load ranging between 50 and 500 N. The implant manufactured by additive manufacturing, on the other hand, had an initial load applied 600 N and every 500,000 cycles also occurred an increase of 100 N, until the fracture of the specimen. The only sample tested from AM manufacturing, in this preliminary evaluation, fractured at 5.2 ×106 cycles, with a cyclic load ranging between 120 and 1200 N. Despite being a single implant test manufactured by additive manufacturing to be confronted with the 3 machined samples, apparently, there was a superior strength of the material from the additive manufacturing, not only for the initial applied load, but also for the number of cycles supported before the fracture with the load increment (100 N) every 500,000 cycles.

Conclusions: As the fatigue tests on implants manufactured by additive manufacturing of the Ti6Al4V alloy have not yet been completed, few conclusions could be drawn. However, comparing the result obtained in the fatigue test of machined implants to the CP value tested in fatigue of the implant manufactured by MA, the superior performance of implants manufactured by additive manufacturing compared to those manufactured by the machining process is evident.

https://doi.org/10.1016/j.dental.2021.12.082

53

Use of EDTA on Bond of Adhesives to Fluorotic Enamel

LP Muniz, PHA Moreira, MWC Ferreira, A Reis, AFM Cardenas, AD Loguercio, FSF Siqueira

Centro Universitário Do Maranhao- Uniceuma, São Luis, Brazil

Purpose/Aim: To compare the effect of active pre-conditioning with 17% ethylenediaminetetraacetic acid (EDTA) vs. 37% phosphoric acid (PA) on the resin-enamel microshear bond strength (μSBS), enamel-etching pattern, and in-situ degree of conversion (in-situ DC) of four universal adhesive systems on sound enamel and fluorotic enamel.

Materials and Methods: 224 extracted human molars (112 with no fluorosis and 112 with fluorosis) were sectioned into 4 parts and divided into 16 experimental groups based on the enamel surface (sound or fluorotic enamel), adhesive system (Clearfil Universal Bond [CUB], Futurabond U [FBU], iBond Universal [IBU], or Scotchbond Universal [SBU]), and enamel conditioning agent (phosphoric acid [PA] mode or EDTA mode). The specimens were stored for 24 h and tested under shear stress at 1.0 mm/min (μSBS). The adhesive-enamel interfaces were evaluated for in situ DC using micro-Raman spectroscopy. The enamel-etching pattern was evaluated using a scanning electron microscope. The SBS and in situ DC data were analyzed separately using three-way analysis of variance and Tukeys post-hoc test ($\alpha = 0.05$).

Results: Sound enamel showed higher μSBS and DC values as compared to fluorotic enamel ($p < 0.05$). However, no significant difference was observed for μSBS, DC ($p > 0.05$), and etching patterns when the PA and EDTA modes were compared in sound and fluorotic enamel. Moreover, CUB and SBU showed higher mean values of μSBS than that of FBU and IBU in both sound and fluorotic enamel ($p < 0.05$).

Conclusions: As compared to PA, active pre-conditioning with EDTA showed similar μSBS values and enamel etching patterns for all the adhesive systems in fluorotic enamel, without compromising the in situ DC.

https://doi.org/10.1016/j.dental.2021.12.083

54

Fracture Strength of CAD/CAM CROWNS after Enhancement of Occlusal Morphology

L. Passos [1,*], S. Butler [2], Y. Torrealba [3], B. Linke [3]

[1] *School of Dentistry, Federal Fluminense University, Nova Friburgo, Brazil*
[2] *Schulich School of Medicine & Dentistry, Western University, London, Canada*
[3] *School of Dentistry, University of Alberta, Edmonton, Canada*
[*] *Corresponding author.*

Purpose/Aim: The aim of this study was to investigate the fracture strength of computer-aided design/computer-aided manufacturing (CAD/CAM) posterior ceramic crowns with and without post-milling manual enhancement of occlusal morphology (MEOM), as indicated especially with

early CAD/ CAM restorations that have limited capacity to generate natural occlusal morphology.

Materials and Methods: A mandibular molar of an acrylic tooth model was prepared to receive a CAD/CAM all-ceramic crown and was used as a master die to fabricate 80 prepared tooth replicas using an epoxy resin with an elastic modulus (E) of 18 GPa. The crown was designed using CEREC softwares Biogeneric Copy Design mode (Sirona). Eighty identical monolithic crowns were fabricated by milling four types of ceramic blocks. Forty monolithic crowns (10 of each ceramic system) were randomly selected as the control group, and MEOM was performed for each of the other 40 crowns by a certified dental technician. Restorations were crystallized and glazed according to the manufacturers instructions and firing protocols. All crowns were cemented to their respective die using resin cement and loaded to fracture at a crosshead speed of 0.5 mm/min. The resultant fractures were classified into three modes. Data were statistically analyzed using the nonparametric Mann-Whitney U test at ? = 0.05.

Results: The MEOM treatment decreased the fracture load for all ceramic brands.

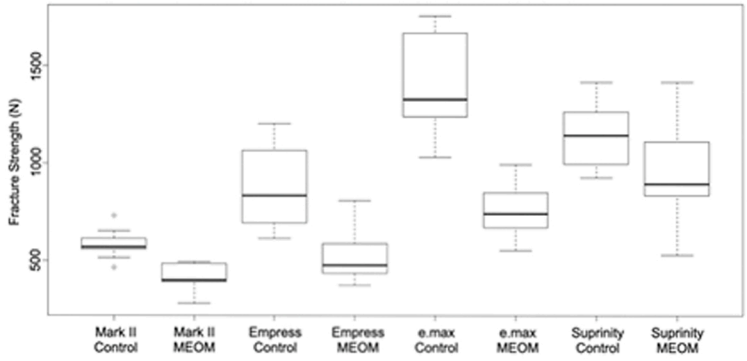
Conclusions: The MEOM procedure should be considered detrimental for monolithic CAD/CAM-generated crowns and should thus be avoided.

https://doi.org/10.1016/j.dental.2021.12.084

Fracture load data (MPa) and P values for the control and MEOM-treated CAD/CAM-generated crowns of Vita Mark II, IPS Empress CAD, IPS e.max CAD, and Suprinity PC block ceramics

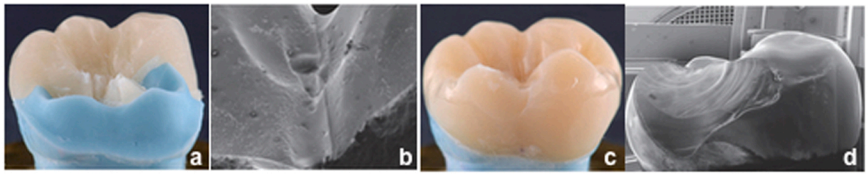
	VITA Mark II		IPS Empress CAD		IPS e.max CAD		Suprinity PC	
Sample	Control	MEOM	Control	MEOM	Control	MEOM	Control	MEOM
Mean	585.2	419.2	874.2	515.0	1377.4	753.5	1142.1	939.4
SD	74.4	49.1	193.0	138.4	198.7	151.3	120.0	172.1
P value (MW)		0.0005		0.0009		0.0002		0.0233

Box plot diagram (whiskers show maximum and minimum fracture loads) comparing the control and MEOM groups for each ceramic system: Vita Mark II; IPS Empress CAD; IPS e.max CAD; and Suprinity PC.



Groups	Mode 1	Mode 2	Mode 3
VITA Mark II - Control	10	0	-
VITA Mark II - MEOM	10	0	-
IPS Empress CAD - Control	8	2	-
IPS Empress CAD - MEOM	10	0	-
IPS e.max CAD - Control	1	9	-
IPS e.max CAD - MEOM	7	3	-
Suprinity PC - Control	6	2	2
Suprinity PC - MEOM	9	0	1

Fracture mode data: Mode 1 – fracture through crown, epoxy resin die intact; Mode 2 – fracture through crown and epoxy resin die; Mode 3 – chipping fracture of crown wall



a) Example of mode 1 fracture in a Vita Mark II sample (MEOM group); (b) example of mode 3 fracture in a Suprinity PC sample (control group); (c) detail of a crack in a groove along with central fossae at a SEM magnification of 98× in a Vita Mark II sample; (d) detail of the chipping fracture of the crown wall at a SEM magnification of 22× in a Suprinity PC sample.

55

Dental Ceramic Surface Properties after Resin-Cement Removal by Burning Technique

N. Pesun *, I.J. Pesun, B. Vallerini, R. Franca

University of Manitoba, Department of Restorative Dentistry, Winnipeg, Canada
* *Corresponding author.*

Purpose/Aim: There are situations in which resin-cement needs to be removed from the crown's intaglio surface before it can be recemented. Some authors have proposed to burn off this cement; however, questions remain related to the effect of this technique on the surface properties of the ceramics.

The goal was to test the effect of burning cements off on the surface properties of zirconia and lithium disilicate dental ceramics. The mechanical properties (hardness and elastic modulus) and removal effectiveness were tested in this study.

Materials and Methods: Two kinds of ceramics: zirconia (Cercon, Dentsply Sirona) and lithium disilicate glass-ceramics (Emax, Ivoclar Vivadent) and two universal resin-cements; Calibra Universal (Dentsply) and Multilink Automix (Ivoclar Vivadent), were used in this research. Samples (n=8) were 1.3 mm thick and were sintered according to manufacturer recommendations. Zirconia samples were sandblasted with 150 aluminum oxide, and lithium-disilicate were etched with 9.6% hydrofluoric acid and then thoroughly rinsed. The application of each resin-cement followed the manufacturer's recommendations, and the samples were light-cured for 20 s. After 15 days of storage (100% humidity and 36 C), the samples were placed into a furnace at a temperature of ~150 C then heated a rate of ~30 C/min until reaching a temperature of 400 C where the temperature was held for 1 minute. The samples were removed from the furnace and allowed to cool before the cement was removed. Fourier Transformed Infra-Red (FTIR) was used, before and after cementation, to check the surface chemical composition and the effectiveness of the resin-cement removal. A nanoindenter (Hysitron TI 750 Ubi Triboindenter) using a Berkovich tip (100 mN) was used to assess the surface properties. Statistical analyses of the results were performed using two-way ANOVA and a post hoc Tukey test ($\alpha = 0.05$).

Results: FTIR showed that the burning technique was effective to remove the residual resin-cement from the ceramic samples. Also, there was no significant statistical difference between the hardness and the elastic modulus of the dental ceramic surfaces from before and after the burning technique.

Conclusions: This study showed that the removal of the resin-cements from crowns intaglio by the burning technique could be a viable clinical solution before recementing dental ceramics.

https://doi.org/10.1016/j.dental.2021.12.085

56

Reduction of EPS Formation in S. Mutans Biofilms

PMC Scaffa [1], MY Icimoto [2], A Kendall [1], APP Fugolin [1], X Cao [1,2], CS Pfeifer [1,*]

[1] *Oregon Health & Science University, Biomaterials & Biomechanics, Portland, USA*
[2] *Department of Biophysics, UNIFESP-EPM, Sao Paulo, Brazil*
* *Corresponding author.*

Purpose/Aim: Streptococcus mutans is the primary oral caries-forming bacteria, being very efficient in producing sticky biofilms via the synthesis of insoluble extracellular polysaccharides (EPS), catalyzed by glucosyltransferases (Gtfs). By selectively targeting EPS formation in cariogenic species, this study aims to shift the ecological composition of oral biofilms to favor commensal species. The aim of this study was to modify existing EPS-targeting small molecules, to ultimately produce antimicrobial polymer surfaces with specificity against S. mutans.

Materials and Methods: One S. mutans-specific nitro molecule (G43) was modified with the addition of methoxy/triethyleneglycol substitutions in different positions (nine derivatives total, tested at 50-M). The metabolic status and viability of UA159 biofilm were evaluated by bioluminescence (Luciferase Assay). The polysaccharides were purified from the biofilms, and the composition was determined using colorimetric assays. The GTF-BCD complete knockouts were used as the negative control. GTF-C enzyme inhibition was evaluated using Dynamic Light Scattering (DLS) and dose-response inhibition (IC50) was calculated. The structural organization and architecture was determined by confocal laser scanning microscopy. Data were analyzed with one-way ANOVA and Tukeys test ($\alpha = 0.05$).

Results: Exposure of biofilm to the compounds did not reduce the bacterial viability, showing no antibacterial effect, as expected (Fig. 1A). In general, the compounds with methoxy substitution were not effective in reducing EPS formation, while the triethyleneglycol substitution (G43-TEG) led to reduced concentration of insoluble EPS (Fig. 1B), albeit less marked than for the parent G43. This agrees with the DLS results demonstrating that GTF-C activity was inhibited by different concentrations of G43-TEG (Fig. 1C). Likewise, the confocal images also demonstrated reduction of EPS formation, as well as visible structural changes (Fig. 1D).

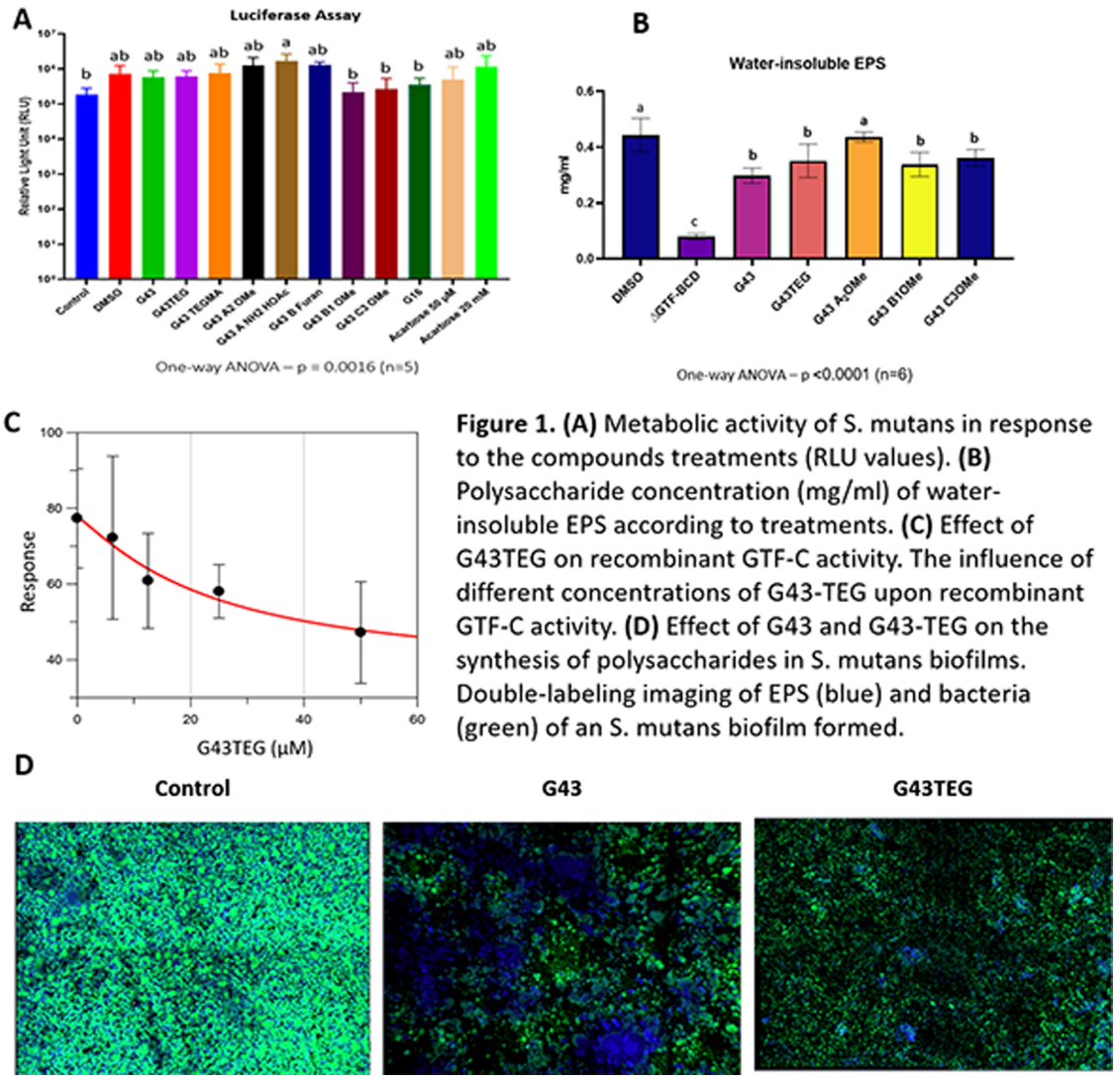


Figure 1. (A) Metabolic activity of S. mutans in response to the compounds treatments (RLU values). **(B)** Polysaccharide concentration (mg/ml) of water-insoluble EPS according to treatments. **(C)** Effect of G43TEG on recombinant GTF-C activity. The influence of different concentrations of G43-TEG upon recombinant GTF-C activity. **(D)** Effect of G43 and G43-TEG on the synthesis of polysaccharides in S. mutans biofilms. Double-labeling imaging of EPS (blue) and bacteria (green) of an S. mutans biofilm formed.

Conclusions: One modified compound, G43-TEG, exhibits very promising efficacy in vitro. It is non-bactericidal and was demonstrated to selectively reduce the biofilm formation, by targeting S. mutans Gtfs.

Funding: NIH-NIDCR (R35-DE029083; K02-DE025280)

https://doi.org/10.1016/j.dental.2021.12.086

57

Can Smoking affect Whiteness and Color Change after At-Home Bleaching?

R.R. Silva*, J.P De Carli, O.E. Pecho, K.F. Collares, A. Della Bona, J.R. Dieterich-Jnior, P. Benetti

Dental School, University of Passo Fundo, Passo Fundo, Brazil

* *Corresponding author.*

Purpose/Aim: To evaluate the effect of smoking on tooth whiteness and color change after at-home bleaching.

Materials and Methods: The present investigation is a cohort study with 40 patients (N=40), assigned into 2 groups: NS- non-smokers (n=24) and S- smokers (n=16). At-home bleaching was performed with 22% carbamide peroxide (CP) using individual trays for 1 h a day for 14 days. CIELAB color coordinates were obtained from the six upper anterior teeth (CI- central incisors, LI- lateral Incisors and C- canines) using a Vita Easy Shade spectrophotometer before bleaching (D0-baseline), one day (D1), 15 days (D15) and one month (D30) after the end of the treatment. Whiteness index for dentistry (WID) and CIEDE2000 color difference (ΔE00) were calculated and used to evaluate the bleaching efficacy. Whiteness (ΔWID) and color (ΔE00) changes were compared between NS and S in distinct dental groups using the Mann-Whitney test (α=0.05). The corresponding 50:50% acceptability thresholds were used to analyze the whiteness (WAT) and color (AT) differences obtained in this study.

Results: For all teeth groups, NS showed similar median WID values than S at baseline (D0) ($p>0.05$), but higher values than S for the other evaluation times (D1, D15, and D30) ($p\leq0.05$).For ΔWID values, NS showed greater differences values (D1-D0, D15-D0, and D30-D0) for CI and C when compared to those of S ($p\leq0.05$), and all these differences were above WAT value. In addition, although

NS showed higher ΔWID values than S for the period D30-D1 ($p \leq 0.05$), both of them were below WAT value. ΔE00 values showed similar behavior than ΔWID for all the groups.

Conclusions: Smoking influenced on the whiteness and color alterations, after at-home bleaching treatment using 22% CP. However, the observed whiteness and color alterations were clinically acceptable for smokers.

https://doi.org/10.1016/j.dental.2021.12.087

58

Experimental Silver-Infiltrated Glass on Biofilm Formation in Monolithic Zirconia

R.M.M. Marinho [1], C.F. Sabino [1,*], T.M.B. Campos [2], A.O.P. Ribeiro [1], A.C. Silva [1], F.C. Ribeiro [1]

[1] *Department of Dental Materials and Prosthodontics, Sao Paulo State University, Sao Jose dos Campos, Brazil*
[2] *Aeronautics Institute of Technology, Department of Physics, Sao Jose dos Campos, Brazil*
[*] *Corresponding author.*

Purpose/Aim: The aim of this study was to evaluate the effect of different coating applications of experimental glass with silver particles on surface properties, biofilm formation and inhibition of microbial adhesion to yttria-stabilized tetragonal zirconia (Y-TZP).

Materials and Methods: 105 YZ T zirconia samples (VITA Zahnfabrik, Germany) with dimensions of 5.0 ×5.0 ×2.0 mm were divided into 7 groups: Polished YZ (P), Glazed YZ (G), YZ with infiltration glass (INF), YZ + 4% Ag (Ag4), YZ + 5% Ag (Ag5), YZ with glass + 4% silver (IAg4) and YZ with glass + 5% silver (IAg5). The experimental infiltration glass was made from silicic acid, which was obtained when sodium meta silicate (Na_2SiO_3 $5H_2O$) passed through aqueous solution (10% m / m) and an ion exchange resin (IR120 - Rohm and Haas). The glass with was obtained through a similar protocol, which was then followed by the addition of silver nitrate ($AgNO_3$) and silicon (SiO_2), aluminum (Al_2O_3), calcium (CaO), sodium (Na_2O), and potassium (K_2O) oxides. The product upon completion comprised 5% $AgNO_3$, 65% SiO_2, 1.1% Al_2O_3, 0.59% K_2O, 14.54% Na_2O, 8.93% CaO and 3.41% MgO. Specimens were submitted to the following tests: surface roughness, colony-forming unit count (CFU) of Candida albicans, Streptococcus mutans and Streptococcus sanguinis, and Scanning Electron Microscopy (SEM).

Results: The different coating exhibited notable differences, both in relation to surface roughness, and bacterial and fungal adhesion. Regarding surface roughness, the Ag5 and IAg5 had a rougher profile when compared to the other groups, that were smoother and statistically similar to each other. However, in the CFU tests of Candida albicans and Streptococcus mutans groups P, G, and INF showed higher adherence of microorganisms, while all silver groups had less biofilm adherence, being statistically similar to each other. In the SEM it was possible to observe that all the groups of glass with silver (Ag4, IAg4, Ag5 and IAg5) presented silver particles anchored to the zirconia-glass system.

Conclusions: The application of silver coating made the surface of the monolithic Vita HT zirconia resistant to the tested oral pathogens, causing inhibition of bacterial growth in the nearby surrounding region and also preventing the formation of biofilm on the ceramic surface.

https://doi.org/10.1016/j.dental.2021.12.088

59

Characterization of Experimental Short Fiber Reinforced Dual-Cure Core Build-Up Composites

E. Sailynoja [1,2], S. Garoushi [1], P.K. Vallittu [1], L. Lassila [1]

[1] *University of Turku, Turku, Finland*
[2] *Stick Tech Ltd Member of GC Group, Turku, Finland*

Purpose/Aim: As a core build-up material, dual-cured (DC) resin-based composites are getting popular. This study aimed to evaluate certain physical properties of a new experimental short fiber-reinforced DC resin composites (SFRCs) in comparison with different commercial conventional DC materials (Gradia Core, Rebilda DC, Luxa Core and Visalys CemCore).

Materials and Methods: Degree of monomer conversion (DC%) was determined by FTIR-spectrometry using either self or light-curing mode. The flexural strength (FS), modulus (FM), and fracture toughness (FT) were measured using a three-point bending setup. The surface microstructure of each resin composite was investigated with scanning electron microscopy (SEM). Data were statistically analyzed with analysis of variance ANOVA ($p = 0.05$).

Results: The light-curing mode showed significant ($p<0.05$) effect on the DC% and flexural properties of tested DC resin composites and differences were material-dependent. SFRC exhibited the highest fracture toughness (2.3 MPa m1/2) values and Luxa showed the lowest values (1 MPa m1/2) among the tested materials ($p<0.05$). Gradia and SFRCs showed the highest flexural modulus ($p<0.05$), while the other resin composites had comparable values.

Conclusions: The new DC short fiber-reinforced core build-up resin composite differed significantly in its

fracture toughness compared to the tested conventional DC composites.

https://doi.org/10.1016/j.dental.2021.12.089

60

Temporal Assessment of Remineralizing Demineralized Enamel Using Micro-Computed Tomography

M. Salah [1,2,*], T. Abdelrehim [1], K.A Nour [2], M.N Anwar [2], H.P Chew [1]

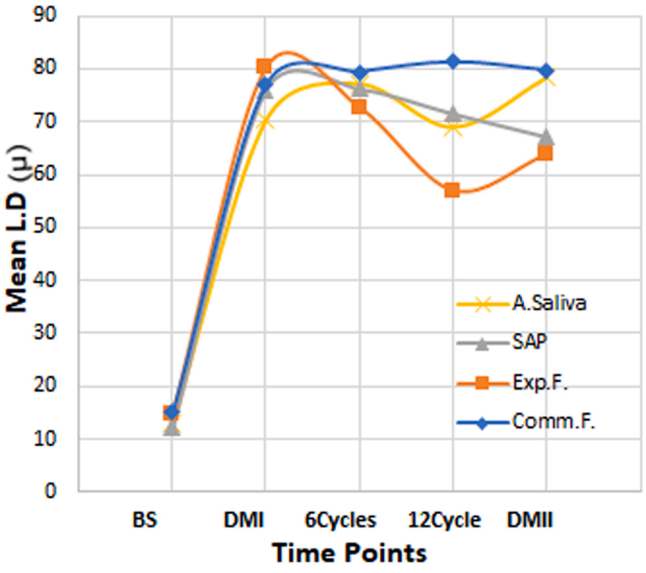
[1] *University of Minnesota, USA*
[2] *Operative Dentistry, University of Ain Shams, Egypt*
[*] *Corresponding author.*

Purpose/Aim: Remineralizing enamel is an important approach of treating early carious lesion without surgical intervention allowing for preservation of tooth structure. This study objective is longitudinal assessment of enamel microstructure using non-destructive micro-CT to monitor the remineralization process undergoing fluctuating changes in pH after treatment with different remineralization agents.

Materials and Methods: Twelve human extracted premolars were collected. Calculus and soft tissue were removed from the root, kept in distilled water, and stored at 4 C. The teeth were screened using Swept Source OCT (SANTEC IVS-2000) to identify a 3 ×3 mm2 caries-free region of interest on the crown for artificial caries induction. The whole crown, except for the identified sound area, was coated with two layers of acid-resistant nail varnish. Then samples were mounted using acrylic resin and customized mounts to standardize successive scans with micro-Ct. Each mounted sample was incubated in 20 ml of buffered lactic acid (2.2 mM $CaCl_2$, 2.2 mM $K2HPO_4$, 0.1 M Lactic acid adjusted pH to 4.5) for 72 hours in 37 C to induce caries-like lesions of approximately 100 micron in depth. After 72 hours, the samples were rinsed with deionized water and stored in distilled water to be scanned. The samples were grouped into four groups (n=3) that consist of three intervention groups and one negative control group. The 3 intervention groups consist of two fluoride varnish and one polypeptide-based remineralization agents. Each sample received the remineralizing treatment after the lesion formation according to manufacturers instructions. After that all samples were subjected to pH cycling for 2 weeks in 37 C incubation on a shaker table. Ph cycling solutions were refreshed at the end of every cycle following [ten Cate and Duijsters, 1982] protocol which is: 1-three hours in demineralization solution,2-rinse for 30 s with distilled water and 3- 21 hours in artificial saliva.Micro-Ct scans were carried out after 6 and 12 pH cycles. Lesion depth, ld and Delta Z, ΔZ were calculated

Results: The mean lesion depth developed in the different groups showed no noticeable difference after 6 ph. cycles while after 12 ph. cycles lesion depth were decreased in the different groups with more observable decrease in the experimental fluoride group. Both self-assembly peptide agent and experimental fluoride showed no further increase in the lesion depth after the acidic challenge at the end of the ph. cycles.

Conclusions: Remineralized enamel with different remineralizing agents reacts differently under the same fluctuating ph. conditions at different time intervals.



https://doi.org/10.1016/j.dental.2021.12.090

61

Effect of Zinc Chloride on HOCl-Smear Layer Deproteinization

K. Sanon [1,*], T. Hatayam [1], K. Hosaka [2], M Nakajima [1]

[1] *Tokyo Medical and Dental University, Japan*
[2] *Tokushima University, Japan*
[*] *Corresponding author.*

Purpose/Aim: It has been demonstrated that HOCl-smear layer deproteinization improves resin-dentin adhesion of self-etch adhesive by eliminating the hybridized smear layer. However, its residual oxidizing effect on treated dentin surface adversely affects the polymerization of adhesive. An addition of zinc chloride presumably resolves this issue by enhancing the initiation of polymerization. On the other hand, the addition of zinc chloride might inactivate HOCl molecules by oxidation reactions, which might reduce the deproteinzing effect on dentin surface. Therefore, this study aimed to evaluate microtensile bond strength (TBS) of 1-step self-etch adhesives (1-SEAs) to smear layer-deproteinized dentin by HOCl solution with or without zinc chloride, and their deproteinizing effects on smear layer-covered dentin surface were analyzed.

Materials and Methods: Following the ethical approval by the Ethics Committee of Tokyo Medical and Dental University (No. 2013-022), human dentin surfaces were

deproteinized with 105 ppm HOCl solution with or without 0.7, 1.4, or 2.7 wt% zinc chloride, for 5 s, 15 s, or 30 s and rinsed off with water for 5 s, 15 s, or 30 s, whereas no pretreatment was used as control (n=5 teeth, 20 beams). The TBS was tested 24 h after bonding with either Bond Force II or Clearfil Universal Bond Quick. The deproteinizing effects on smear layer-covered dentin were compared by measuring changes in the amide:phosphate ratio using the attenuated total reflection Fourier transform infrared (ATR-FTIR).

Results: The results of TBS are summarized in Fig. 1. HOCl-pretreatment for 15 s and 30 s significantly increase TBS of both adhesives when rinsed off with water for 30 s, whereas pretreatment for 5 s did not affect their TBS. The addition of zinc chloride significantly increased the TBS with reduction of rinse-off time when the higher concentration was added. FTIR revealed that HOCl-smear layer deproteinization for 15 s and 30 s significantly reduced amide:phosphate ratio of smear layer regardless of the concentration of zinc chloride and rinse-off time.

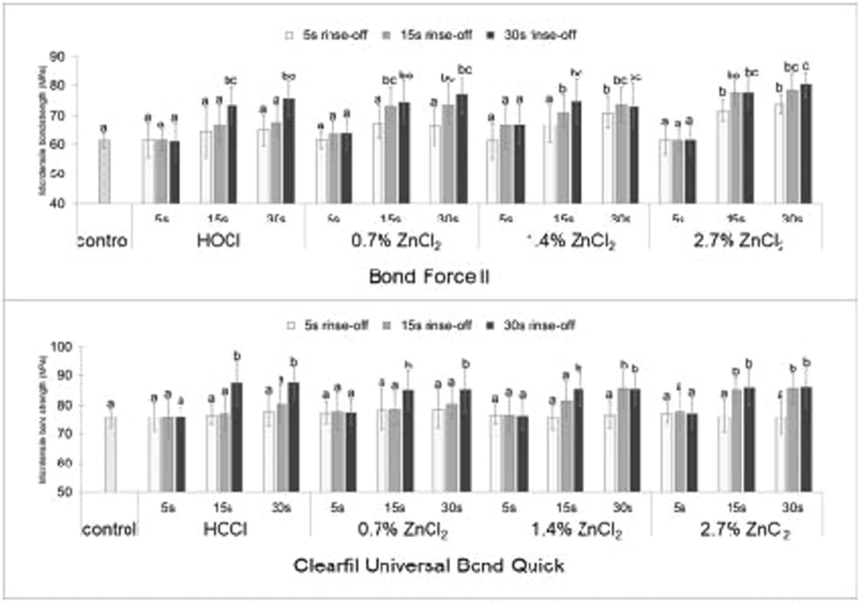


Fig. 1 Means and standard deviations of microtensile bond strength (MPa). The different script letter indicates the statistically significant difference ($p<0.05$).

Conclusions: HOCl-smear layer deproteinization for 15 s and 30 s with following 30 s rinse-off could increase dentin bond strength of 1-SEAs. The addition of zinc chloride could increase their dentin bond strengths with minimizing the rinse-off time. Additionally, the addition of zinc chloride did not alter the deproteinizing effect of HOCl solution.

https://doi.org/10.1016/j.dental.2021.12.091

62

Compression Force Testing of Veneer-Retained Anterior Fixed Partial Dentures

C. Serban [1,*], C.C. Cotca [2], I.D. Bretean [1], C. Zaharia [1], M.L. Negrutiu [1], M. Rominu [1], L. Marsavina [3], C. Sinescu [1]

[1] *Victor Babes University of Medicine and Pharmacy Timisoara, Romania*
[2] *Washington Institute of Dentistry and Laser Surgery, USA*
[3] *Polytechnic University of Timisoara, Romania*
[*] *Corresponding author.*

Purpose/Aim: The focus of this study is twofold; the first objective is to evaluate the resistance of veneer-retained anterior fixed partial dentures to compression testing. The second objective is to determine if veneer retainers with these axial grip extensions improve the restorations resistance to compressive forces as demand for biomaterial and access to care is often globally differentiated.

Materials and Methods: Two maxillary typodont models with edentulous spaces in the left lateral incisor area were obtained. On each typodont model, the central incisor and canine neighbouring the edentulous space were given veneer-type preparations with a chamfer finish line. On one model, 2-mm axial grip extensions were added to the prepared facial surface of the abutment teeth. Metal duplicates of the prepared abutment teeth and edentulous

spaces of each typodont model were produced using the lost wax casting technique. The two metal duplicates were scanned, and ten identical CAD/CAM restorations were produced for each metal duplicate. The restorations were cemented to metal duplicates and were subjected to compressive strength testing using a universal testing machine. Compressive forces were applied from the incisal margin towards the cervical in order to determine the force at which the restorations undergo debonding or fracture.

Results: Subject specimen N tested totalled 20. The veneer-retained restorations without axial grip extensions all underwent debonding but none fractured. In the veneer-retained restorations with axial grip extensions retention, nine cases of debonding (90%) were recorded and one case of fracture (10%) was recorded. The veneer-retained restorations with axial grip extensions (M = 302 N, SD = 79) compared to the restorations without axial grip extensions (M = 228 N, SD = 60) withstood significantly higher compressive forces ($p < 0.05$).

Conclusions: This study shows that veneer-retained anterior fixed partial dentures with axial grip extensions can withstand higher compression forces than veneer-retained anterior fixed partial dentures without axial grip extensions. Veneer-retained anterior bridges can be useful in addressing esthetic concerns in a minimally invasive manner. This study shows that axial grip extensions can play a crucial and important role in addressing concerns about resistance and long-term success of this type of restoration. An important clinical relevance will be highlighted for endodontically treated dentition versus non-endodontic treated dentition. Additionally, there will be reporting on intersectional pending studies regarding custom geo-position of axial grip extensions preparation design.

https://doi.org/10.1016/j.dental.2021.12.092

63

Aesthetic Properties of New Hybrid Resin Block for CAD/CAM

T. Shoji *, D. Machida, F. Fusejima, T. Kumagai

GC Corporation, Tokyo, Japan
* *Corresponding author.*

Purpose/Aim: Hybrid resin block for CAD/CAM are known as useful material for clinical use. In last year, hybrid resin crown for CAD/CAM restoration in anterior teeth was approved by Japanese national health insurance. Recently we launched highly aesthetic resin block CERASMART LAYER only in Japan. CERASMART LAYER can materialize an aesthetic appearance close to natural teeth because it has three-layered composition. The purpose of this study was to evaluate aesthetic properties of the new material and other products in the marketplace.

Materials and Methods: Five materials were selected for experimental and analysis, 1) CERASMART LAYER (GC Corp.), 2) KATANA AVENCIA N (Kuraray), 3) KZR-CAD HR Block4 E-VA (YAMAKIN), 4) HC HARD AN (SHOFU), 5) ENAMIC Multicolor (VITA). These blocks were evaluated by Tooth-brush test. The specimen of tooth-brush test was formed into anterior teeth shape by using Cerec inLab MC XL (Dentsply Sirona) and was recontoured and polished in accordance with instructions. The specimen was placed in silicone mold in order to define the position of abrasion by brush. The test was conducted with tooth-brush machine for 12,000 cycles. The surface morphology of specimens before and after test was investigated with laser microscope (KEYENCE) and evaluated surface roughness (Ra value). All results were analyzed by one-way ANOVA ($p<0.05$).

Results: The results of tooth-brush test, CERASMART LAYER showed the lowest Ra value after 12,000 cycles of tooth-brush abrasion because of uniformly dispersion and high loading of inorganic nano-filler. In addition, only CERASMART LAYER and KATANA AVENCIA N showed glossy surface in spite of after 12,000 cycles of tooth-brush test.

Conclusions: From the results, CERASMART LAYER exhibited the lowest surface roughness and highly gloss retention. Therefore, it is expected that CERASMART LAYER is a durable and aesthetic material and may have clinical advantages.

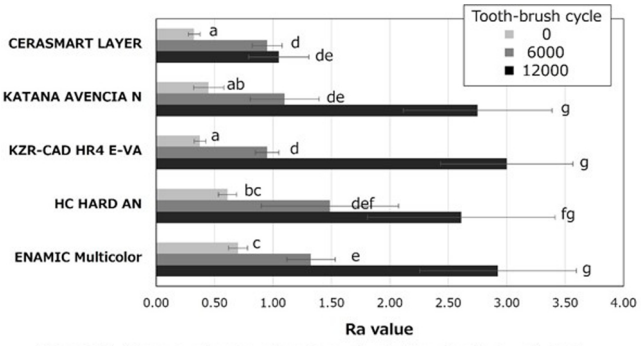


Figure Surface roughness of each product after tooth-brush test. (Same alphabet means no significant difference : $p<0.05$)

https://doi.org/10.1016/j.dental.2021.12.093

64

Ceramic Composites from Bovine Hydroxyapatite, ZrO_2@SiO_2, and Hydroxyapatite + 15%ZrO_2@SiO_2

L.J. Azevedo-Silva [1], D.S.S. Padovini [2], B.M Ferrairo [1], P.R. Minim [1], L.F. Pereira [1], R.S. Monteiro [1], C.A. Fortulan [3], P.N. Lisboa-Filho [4], A.F.S. Borges [1]

[1] *School of Dentistry, University of Sao Paulo, Bauru, Brazil*
[2] *Department of Chemistry, Sao Paulo State University, Bauru, Brazil*
[3] *Department of Mechanical Engineering, University of Sao Paulo, Sao Carlos, Brazil*
[4] *Department of Physics, Sao Paulo State University, Bauru, Brazil*

Purpose/Aim: This study aimed to synthetize and evaluate the biaxial flexural strength of dense polycrystalline

experimental composites from bovine hydroxyapatite (HA); ZrO_2@SiO_2 coreshell; and HA + 15%ZrO_2@SiO_2.

Materials and Methods: HA was extracted from solid bovine bone residues and broken to submicrometric powder. ZrO_2 coreshell covered by SiO_2 was synthetized through Stober sol-gel method. Disc-shaped specimens (12 ×1.2 mm) were synthesized at 1300 C (HA), 1340 C (ZrO_2@SiO_2), and 1300 C (HA + 15%ZrO_2@SiO_2). The sintering temperatures followed the maximum temperature indicated for each material, according to the literature. Next, the specimens were submitted to biaxial flexural strength test. The results were analyzed regarding normality by Shapiro Wilk test. Comparisons were made by Kruskall-Wallis test (α = 0.05) followed by Tukey test.

Results: DRX analysis demonstrated the characteristic peaks of ZrO2 and HA in HA +15%ZrO_2@SiO_2. It was also possible to observe HA crystallinity decreasing with the addition of the coreshell. ZrO_2@SiO_2 biaxial flexural strength (140.2 16.05 MPa) was significantly greater (p<.001) than HA (99.2 8.66 MPa), and HA + 15%ZrO_2@SiO_2 (107.5 5.44 MPa). HA and HA + 15%ZrO_2@SiO_2 showed no statistically differences.

Conclusions: ZrO_2@SiO_2 sintering was a promising alternative to make crystalline materials and HA-ZrO_2@-SiO_2 composite can be a promising biomaterial, after the search for adjustments in the sintering process.

https://doi.org/10.1016/j.dental.2021.12.094

65

Evaluating Boron-Doped Soda Lime Glass for Finishing Dental Zirconias

A.C. Silva [1,*], C.S. Rodrigues [1], T.M.B. Campos [2], R.M.M. Marinho [1]

[1] *Department of Dental Materials and Prosthodontics, Sao Paulo State University (Unesp), Sao Jose Dos Campos, Br*
[2] *Physics Departament, Aeronautics Technological Institute (Ita), Br*
[*] *Corresponding author.*

Purpose/Aim: Even though monolithic restorations can be produced from dental zirconias, glaze and stains applications are routine procedures for a natural appearance result. Thus, this study evaluated the use of boron-doped soda lime glass as an alternative for finishing zirconia restorations.

Materials and Methods: Disc-shaped samples of second and third generations zirconia were prepared: 3Y-TZP (ZPex, Tosoh) and 5Y-PSZ (Zpex Smile, Tosoh) (ISO 6872, diameter: 12 mm; thickness: 1.2 mm). The samples were polished with SiC #1200 sandpaper, sintered at 1550 C for 2 hours (Sirona inFire HTC speed) and randomly divided into 4 groups: 3Y-TZP with comercial glaze (3Y-G); 5Y-PSZ comercial glaze (5Y-G); 3Y-TZP with boro-doped soda-lime glass (3Y-SL) and 5Y-PSZ with boron-doped soda lime glass (5Y-SL). Then, glaze layer (Vita Akz 25, VITA Zahnfabrik, Germany) was mixed with the manufacturer building liquid, applied over the zirconia discs with a brush and fired at 950 C for 20 min. The boron-doped soda lime glass powder was mixed with propylene glycol, applied with a brush and fired at 1200 C for 20 min. The samples were subjected to surface roughness analysis in a contact profilometer for average (Ra) and ten-point-mean roughness (Rz) assessment. The biaxial flexural strength (MPa) was measured in a universal testing machine with a loading speed using the piston-on-three-ball method. The strength and roughness values (MPa) were analyzed by two-way ANOVA (α= 0.05).

Results: The glaze application led to slightly lower Ra values when applied over the 5Y-PSZ when compared to the other groups: 3Y-G (Ra-0.011; Rz-0.083), 3Y-SL(Ra-0.011; Rz-0.076), 5Y-G (Ra-0.008; Rz-0.054), 5Y-SL (Ra-0.011; Rz-0.076). However, no statistical difference was observed in Rz (p>0.05). The highest flexural strength values were observed for 3Y-TZP samples. The statistical analysis showed significant differences as follows: 3Y-SL (1026.99 MPa 130.04) > 3Y-G (818.401 MPa 89.63) > 5Y-SL (762.91 MPa 123.30) > 5Y-G (620.87 MPa 50.38).

Conclusions: Although roughness values were similar among the experimental groups, boron-doped soda lime glass was able to improve flexural strength of both 3Y-TZP and 5Y-PSZ when compared to commercial glaze.

https://doi.org/10.1016/j.dental.2021.12.095

66

Polyvinylsiloxane Impression Dimensional Stability after Immersed in Chloroxylenol 5% Solution

N. Mohamed Kutty, W. Siswomihardjo [*], S. Sunarintyas, D.A. Widyasrini

Department of Dental Biomaterial, Faculty of Dentistry, Universitas Gadjah Mada, Yogyakarta, Indonesia
[*] *Corresponding author.*

Purpose/Aim: The aim of the study was to determine the polyvinylsiloxane impression dimensional stability immersed in 5% chloroxylenol disinfection solution for different durations.

Materials and Methods: The study used Polyvinylsiloxane (Light Bodied), 5% chloroxylenol (Dettol), and a master cast in the form of a block measuring 30 mm length, 30 mm width, and 20 mm height. The research subjects were made by using a mixing gun to mix the catalyst then the impression was taken on the master cast. The research subjects were 16 samples divided into 3 treatment groups of immersion in 5% chloroxylenol disinfectant solution, namely immersion for 5 minutes, 10 minutes, 20 minutes and 0 minute for control group, then rinsed with distilled water. Next, the impression was filled with dental stone. The dental stone impression was measured in dimensions (length, width, height) with a manual caliper with an accuracy of 0.05 mm and then the volume was calculated. The dimensional changes were measured by reducing the treatment volume with the control volume.

Results: The collected data showed that the mean and standard deviation polyvinyl siloxane impressions dimensional changes after immersed in 5% chloroxylenol disinfectant solution were 29.92 12.20 mm^3 (5 minutes), 59.78 17.25 mm3 (10 minutes), 82.17 14.91 mm^3 (20 minutes). One way ANOVA test result showed $p<0.05$ and there was a significant difference ($p<0.05$) among the durations tested.

Conclusions: From this study can be concluded that the immersion duration in 5% chloroxylenol disinfectant solution affected on the dimensional stability of the polyvinylsiloxane impression. The longer the immersion duration, the greater the dimensional changes of the polyvinylsiloxane impression. However, all the immersion duration tested were still within the tolerance limits specified by the ADA.

https://doi.org/10.1016/j.dental.2021.12.096

67

Development of a Magnetic Nanorod Reinforced Bulk Fill Composite

Z.R. Skeete [1,*], A.R. Ochoa A [2], J.P. Bequette [1], R.A. Brothers [1], T.T. Yuan A [2], Cdr N.J. Hamlin [3], Col W. Lien B [2], Lt T.A. Truong [3], Lcdr T.A. Sarwar [1], Dr. John W Simecek [1]

[1] *Naval Medical Research Unit at San Antonio, Craniofacial Health and Restorative Medicine, USA*
[2] *United States Air Force 59Th Medical Wing, a Diagnostic and Therapeutic, B Dental Research and Consultation Service*
[3] *Naval Medical Leader & Professional Development Command, Research Department, USA*
[*] *Corresponding author.*

Purpose/Aim: The purpose of this study is to develop a magnetically active dental composite that has improved mechanical properties. Methods of resin formulation were explored for nanomaterials incorporation and to monitor the effect on mechanical reinforcement.

Materials and Methods: Magnetically-active composite resins (MCRs) were formulated up to 0.05% (w/w) of iron oxide nanorods (GetNanoMaterials) with Filtek (A2 Shade) dental composite resins. Control samples (Filtek OneBulk and Flowable) were prepared in the same manner as MCRs but without nanorods. These formulations were dispensed into 3-D printed molds and photocured (3 M Elipar DeepCure-S and Paradigm LEDs at 1470 and 1200 mW/cm^2, respectively) for 20 s on one or both sides depending on analyses. Physical and chemical evaluations of MCRs were analyzed by depth-of-cure (DoC) testing (ISO 4049), shade determination (Vita shade guide and Vita Easyshade), shear bond and compressive strength using the Alliance test system by Materials Test System (MTS). Results were analyzed using one-way ANOVA / post-hoc Tukey test (alpha = 0.05).

Results: Compared to the flowable controls, 0.01% (w/w) MCRs were found to have:

(1). change in hue, value, and chroma, having D4 instead of A2 shade due to the dark color of the MCRs. (2). statistical reduction in DoC (2.4 0.1 vs 3.4 0.2 mm, N=10, $p<0.0001$) and compressive strength (231.0 34.8 vs 252.1 52.9 N/mm^2, N=10, $p<0.05$).However, shear bond tests were not statistically different (2.9 1.3 vs 4.1 3.0 N/mm^2, N=10, $p>0.05$). Alternatively, 0.001% (w/w) MCRs (C2 shade) showed no statistical differences ($p>0.05$, N=10) for compression, shear bond, and DoC with the controls, at 241.2 61.8 N/mm^2, 2.6 1.1 N/mm^2, and 3.4 0.1 mm, respectively. Notably, one bulk sample revealed a similar trend as flowable samples when compared to their controls.

Conclusions: Overall, magnetic nanorod integration into commercial composites were promising; however, MCRs mechanical and bond strengths were mixed. Theoretically, the random orientation of the magnetic nanorods could be a probable cause for decreased compressive strength and depth of cure. Future work will involve nanorod alignment using external magnetic fields during curing to strengthen the framework, followed by the investigation of 3-D printing applications.

Disclaimer: The views expressed in this article reflect the results of research conducted by the authors and do not necessarily reflect the official views, policy or position of the Department of the Navy, Department of Air Force, Department of Defense, nor the United States Government.

https://doi.org/10.1016/j.dental.2021.12.097

68

Toothbrushing Duration Effect on Streptococcus Mutans Adherence to FRC

S. Vayravel, S. Sunarintyas [*], W. Siswomihardjo, D.A. Widyasrini

Department of Dental Biomaterial, Faculty of Dentistry, Universitas Gadjah Mada, Yogyakarta, Indonesia
[*] *Corresponding author.*

Purpose/Aim: The purpose of this research was to study if there was an effect of toothbrushing duration on the adherence of S. mutans to FRC.

Materials and Methods: The FRC sample (EverX Posterior, GC Corp, Japan) was first prepared using the mold in the shape of a disc with a diameter of 10 mm x 2 mm thickness. A total of 16 samples were prepared. Toothbrushing simulation using soft bristles was carried out on 16 samples prepared. The brushing was done with a simulated brushing tool with a speed of 250 rounds/minute and a weight of 200 grams drained in aquades. The durations selected for the simulation were 20, 40 and 60 min. A control group of 0 min toothbrushing was prepared. Streptococcus mutans were first grown, then cultured in liquid BHI medium, and incubated at 37 C for 24 hours. The turbidity of the bacterial suspension was standardized with McFarland standard of 0.5 which was equal to 1.5×10 CFU/mL. The FRC which was given the toothbrushing intervention was added into the BHI culture medium which contained S. mutans. It was then incubated at 37 C

for 2 hours. After 2 hours, the FRC samples were removed, washed with PBS and vortexed for 1 minute. The solution containing the S. mutans was analyzed using ELISA reader at a wavelength of 540 nm. Statistical analysis of Anova and LSD were examined after obtaining the data.

Results: The results showed the optical density value mean of 0, 20, 40, and 60 minutes of toothbrushing were 0.04300.0003, 0.04310.0005, 0.04320.0012, and 0.0530.0005. Statical analysis showed that there was a significant effect of toothbrushing duration on the adherence of S. mutans on FRC ($p<0.05$). LSD result showed there was a significant difference between the 60 minutes group and the others ($p<0.05$).

Conclusions: It can be concluded that the toothbrushing simulation duration up to 60 minutes increased the number of S.mutans adherence to the FRC sample.

https://doi.org/10.1016/j.dental.2021.12.098

69

Wear Resistance Comparison of 3D-Printed Composite Resin Material

D. Takada *, T. Kumagai, F. Fusejima, T. Ueno, S. Kariya

GC Corporation, Leuven, Belgium
* *Corresponding author.*

Purpose/Aim: The use of 3D printing technology to produce dental restorations has recently been introduced in the market and has become popular as a new production method. The development of optimized filler distribution has significantly improved the mechanical properties and long-term stability of the restoration. This study aimed to compare the wear resistance of 3D printed composite resin material for crown and bridge applications.

Materials and Methods: Four samples (n=4) of three different 3D printable composite resin materials were tested. The materials were GC Temp PRINT(GC), Nextdent C&B MFH (3D Systems) and CROWNTEC (Saremco dental). All specimens for the three-body wear test were printed with Asiga MAX UV printer and post-cured with the light curing device and the settings recommended by the respective manufacturer. They were submersed in 37Cwater for 24 hours, subsequently they were subjected to 100,000 cycles at a load of 0.84 MPa in a wear simulator. An acrylic plate was used as antagonist, and a slurry of PMMA and glycerin as abrasive medium was applied to the contact area during test performance. Wear value was calculated as the difference in specimen height before and after the three-body wear. Results were analyzed by one-way ANOVA ($p<0.05$). Also, the specimens were examined with a FE-SEM.

Results: It was found that GC Temp PRINT (16.36.6um) and CROWNTEC (35.530.2um) had significantly lower wear value compared with Nextdent C&B MFH (86.79.0um), though fillers were observed in all materials.

Conclusions: Within the limitations of this study, GC Temp PRINT showed higher wear resistance property thanks to its uniformly dispersed fillers and the proper silane treatment of the filler surface. Consequently, it was predicted that GC Temp PRINT can be durable for long term use in the oral environment.

https://doi.org/10.1016/j.dental.2021.12.099

70

Effect of Synthesis Parameters on Calcium Phosphates Phases and Properties

R.B. Trinca *, R.R. Braga

School of Dentistry, University of Sao Paulo, Sao Paulo, Brazil
* *Corresponding author.*

Purpose/Aim: Calcium orthophosphates (CaP) synthesis involves several chemical equilibria that define the phases in the final product. A 2 factorial design (three factors, two levels) was conducted to evaluated the interaction between pH (pH = 5 or drifting), reactants concentration ([c] = 0.25 or 1.25 mol/L) and addition velocities (add=10 or 30 mL/min) over the synthesis of Dicalcium Phosphate Dihydrate (DCPD).

Materials and Methods: Particles were synthesized by mixing $Ca(NO_3)2.4H2O$ and $(NH_4)2HPO_4$ solutions of same concentration. The calcium solution was added to the receiving phosphate solution (2000 rpm, hybrid cowles propeller), pH was either kept at 5.00.1 or let to drift. After 15 min stirring, the resulting solid was vacuum filtered, washed with water and ethanol, vacuum drying for 4 hours. All the experimental designs conditions were conducted in triplicate (n=3 for each condition, n=24 for whole design). The DCPD samples were characterized in terms of yield, phase formation, morphology and size distribution. Statistical treatment of the experimental data was conducted using the software MiniTab 19 (DOE, ANOVA and modeling).

Results: Values for synthesis yield, particle size and identified phase and morphology are shown in Table 1. Yield ranged from 87.1% to 97.9%, it was verified from ANOVA that both pH and [c] factors are significant, leading to an increase in yield when selecting drifting pH and 1.25 mol/L concentration. In overall, drifting pH leads to the highest yields, while concentration plays a secondary hole. Regarding particle size, significant effects of pH, [c], add were found for D(0.5) and Span. Briefly, selecting the levels of drifting pH, higher concentration and faster reactant addition, will lead to smaller particles, while higher concentrations lead to wider particle size distribution. X-ray diffraction confirmed the presence of a pure DCPD phase, relative intensity of peaks located at 2? equal to 11.69 and 20.95 indicates that plate like morphology was achieved for drifting pH and higher concentration, while petal like morphology were obtained at pH=5 and lower concentration.

Conclusions: Pure DCPD phase were obtained in all synthesis conditions, which particle size and morphology are directly affected by the considered factors. Mainly, conducting a synthesis in a drifting pH and high reactant concentration leads to a higher Yield% and lower particle size, while also representing advantages in meanings of simplicity and scalability of the process. The finds of this study are being used in the synthesis of DCPD for

Table 1 – Experimental conditions employed in particle synthesis. Mean values of yield and particle size and DRX characterization finds.

					Light scattering (μm)		DRX	
#	pH	[c]	add	Yield %	D(0.5)	Span	Phase	morphology
1	-	-	-	89.4±2.4	30.5±10.2	1.71±0.02	DCPD	petal
2	+	-	-	97.3±0.9	18.0±2.0	1.57±0.13	DCPD	mixture
3	-	+	-	94.5±0.5	17.7±0.6	1.76±0.10	DCPD	mixture
4	+	+	-	96.1±0.4	12.7±3.4	1.68±0.01	DCPD	plate
5	-	-	+	91.3±0.6	16.4±0.5	1.44±0.18	DCPD	petal
6	+	-	+	96.6±1.3	17.0±2.0	1.45±0.05	DCPD	mixture
7	-	+	+	94.3±0.5	12.9±0.5	1.70±0.10	DCPD	mixture
8	+	+	+	96.7±0.5	11.1±1.6	1.44±0.05	DCPD	plate

(-) levels: pH = 5, [c] = 0.25 M, add= 10 mL/min. (+) levels: pH = drift, [c] = 1.25 M, add= 30 mL/min.

experimental resin composite studies. (FAPESP 2019/04737-4 and 2020/13983-6).

https://doi.org/10.1016/j.dental.2021.12.100

71

Biomimetic Approach to Evaluate Mineralization of BAG-Containing Resin Composite

J. Yun [1], K.-H. Tsui [1], Z. Fan [2], M.F. Burrow [1], J.P. Matinlinna [1], Y. Wang [3], A. Fok [4], J.K.H. Tsoi [1,*]

[1] *University of Hong Kong, Hong Kong*
[2] *Hong Kong University of Science and Technology, Hong Kong*
[3] *Sun Yat-Sen University, China*
[4] *University of Minnesota, USA*
[*] *Corresponding author.*

Purpose/Aim: This study aims at explores immersion solutions other than standard SBF that could evaluate mineralization of dental resin composites containing low percentage bioactive glass (BAG).

Materials and Methods: Experimental UDMA/TEGDMA resin composites containing total 25 vol% glass fillers (with 0.0, 1.9, 3.8 or 7.7 vol% of 45S5 bioactive glass (BAG) fillers) were prepared. The specimens were immersed in three different solutions either with bicarbonate which are Hanks balanced salt solution (HBSS) and cell culture medium (MEM), or without bicarbonate which is a novel Simple HEPES-containing Artificial Remineralization Promotion (SHARP) solution, for 3, 7 and 14 days. These solutions were then analyzed by ICP-OES and pH, and the surfaces of the BAG composites were analyzed by SEM, XRD and FTIR.

Results: ICP-OES revealed Ca and P concentration continuously decrease, while Si concentration increases with time in all groups. Only SHARP solution is able to maintain a constant pH over the immersion time. SEM, together with XRD and FTIR, showed nano-sized octacalcium phosphate (OCP) nanospheres formation on 3.8 and 7.7 vol% BAG composites after 14 days immersion in HBSS (500-600 nm) and MEM (300-400 nm). SHARP solution enabled OCP formation after 3 days and then self-assembled into urchin-like carbonated hydroxyapatite (CHA) microspheres encompassed with nanorods of 100 nm width and 8 m length after 14 days of immersion for 7.7 vol% BAG composites.

Conclusions: This study suggests the SHARP solution can evaluate mineralization biomimetically whereas CHA microspheres can be formed on BAG-containing resin composites.

https://doi.org/10.1016/j.dental.2021.12.101

72

Six-Year Bond Stability of Universal Adhesives with Alternative Dentin Treatments

R.V. Rodrigues [*], T. Al-Mosuli, R.M. Carvalho, A.P. Manso

Faculty of Dentistry, University of British Columbia, Vancouver, Canada
[*] *Corresponding author.*

Purpose/Aim: Evaluate the effects of four dentin treatments on microtensile bond strength (MBS) for two universal adhesives, ScotchBond Universal (SBU) and All-Bond Universal (ABU), after 24-hour, 1-year and 6-year water storage.

Materials and Methods: Flat dentin surfaces from human molars were treated as follows: (i) phosphoric acid 35% (PA) for 15 s; (ii) PA for 5 s; (iii) 17% EDTA for 60 s; (iv) no treatment (self-etch mode). One of the two universal adhesives was then applied to the surface. After 24-hour storage at 37 C, teeth were sectioned to obtain beams (~0.9mm2) and randomly assigned to one of the storage times (24 h, 1-y and 6-y). Specimens were tested until failure at 1.0 mm/min on each incubation period. Failure modes were assessed with light microscope at 40x (Olympus, Tokyo, Japan). Data was submitted to Three-Way ANOVA and all pairwise multiple comparison (Holm-Sidak) at significance level = 0.05.

Results: Statistical differences were detected for surface treatments and storage times. A significant interaction between adhesive and treatment was found ($p<0.01$). The bond strengths were affected by the different surface treatments, depending on the adhesive, except for 17% EDTA with similar results for both systems. After 6-year storage, SBU showed more stable MTBS with 17% EDTA 32.36 (14.09) and self-etch mode 30.10 (13.80) ($p<0.05$). For ABU, the lowest MTBS was observed with the self-etch mode for all storage times ($p<0.01$). However, 17% EDTA

treatment for ABU at 6-year storage 39.85 (21.03) exhibited the highest MTBS ($p<0.01$). Overall, 17% EDTA treatment showed a positive effect on dentin bonding stability. The self-etch mode showed better performance for SBU compared to ABU. The failure modes for all groups were predominantly adhesive and mixed.

Conclusions: The dentin bonding stability with universal adhesives depends on the surface treatment for each adhesive material. The use of 17% EDTA for 60 s to treat dentin prior to the application of universal adhesives could be considered an alternative approach to improve bond durability.

Acknowledgements: Start-up Funds, UBC Faculty of Dentistry (AM and RC); Summer Research Award (TA), UBC Faculty of Dentistry.

https://doi.org/10.1016/j.dental.2021.12.102

73

Wear of Orthodontic Aligners Through Simulated Bruxing

B. Van Heel*, A. Fok

University of Minnesota, MDRCBB Minneapolis, USA

* *Corresponding author.*

Purpose/Aim: Studies to simulate bruxing on polymeric materials can provide clinicians with important information when selecting materials for fabricating orthodontic aligners/retainers. The aim of this study was to evaluate and compare the wear produced by one-year equivalent of simulated nighttime bruxing on clear aligners.

Materials and Methods: A set of upper and lower first and second premolars and molars were milled out of a zirconia puck and then micro-CT scanned for manufacturing the aligners. The aligners (n=2 for each material) were made of six materials: Bioacryl (B) ComfortTrack (CT) Duran (D) Endure (E) Hard Cast (HC) and Invisacryl (I).

12k cycles, i.e. approximately one-year equivalent, of moderate nighttime bruxing at 75 N was applied to the samples using the chewing simulator at the Minnesota Dental Research Center for Biomaterials and Biomechanics (MDRCBB). The MDRCBBs contact profiling system and the corresponding software Ansur were used to measure the volume, surface area, and maximum and mean depths of wear. Furthermore, micro-CT images of the samples were taken for fracture analysis.

Results: The combined volume loss ranged from 0.056 mm (CT) to 0.502 mm (B), with CT < D < E < HC < I < B. The wear surface area for the maxillary ranged from 1.8 mm (D) to 10.9 mm (B), with D < CT < I < HC < E < B. That for the mandibular ranged from 2.7 mm (CT) to 20.15 mm (HC), with CT < D < B < E < I < HC. The maxillary maximum wear depth ranged from 32.83 m (D) to 137.61 m (B), with D < I < HC < E < CT < B. The mandibular maximum depth ranged from 60.11 m (CT) to 112.75 m (B), with CT < I < HD < D < E < B. Fractures were observed at the mandibular internal fitting surface of the buccal-lingual & mesial distal cross-sections of both samples of E and CT and on one of the HC samples. Only one maxillary of D had a fracture observed at the same area.

Conclusions: The wear rate of orthodontic aligners under bruxing was highly material-dependent. Samples with higher wear rates did not fracture but those with the lower wear rates fractured.

https://doi.org/10.1016/j.dental.2021.12.103

74

CAD/CAM Fabricated Prosthetic Accuracies of Lithium Disilicate Glass Ceramic Block

K. Yamamoto *, Y. Hokii, F. Fusejima

GC Corporation, Research & Development Department, Tokyo, Japan
* *Corresponding author.*

Purpose/Aim: Lithium disilicate has been widely used as a restorative material because of its superiority in terms of esthetics and physical properties. Especially, single-appointment treatment using CAD/CAM has attracted much attention in recent years. From this kind of circumstance, a novel lithium disilicate glass ceramic (Initial LiSi Block) which does not require the crystallization process after CAD/CAM fabrication has been developed. In this study, the geometric crown cases which was designed by 3D CAD were fabricated by CAD/CAM system and their accuracy were evaluated.

Materials and Methods: Three different types of lithium disilicate glass ceramic blocks were tested. Initial LiSi Block (LS, GC Corp.) does not require a crystallization process after fabrication, while IPS e.max CAD (EM, Ivoclar Vivadent) and CEREC Tessera (TE, Dentsply Sirona) require that process.

The STL data of the geometric crown was created using CAD software. The crowns were fabricated from the lithium disilicate glass ceramic blocks using a CAD/CAM machine (CEREC MC XL (Production repeatability: 25 m), Dentsply Sirona). After fabrication, EM and TE ware crystallized or glazed by heat treatment using a furnace (Programat EP 5000, Ivoclar Vivadent) according to manufacturers instructions. The accuracy of the geometric crown was measured using an optical precision measuring machine (ATOS Capsule, GOM) (n=3), and the accuracy was compared by superimposing the fabricated crowns and the original STL data. The data was analyzed with one-way ANOVA and Tukeys tests ($p < 0.05$).

Results: The figure shows the accuracy (Percentage within 25 m, which is the repeatability of CAD/CAM machines) between the crown and STL data for each sample. LS had an accuracy of 63.2% within 25 m. The accuracy of EM decreased from 53.6% to 27.2% because of crystallization. TE had an accuracy of 25.0% before heat treatment, and the accuracy was equivalent to EM after heat treatment.

Conclusions: EM requires heat treatment at high temperature for crystallization after fabrication. Therefore, it is thought that the dimensions were deformed during the process of lithium metasilicate becoming lithium disilicate. TE is took longer grinding process time. This means TE is difficult to grind and it may affect to accuracy. Thus, TE is considered that it could not be grind it accurately in accordance with the STL data, and the lower accuracy values were obtained. It was suggested that LS can obtain an accurate workpiece because LS has good grinding properties by CAD/CAM machines and does not require crystallization process and glaze firing process.

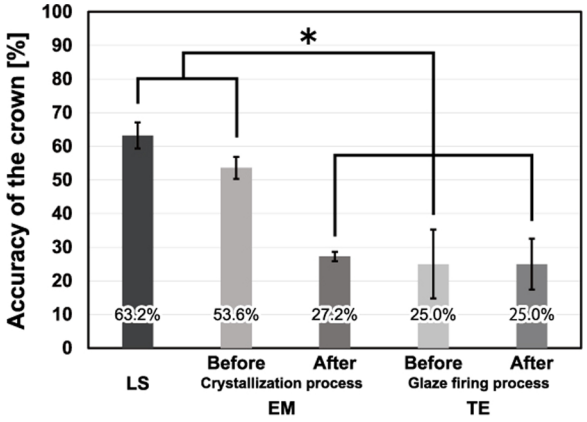


Figure Accuracy of the crown (machining accuracy of CAD/CAM machine: ±25 μm) (Tukey' s test, *:p<0.05).

https://doi.org/10.1016/j.dental.2021.12.104

75

Bond Strength of Multi-Step Adhesive at Intraoral Repair

M. Yamashita *, K. Hirano, F. Fusejima

GC Corporation, Tokyo, Japan
* *Corresponding author.*

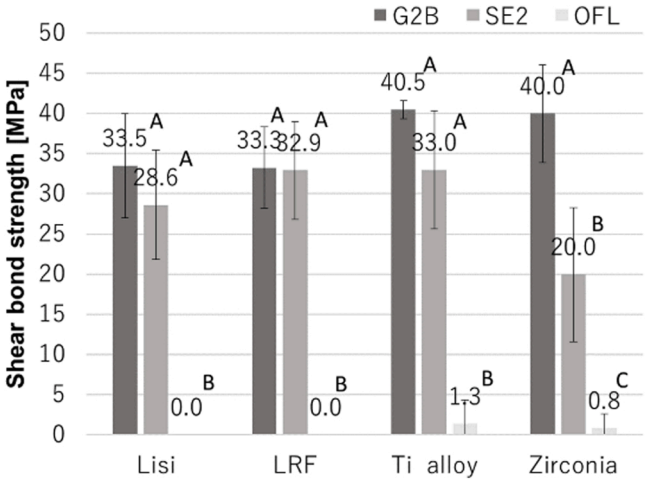
Purpose/Aim: In recent years, dental bonding system have been improved its bond strength not only to tooth structure but also to prostheses such as metals and ceramics at intraoral repair. However, in order to provide reliable adhesion to prostheses, repairing procedure is complicated and different depending on product and type of prosthesis and its bonding durability has not been much reported. We have developed a new two-step self-etching adhesive "G2-BOND Universal" that make simplify repairing procedure even multi-step adhesive. In this study, bonding durability of multi-step adhesive at intraoral repair cases was evaluated.

Materials and Methods: Several prostheses, [initial LiSi Block] (GC, LiSi), [initial LRF BLOCK] (GC, LRF), [Ti alloy] (GC, T-ALLOY) and [Aadva Zirconia disk EI] (GC, Zirconia) were used. The adherend were embedded in acrylic resin (GC, Unifast II). The multi-step adhesives used in this study

were G2-BOND Universal (GC, G2B), SE BOND2 (kuraray, SE2) and Optibond FL (Kerr, OFL). The flat adherend surface was prepared by 600-grit SiC paper. Each adhesive was applied to the prepared adherend surface according to the manufacturer's instructions, and composite resin (Clearfil AP-X, kuraray) was applied to create an adhesion test specimen referred to ISO29022. After 24 h storage in 37 degree C, the specimens were subjected to a thermocycling (5-55 C, 30 s). Shear bond strength (SBS) was tested by Universal testing equipment, SHIMADZU Autograph, testing speed at 1 mm/min (n=5). Data were analyzed by Tukey test ($p<0.05$).

Results: As results of OFL, its SBS was low and pre-testing failures (PTF) were observed in all prostheses cases. On the other hand, G2B showed high SBS for all prosthesis cases, since G2B contains thiophosphate ester monomer and phosphate ester monomer for precious metal and zirconia. On comparison with G2B and SE2, there was significant difference of SBS on Zirconica which might indicate difference of functional monomer effectiveness and G2B could make functionalize its phosphate ester monomer.

Conclusions: G2-BOND Universal has high bond strength at intraoral repair cases, so stable bond strength may be expected in clinical practice.



https://doi.org/10.1016/j.dental.2021.12.105

76

Validation of Finite Element Models for Orthodontic Aligners

N. Ye [1,*], B.E. Brown [2], S.C. Mantell [1], A.S. Fok [3], Y.C. Heo [3], B.E. Larson [2]

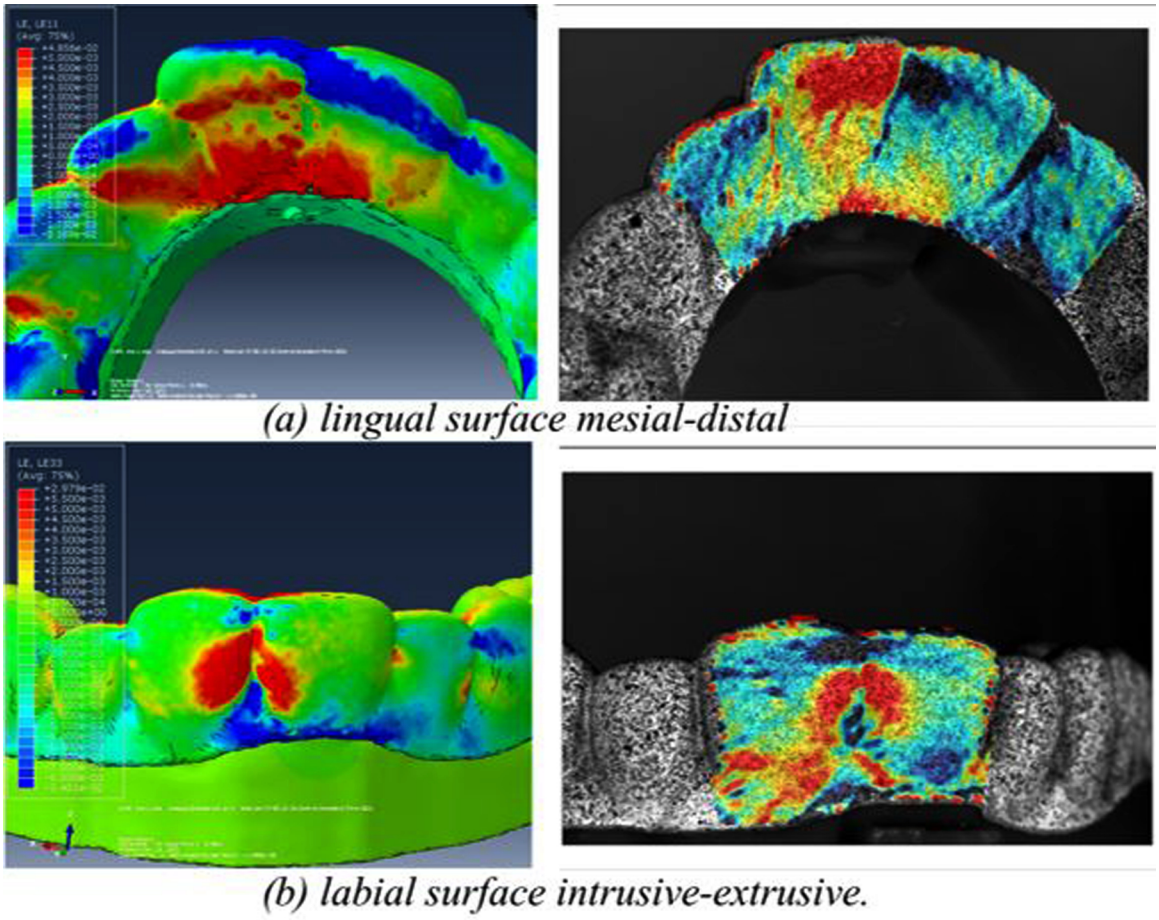
[1] *Mechanical Engineering, University of Minnesota, Minneapolis, USA*
[2] *School of Dentistry, University of Minnesota, Minneapolis, USA*
[3] *Minnesota Dental Research Center for Biomaterials and Biomechanics, University of Minnesota, Minneapolis, USA*
[*] *Corresponding author.*

Purpose/Aim: Clear thermoplastic teeth aligners with incremental misfits with the underlying teeth have become popular in orthodontics, but the biomechanics of these devices is not well understood. Neither is the tooth movement induced by such devices. The aim of this study was to develop and validate finite element (FE) models for clear thermoplastic teeth aligners for orthodontic force prediction.

Materials and Methods: FE models were created from Micro-CT scans of an aligner and a model arch of teeth with one of the incisors rotated buccal-lingually by 2.4 degrees. The models were uniformly meshed with 0.3-mm long elements. Linear-elastic mechanical properties provided by the material manufacturers were used. Fitting of the two components was simulated using Abaquss interference fit, followed by frictional surface-to-surface interaction. The assembled FE model was validated by comparing its prediction for the teeth-aligner gaps and aligner surface strains with experimental data. The experimental teeth-aligner gaps were obtained from the Micro-CT scans whereas the aligner surface strains were measured using a 2-camera digital image correlation (DIC) system.

Results: Good agreement between prediction and measurement was obtained for both the teeth-aligner gaps and aligner surface strains; see Fig. 1 for strain comparison. The linear regression between prediction and measurement for teeth-aligner gaps sampled at different positions had a R2 value of 0.99. The mean differences between prediction and measurement for the aligner surface strains (von

Mises) over 1544 nodes on labial side and 1929 nodes on lingual side were 0.07% and 0.01% respectively; both were lower than the mean background noise.



(a) lingual surface mesial-distal

(b) labial surface intrusive-extrusive.

Figure 1. Strain distributions of FE and DIC results.

Conclusions: A FE model for clear thermoplastic teeth aligners has been successfully developed and validated. The model can therefore be used with confidence to predict the forces and moments applied to teeth by the aligners, thus improving our understanding of the biomechanics of such devices and the tooth movement they induce.

https://doi.org/10.1016/j.dental.2021.12.106

77

Polymerization Behavior of Composites at Top/Bottom of Cavity Using Different-Lights

T. Yoshikawa [1,*], A. Sadr [2]

[1] *Tokyo Medical and Dental University, Japan*
[2] *University of Washington, USA*
[*] *Corresponding author.*

Purpose/Aim: We reported homogeneous polymerization of resin composite improved resin-cavity adaptation in Dent Mater 2001. Hardness ratio near 1 show degree of conversion at the bottom surface is near that of the top surface. The aim of this study was to evaluate microhardness and hardness ratio of various resin composites using different lights irradiation related to cavity wall adaptation.

Materials and Methods: Light-curing units were LED light-curing unit (Demi Ultra; Kerr). The light-cured resin composites were hybrid type Clearfil AP-X (AP, shade A3, Kraray Noritake Dental), structural color type OMNICHROMA (OC, Tokuyama Dental) and bulk fill flowable type GRACEFIL BulkFlo (BF, shade U, GC). Composite specimens of 2 mm thickness were polymerized in Teflon molds using energy density of 24,000 mJ/cm. Light irradiance were 1,200 mW/cm 20 s, 600 mW/cm 40 s (light tipresin distance: 6 mm). Just after light curing, Knoop hardness (KHN) was measured at the top and bottom surfaces of each specimen using a load of 100 g and a dwell time of 15 s (Hardness tester). The hardness ratio=KHN of bottom surface/KHN of top surface was calculated. All experiments were performed at room temperature of 232 C with humidity of 5010%. Data (n=6) were analyzed using Bonferroni/Dunn test.

Results: Immediately after light curing, KHN at the bottom surfaces of resin composites were significantly lower than that of at the top surfaces using 1,200 mW/cm

Table 1 – Knoop hardness at top and bottom surfaces of resin composite and hardness ratio.

Light-curing method/Material		KHN		Hardness ratio	
		1,200 mW/cm² 20 s	600 mW/cm² 40 s	1,200 mW/cm² 20 s	600 mW/cm² 40 s
AP	Top	62.7 (1.4)a	57.2 (1.3)	0.89 (0.01)A	1.01 (0.01)A,D
	Bottom	56.1 (1.1)a	58.1 (1.5)		
OC	Top	20.5 (0.9)b	20.0 (1.6)	0.93 (0.04)B,D	1.08 (0.06)A,B,C
	Bottom	19.1 (0.7)b	21.5 (0.9)		
BF	Top	22.9 (1.0)c	22.2 (1.2)	0.82 (0.05)A,B,C	0.92 (0.01)C
	Bottom	18.4 (1.7)c	21.2 (1.1)		

Intergroup data designated with same superscript lowercase letters for each top and bottom knoop hardness are significantly different ($p < 0.05$). Intergroup data designated with same superscript uppercase letters for each hardness ratio are significantly different ($p < 0.05$).

20 s ($p < 0.05$). Those hardness ratios were < 1. 1,200 mW/cm 20 s showed significantly smaller hardness ratio compared with that of 600 mW/cm 40 s for every resin composite ($p < 0.05$).

Conclusions: When energy density was the same, polymerization of resin composite at the bottom surface was inhibited compared with that of at the top surface using high irradiance light for three types of resin composites. Supported by Grant #25462950 and #16K11543 from JSPS. (Table 1)

https://doi.org/10.1016/j.dental.2021.12.107

78

Effect of Bevels on Load Capacity of Composite-Restored Incisors

L. Zhang[1,2,*], N. Ye[2], W.A. Aregawi[2], A. Fok[2]

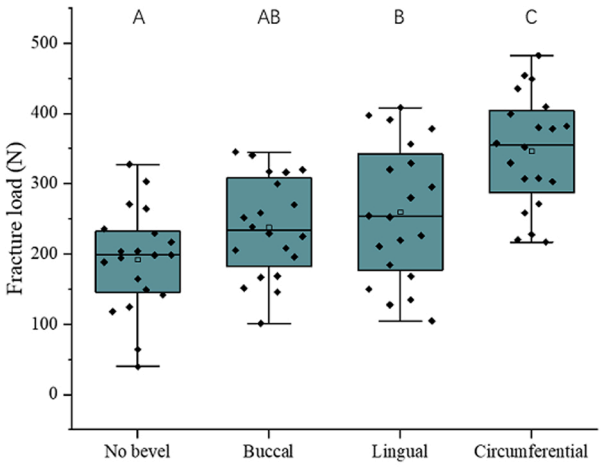
[1] *Wuhan University, China*
[2] *University of Minnesota, USA*
[*] *Corresponding author.*

Purpose/Aim: This study aimed to evaluate the effect of different bevel designs on the load capacity of incisors with a Class-IV resin-composite restoration under lingual loading.

Materials and Methods: Eighty bovine incisors were randomly assigned to 4 groups of 20. They were all given Class-IV preparations, and restored with selective etching, an adhesive and a resin composite. The groups contained preparations with: 1) no bevel; 2) a buccal bevel; 3) a lingual bevel; or 4) a circumferential bevel. The teeth were tested for their load capacity under a lingual load on a universal testing machine. Finite element models were also used to examine the stresses in them to help interpret the experimental results.

Results: The buccal-bevel group had a higher mean load capacity than the no-bevel group, but the increase was not significant. The lingual and circumferential bevels significantly increased the fracture load of the restored incisors by 35.2% and 80.3%, respectively ($p < 0.05$). The fracture load of the circumferential-bevel group was also significantly higher than that of the lingual-bevel group. Fracture in the lingual and circumferential groups started predominantly from the resin composite and then deflected cohesively into the adjacent tooth structure. The other two groups had most of their fracture modes involving interfacial failure. Finite element analysis showed that the lingual and circumferential bevels reduced the fracture-causing tensile stress at the lingual margin of the restored interface.

Conclusions: Class-IV preparations with a lingual or circumferential bevel increases the load capacity of incisors restored with resin composite under a lingual load.



Fracture load of each group. Different letters above the boxes indicate significant difference ($p < 0.05$).

https://doi.org/10.1016/j.dental.2021.12.108

79

Designing Molecules for S. mutans Biofilm Inhibition

A.J. Kendall[*], P.M.C. Scaffa, M. Logan, S. Lewis, H. Wu, J.L. Merritt, J. Ferracane, C.S. Pfeifer

Oregon Health & Science University, Biomaterials & Biomechanics, Portland, USA
[*] *Corresponding author.*

Purpose/Aim: The development of biofilms on dental restorations may lead to the formation of secondary caries. The purpose of this study was to determine the efficacy of bioactive small molecules (G43 family – Wu 2017) to disrupt/inhibit biofilm formation of S. mutans biofilms.

Methods: Eight G43 derivatives were synthesized de novo screened against S. mutans for biofilm inhibition. The compounds were dissolved in DMSO and serially diluted in H2O at 50 μM, then added to S. mutans cultures (TH medium with sucrose) & incubated for 96 h at 37°C aerobically. Biofilms were assayed for bacterial viability (metabolic activity via a renilla-reporter S. mutans – Merritt 2016). Biofilms were stained with crystal violet (CV), washed 3x with DI H2O, and then the CV was volumetrically extracted to colorimetrically determine the quantity of biofilm. Next, biofilms were washed 3x with DI H2O, then sterilized with EtOH, azeotropically dried. Insoluble biofilm was chemically digested by 1) methylation, 2) acid depolymerization, 3) reduction, and 4) acylation, resulting in methylated alditol acetates for polysaccharide connectivity determination by GC/MS. Results were analyzed with one-way ANOVA/Tukey's test (α=0.05).

Results: At 50 μM, none of the G43 derivatives showed a significant reduction of viable biofilm cells. G43 and G43TEG showed both a visual disruption of the biofilm, and significant reduction via CV quantification (Fig. 1). All G43 derivatives maintained a statistically indistinguishable polysaccharide connectivity ratio of α-1,3-hexose (mutan) to α-1,6-hexose (dextran) except G43B1OMe, which significantly reduced the mutan linkages.

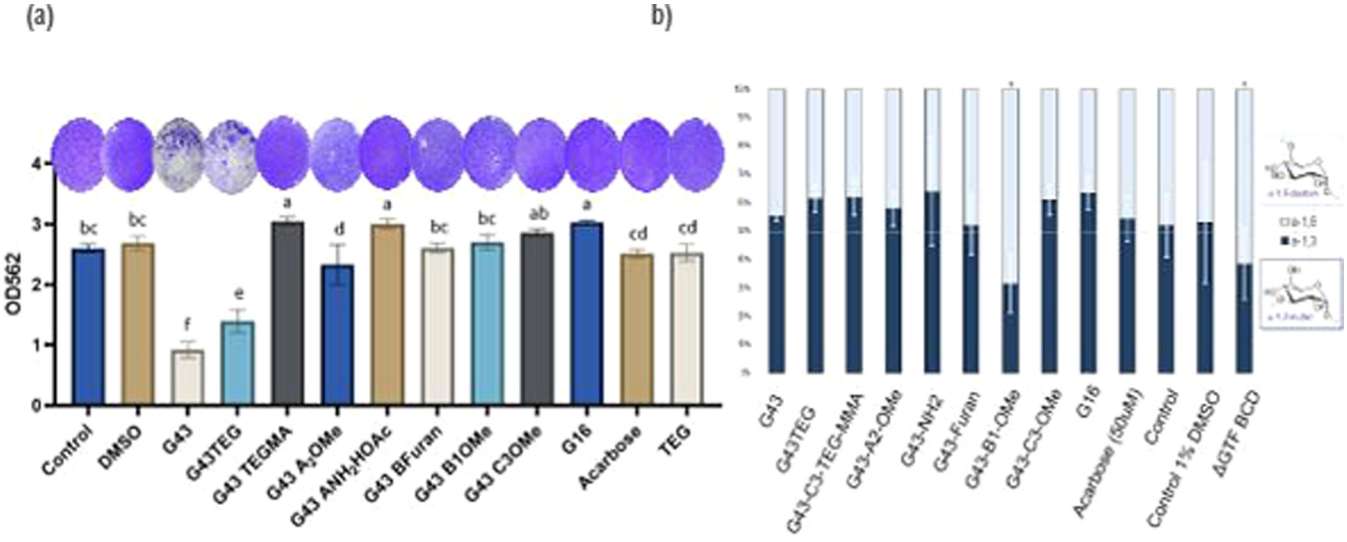


Figure 1. (a) Quantification of biofilm grown under inoculation of small molecules. (b) Polysaccharide connectivity assay for composition of biofilms grown under inoculation of small molecules.

Conclusions: This study demonstrated that the G43 family of biofilm inhibitors maintain cell viability at 50 μM with two derivatives (G43 and G43TEG) significantly reducing biofilm produced by S. mutans. Interestingly, only G43B1OMe significantly changed the polysaccharide composition (as measured by sugar connectivity).

Funded by NIH-NIDCR (R35-DE029083; K02-DE025280).

https://doi.org/10.1016/j.dental.2021.12.109

80

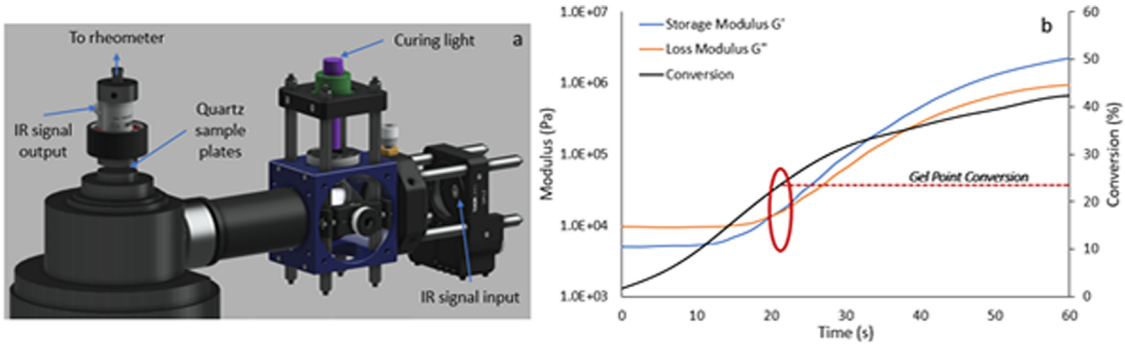
Optimization of a NIR/Photo-rheometer for Measurement of Gel-Point Conversion in Dental Resins

S. Lewis *, A. Tahayeri, J. Ferracane, C. Pfeifer

Oregon Health & Science University, Biomaterials & Biomechanics, Portland, USA
* *Corresponding author.*

Purpose/Aim: The objective of this study was to design and optimize a low-cost, hyphenated system for simultaneous measurement of methacrylate conversion and modulus development in dental resins. It was hypothesized that accurate gel point conversion could be determined using this technique and that low-stress thiourethane-modified resins (TU) would exhibit delayed gel point conversion.

Methods: A rheometer was used to measure storage modulus (G') and loss modulus (G") during polymerization of resin situated between custom quartz plates (DHR-1, TA Instruments; 300 μm thickness, 20 mm diameter, 10 Hz, 0.1% strain). Reaction kinetics (n=3) were measured using near-IR spectroscopy (NIR) and conversion was calculated as the change in area of the methacrylate absorbance peak (6165 cm^{-1}). Preliminary design for the coupled system was modeled using Autodesk Fusion 360 (Fig. 1a). The control resin was composed of BisGMA:UDMA:TEGDMA (BUT; 50:30:20 wt%), while the experimental resin contained 20 wt% thiourethane oligomer (BUT+20%TU; trimethylol-tris-3-mercaptopropionate+dicyclohexylmethane-4,4'-diisocyanate; Bacchi, 2015). Resins contained 0.2 wt% BAPO as the photoinitiator and were polymerized using a mercury arc lamp (5 min, 320-500 nm, 10 m W/cm^2). Data was analyzed with Student's t-test (α=0.05).



	Final Conversion, %	Final Storage modulus, Pa	Gel Point Conversion, %
BUT	54.4 (0.9)[a]	5.9E+06 (2.7E+05)[a]	25.8 (7.7)[a]
BUT + 20% TU	53.5 (0.9)[a]	4.5E+06 (6.0E+05)[b]	38.3 (0.4)[b]

Figure 1. (a) 3D rendering of coupled NIR and photorheometer. (b) Representative plot of BUT resin showing real-time conversion and modulus development. The gel point conversion was defined as the conversion at the crossover of G′ and G″. The data table shows conversion and storage modulus after 5 min as well as the gel point conversion for BUT and BUT + 20% TU. Column values with the same superscript are statistically similar (95%; Student's t-test).

Results: A functional prototype was built and validated, with results shown in Fig. 1. BUT+20%TU demonstrated significantly delayed gel point conversion versus BUT control without any compromise in final conversion. The delayed gelation in the TU-resin is attributed to thiol chain-transfer during polymerization. The storage modulus was reduced relative to the control, potentially due to relatively low irradiance and short experimental run time. Gel point conversion was likely elevated due to oxygen inhibition at the sample perimeter. A nitrogen chamber is currently being developed to improve accuracy.

Conclusions: The results of this study demonstrated proof-of-concept for simultaneous measurement of conversion and modulus evolution during polymerization. Accurate measurement of gel point conversion can aid in developing high performance dental restorative materials.

Support: NIH-NIDCR (R01-DE026113; R35-DE029083; K02-DE025280)

https://doi.org/10.1016/j.dental.2021.12.110

81

Improvement of methacrylate-based polymer networks by introduction of catechol moieties

D Fu*, CR Szczepanski

Chemical Engineering and Material Science. Michigan State University, Michigan, USA
** Corresponding author.*

Purpose/Aim: Dental adhesives mainly consist of methacrylate-based monomers as well as solvents and initiators. The bonding mechanism is based on the penetration of adhesive resins into the demineralized dentin surface and formation of interlocking with exposed collagen fibrils. However, phase separation into hydrophilic/hydrophobic domains leads to water sorption and deterioration of mechanical properties. Furthermore, the esterases and matrix metalloproteinases (MMPs) present in oral environment contribute to methacrylate hydrolysis and collagen degradation, respectively. All these factors accelerate decay along the adhesive interface and cause suboptimal longevity of the resin filling. A bio-inspired moiety, catechol, has been found to form strong bidentate hydrogen bonds with a variety of surfaces. The purpose of the present study was to design a novel bio-inspired adhesive with catechol moieties and evaluate whether catechol can reduce the heterogeneity of methacrylate-based network structure, decrease water sorption, inhibit the enzyme activities, and improve the longevity of adhesive materials.

Materials and Methods: Catechol methacrylate was synthesized by Steglich esterification which is described in the previous literature. The control adhesive formulations include urethane dimethacrylate (UDMA) as crosslinker (50 wt%), 2-hydroxyethyl methacrylate (HEMA) as monomer (50 wt%), and additional 0.5 wt% 2,2-Dimethoxy-2-phenylacetophenone (DMPA) as photoinitiator. In the novel catechol-contained adhesive, 25 wt% of the HEMA was replaced by catechol methacrylate, with the other components unchanged. To evaluate the performance of these two formulations, dynamic mechanical analysis (DMA), Fourier-transform infrared spectroscopy (FT-IR), water sorption and enzyme (esterases) degradation were conducted to characterize the performance.

Results: The novel catechol-contained adhesive showed similar photopolymerization kinetics (final conversion and maximum polymerization rate) to the control one, although multiple works showed that catechol exerts an inhibitory effect on the radial photopolymerization. The water sorption of the novel adhesive, however, was nearly 50% lower than the control adhesive. Moreover, the catechol-contained adhesive showed a higher resistance of the esterase hydrolysis, with less weight loss and lower release of 2-hydroxyethyl methacrylate (HEMA) and methacrylic acid (MMA).

Conclusions: The addition of catechol to adhesive formulations reduces the water sorption and improves the resistance of enzyme degradation of methacrylate. These might contribute to the formation of extra hydrogen

bonding of catechol in the low-density domains and the inhibitory behaviors of catechol to esterases. Introducing catechol into dental adhesive formulations provides a promising way to enhance the long-term performance of dental adhesive materials. Cytotoxicity and micro-tensile bonding strength tests are essential for the future works.

https://doi.org/10.1016/j.dental.2021.12.111

82

Evaluation of Different Coronal Sealing Materials on Endodontically Treated Teeth

T. Hajaj*, M.L. Negrutiu, M. Rominu, A. Barbuzan, C. Sinescu

Victor Babes Medicine and Pharmacy University Timisoara, Timisoara, Romania
* *Corresponding author.*

Purpose/Aim: In vitro studies have shown that rapid penetration of bacteria in the entire root canal system may occur after endodontic treatment without an efficient coronal seal. A proper restorative technique is necessary to ensure this, but there are a lot of materials out there. The aim of this study is to determine which type of restorative materials offer the best possible outcome.

Materials and Methods: The evaluation of the coronal sealing ability of the most relevant clinical materials was done by means of dye penetration (neutral red dye, Sigma-Aldrich, Germany), through the restorative material-tooth interface. Tests were done on all sampled using a light spectrometric device, to establish which one of the tested dental materials possesses the best sealing ability, as in the least microleakage. Forty-two extracted teeth were prepared and used for this experiment; they were sealed with 5 different restorative materials.

Results: The flow composite had the best absorbance value with 0.00675 ± 0.00096 (mean ± standard deviation) for monoradicular samples and 0.025 ± 0.00129 for pluriradicular samples.

Conclusions: The best material for coronal reconstruction post-endodontic treatment is the flow composite, which had the best sealing ability, followed by the packable composite.

https://doi.org/10.1016/j.dental.2021.12.112

83

Verification of Collagenase Production by Streptococcus Mutans

A. Zhang*, B. Lima, R. Chen, W. Aregawi, J. Rudney, C. Aparicio, A. Fok

School of Dentistry, University of Minnesota, Minneapolis, USA
* *Corresponding author.*

Purpose/Aim: The oral environment contains multiple collagenases which are believed to play a role in dentin caries formation, as collagen is one of the major components of dentin. In the laboratory, biofilm and collagenase-containing chemical models have been used to study dental degradation. However, the numerous collagenase sources in the oral cavity pose a challenge when it comes to comparing in vitro and in vivo data. Streptococcus mutans, one of the important cariogenic oral streptococcu, contains genes for at least two collagenases (SMU_759 and SMU_761), which have been shown to be expressed in samples collected from active caries. Here, we investigate if the collagenases produced by S. mutans contribute to dentin degradation.

Materials and Methods: S. mutans UA159 (ATCC700610) was cultured in BHI with/without KHCO3 using different concentrations of sucrose (0%, 0.05%, 0.2%, and 1%) at 37 C and 5% CO2 for 48 hrs. The pH of the media at 48 hrs was measured by using pH test paper strips. RNA from S. mutans biofilms cultured without KHCO3 was collected to measure collagenase gene expression by RT qPCR. To measure collagenase activity, KHCO3-buffered BHI was used for culturing to avoid collagenase denaturing caused by low pH. Supernatants of the same culture were centrifuged, filter sterilized and dialyzed, and exposed to a commercially available colorimetric assay kit. Absorbance readings were collected every 20 min for 16 hrs.

Results: With KHCO3 buffering, the pH of the media containing 48-hrs S. mutans cultured with 0%, 0.05%, 0.2%, and 1% sucrose were around 7.6, 6.5, 6.0, and 5.5, respectively. The corresponding pH values of media without KHCO3 were around 7.0, 5.5, 5.0, and 4.5. Addition of 1% W/V sucrose in BHI led to an approximately 20-fold increase in the expression of both SMU_759 and 761 collagenases compared to BHI only. Collagenase expression increased by less than 3-fold when 0.05% and 0.2% W/V sucrose was added. Although quite slow, a continuous reduction in absorbance was observed in the 16-hr collagenase activity test, indicating collagenase activity of the media containing S. mutans. The collagenase activities of the samples with 0%, 0.05%, 0.2%, and 1% sucrose were: 0.00106, 0.000679, 0.000679, and 0.000931 U/ml, respectively.

Conclusions: Gene expression and collagenase activity test showed that S. mutans produced active collagenase(s) in response to sucrose during the 48 hrs of culturing, which supports the idea that S. mutans contributes to dentin degradation.

https://doi.org/10.1016/j.dental.2021.12.113

Paffenberger Award Finalists

P1

Calcium Silicate Loaded-Porous Chitosan Scaffold for Pulp-Dentin Complex Regeneration

M.L. Leite[1,*], C. Anselmi[1], I.P.M. Soares[1], A. Manso[2], J. Hebling[1], R.M. Carvalho[2], C.A. De Souza Costa[1]

[1] *São Paulo State University, Brazil*
[2] *University of British Columbia, Canada*
* *Corresponding author.*

Purpose/Aim: Innovative pulp therapy strategies based on the use of biomaterials capable of stimulating dental pulp

cells to participate effectively of the complete pulp-dentin complex regeneration is a challenge in Dentistry. Therefore, the aim of this study was to develop and characterize several formulations of calcium silicate (SiCa)-loaded porous chitosan (CH) scaffolds, and evaluate their bioactive and chemotactic potential on human dental pulp cells (hDPCs).

Materials and Methods: Different concentrations of SiCa suspensions (0.5, 1.0 and 2.0%, w/v) were either incorporated (1:5; v/v) or not to 2% CH solution, establishing the following groups: CH (control); CH+0.5SiCa; CH+1.0SiCa; CH+2.0SiCa. The resulting solutions were submitted to thermally induced phase separation followed by freeze drying to obtain porous scaffolds. The topography and chemical characterization (SEM/EDS) of the scaffolds, as well as their pH and calcium release kinetics were assessed. Next, hDPCs were seeded onto the scaffolds to assess their bioactivity potential according with the parameters of cell viability (Live/Dead assay; 1, 7 and 14-days), proliferation (AlamarBlue assay; 1, 7 and 14-days), adhesion and spreading (F-actin assay; 1, 7 and 14-days). The pulp cells were also evaluated for total protein synthesis (Lowry Protein assay; 14-days), alkaline phosphatase activity (ALP Assay Kit; 14-days), mineralized matrix deposition (Alizarin Red assay; 21-days), and gene expression of odontogenic differentiation markers (ALP, DSPP, and DMP-1; RT-qPCR assay, 21-days). The chemotactic stimulus of the scaffolds on pulp cells (Transwell assay; 24 h) was also assessed. Data were analyzed by ANOVA and Tukey post-hoc (?=5%).

Results: The incorporation of SiCa in the chitosan scaffold formulations increased the pore diameter in comparison to control ($p<0.05$). High amounts of SiCa changed the surface nano-topography of the chitosan scaffolds (Image 1) and increased the pH and Ca release ($p<0.05$). Greater cell viability, proliferation, adhesion and spreading, as well as expression of odontogenic markers and mineralized matrix deposition was observed in the CH+1.0SiCa and CH+2.0SiCa groups ($p<0.05$). However, increased synthesis of total protein and mineralized matrix, as well as expression of DMP-1 and DSPP occurred only in group CH+2.0SiCa ($p<0.05$).

Conclusions: Based on the fact that porous chitosan scaffolds enriched with 2% of calcium silicate showed improved bioactive and chemotactic potential on hDPCs, it should be considered as a potential biomaterial for cell-free tissue engineering strategy to drive pulp-dentin complex regeneration.

https://doi.org/10.1016/j.dental.2021.12.114

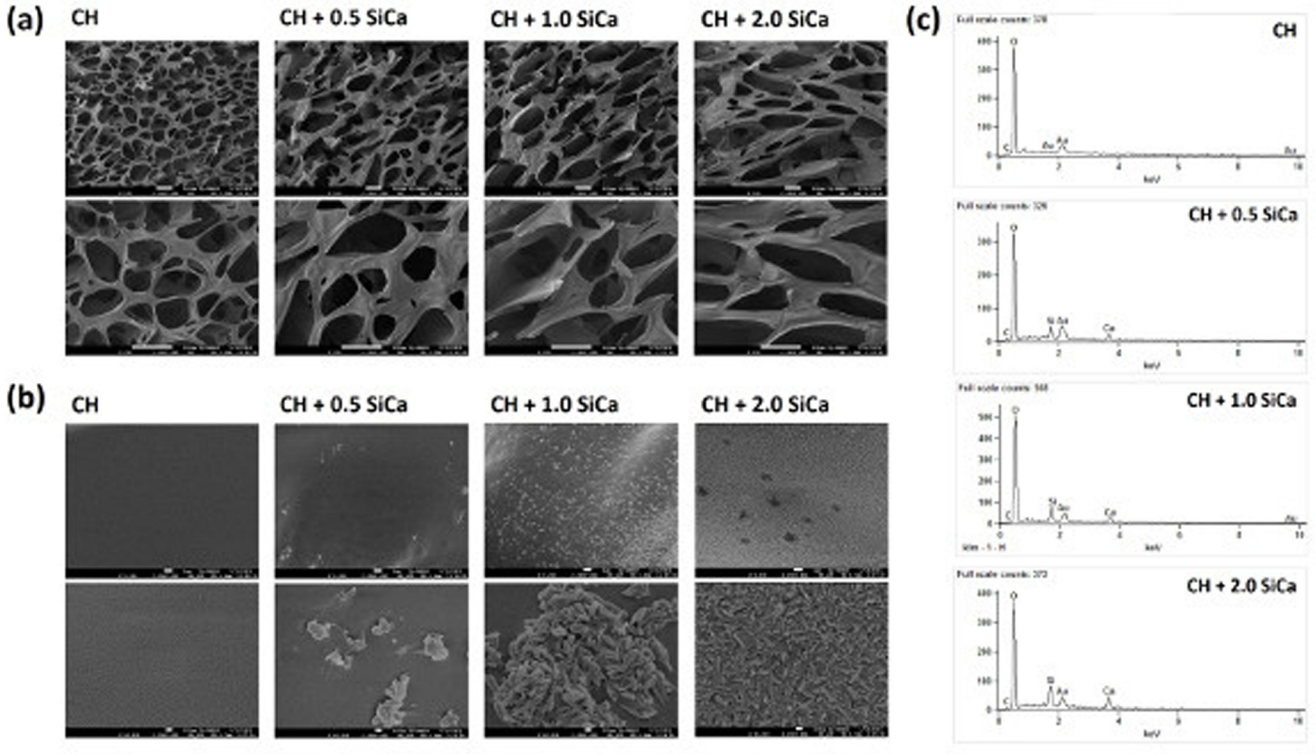


Image 1 – (a) Scanning electron microscopy (SEM) images of the different formulations of the porous chitosan scaffolds associated or not to calcium silicate at 100 and 250 x magnification. (b) SEM images of nano-topography of scaffold surface at 1.000 and 40.000 x magnification. (c) Energy-dispersive X ray spectroscopy of the different formulations of the scaffolds. It was detected the presence of Ca^{2+} and Si^{3+} in the porous chitosan scaffolds associated with calcium silicate.

P2

Optimization of Mechanical Properties of Electrospun PLGA/SEP/HAp Based GTR/GBR Membrane

L. Kalluri [1,*], J.A. Griggs [1], A.V. Janorkar [1], R. Chandran [1], X. Xu [2], Y. Duan [1]

[1] *University of Mississippi Medical Center, Jackson, USA*
[2] *School of Dentistry, Louisiana State University Health, New Orleans, USA*
[*] *Corresponding author.*

Purpose/Aim: We are developing a novel biomimetic guided tissue regeneration/guided bone regeneration (GTR/GBR) membrane with a FDA-approved biodegradable copolymer poly (lactic-co-glycolic acid) (PLGA), a novel and "green" cost-effective biomaterial, soluble eggshell membrane protein (SEP) and nano-hydroxyapatite (HAp) by electrospinning process. Taguchi orthogonal array design delineated PLGA wt% and SEP wt% to be the significant factors affecting the mechanical properties of electrospun PLGA/SEP/HAp membrane. The objective of this study is to optimize the significant factors for achieving the maximum mechanical properties of a novel electrospun PLGA/SEP/HAp membrane.

Materials and Methods: Electrospun PLGA/SEP/HAp membrane specimens (n=22) were prepared with varying concentrations of SEP and PLGA as predicted by DOE software (Central composite design folio, Reliasoft, USA), using an Inovenso apparatus. For all these specimens, the HAp (2 wt %) and electrospinning parameters (S-C distance = 12.5 cm, applied voltage = 18 kV, flow rate = 0.6 ml/h) were maintained constant. The mechanical properties of all the specimens were evaluated using Sintech 2/G mechanical testing system. Based on the obtained tensile testing data, central composite design was used to optimize the significant factors affecting the mechanical properties of the composite membrane. The independent variables investigated were PLGA wt%, SEP wt%, with values ranging from 6 and 11, 0.34 and 20, respectively. The response variables analyzed were tensile strength and elastic modulus.

Results: The elastic modulus and tensile strength values of all the tested specimens varied from 12.33 MPa to 60.86 MPa and 1.23 MPa to 4.10 MPa, respectively. ANOVA outlined SEP wt% and non-linear effect of PLGA wt% as the significant factors affecting the elastic modulus, and, non-linear effect of SEP wt% as the significant factor affecting the tensile strength of an electrospun PLGA/SEP/HAp membrane. SEP wt% (P = 0.0018) and non-linear effect of PLGA wt% (P = 0.074) had a positive correlation with modulus. Non-linear effect of SEP wt% had a negative correlation with tensile strength (P = 0.0977). Furthermore, optimization using central composite design demonstrates that the predicted maximum mechanical properties of 3.062 MPa tensile strength and 39.816 MPa elastic modulus can be obtained at optimum concentrations of 8.9 wt% PLGA and 7.2 wt% of SEP as depicted in Fig. 1.

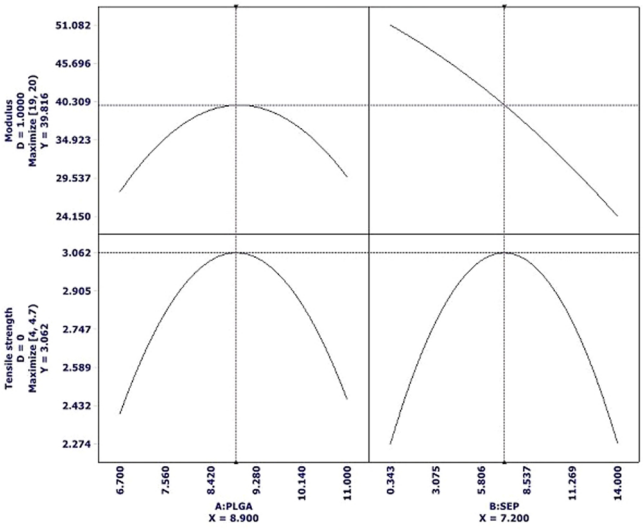


Figure 1: Optimum solution

Conclusions: To conclude, the central composite design predicted that maximum tensile strength of 3.062 MPa and maximum elastic modulus values of 39.816 MPa can be obtained with optimum values of 8.9 wt% PLGA and 7.2 wt % SEP.

https://doi.org/10.1016/j.dental.2021.12.115

P3

Effect of Dental Implant Design Parameters on Its Fatigue Limit

M. Satpathy [1,*], R.M. Jose [1], M.J. Sinclair [1], Y. Duan [1], A. Della Bona [2], J.A. Griggs [1]

[1] *University of Mississippi Medical Center, Jackson, USA*
[2] *University of Passo Fundo, Passo Fundo, Brazil*
[*] *Corresponding author.*

Purpose/Aim: Narrow-diameter dental implants suffer from high incidence of mechanical complications. This study screened the design parameters of a narrow-diameter implant that have a significant effect on the implant fatigue limit.

Materials and Methods: A dental implant assembly (DI1), which included an implant body (Biomet 3i), an abutment (GingiHue®) and a screw (Gold-Tite Square screw), was scanned using micro-computed tomography (Skyscan 1172) and was measured using Mimics (Materialise) and an optical microscope (Keyence). Sixteen design parameters were measured on DI1. The 20% lower and higher levels from these reference values were calculated for each design parameter. Taguchi orthogonal array

(Design of Experiments - DOE) was used to generate 27 combinations of these design parameters. The solid models of these 27 designs and DI1 were constructed using SOLIDWORKS (Dassault Systèmes). For each assembly, a loading cap (to simulate the crown) and a bi-layered bone holder (cortical and cancellous bone) were constructed. Finite Element Analysis (FEA) was performed in ABAQUS (Dassault Systèmes) under a 100 N 30-degrees off-axial load (ISO 14801). fe-safe (Dassault Systèmes) was used to estimate the fatigue limits. ANOVA statistical test in DOE was used to screen the design parameters that had significant effects on the implant fatigue limit.

Results: The best of the 27 designs (fatigue limit: 213 N) had an 83% increase in fatigue limit compared to the original Biomet 3i (DI1) design (fatigue limit: 116 N). The two-way interaction between the degree of coronal and apical tapers of the implant had a significant effect on the implant fatigue limit (p?0.05) (Fig. 1). More specifically, the inverse correlation between these two factors led to higher fatigue limits. Among them, the combination with little coronal taper and large apical taper had the maximum fatigue limit. This is reasonable from a bone maintenance point-of-view because the cone of bone resorption that usually occurs at the bone crest will leave the most coronal portion of the implant without bone contact. Hence, if the coronal portion has little taper, then the gingival portion will have plenty of surface area for distributing forces on the bone.

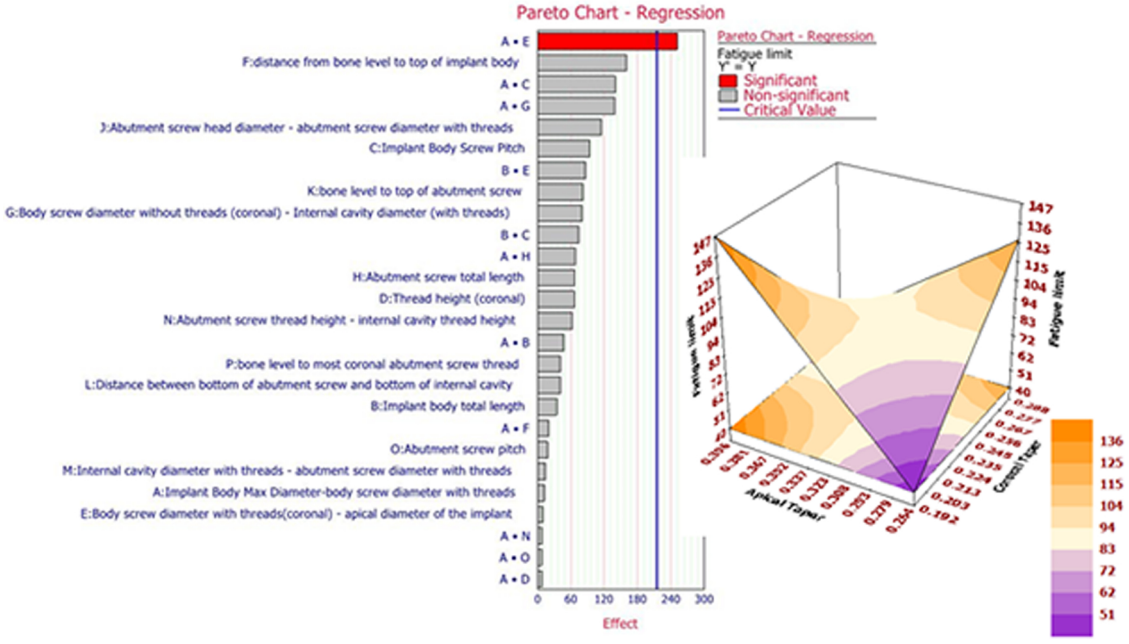


Figure 1: (Left) Pareto regression chart showing the implant design parameters and their relative effects on the implant fatigue limit. Here, 'A' is the degree of coronal taper of the implant and 'E' is the degree of apical taper of the implant. ANOVA statistical test indicated that the two-way interactions between A and E had the most significant effect on the implant fatigue limit (p≤0.05). (Right) Surface plot of the significant parameter indicates that the inverse correlation between A and E led to higher fatigue limits.

Conclusions: Using a Taguchi orthogonal array proved to be an efficient strategy for screening implant design parameters for significant effects on fatigue limit. The fatigue limits of narrow-diameter dental implants can be significantly improved by incorporating a low degree of coronal taper and high degree of apical taper on the implant.

https://doi.org/10.1016/j.dental.2021.12.116

P4

Prevention of Alveolar Bone Loss of Colocasia Esculenta Varnish

S.J. Shin [1,*], S.H. Moon [2], S.H. Oh [1,2], J.M. Bae [1,2]

[1] *Department of Dental Biomaterials, College of Dentistry, Wonkwang University, Iksan, Korea*
[2] *Institute of Biomaterials & Implant, Wonkwang University, Iksan, Korea*
[*] *Corresponding author.*

Purpose/Aim: Periodontitis is the primary cause of tooth loss in adults. Colocasia esculenta extract (CE) was known to have antimicrobial, anti-inflammatory, and anti-osteoclastogenic effects. We fabricated experimental varnish mixed with CE that can be adhered to teeth in the long term. This study aimed to evaluate the prevention effect of the alveolar bone loss of CE varnish using the rat ligature-induced periodontitis model

Materials and Methods: The minimum inhibitory concentration (MIC) and minimum bactericidal concentration

(MBC) of CE against Porphyromonas gingivalis were evaluated. Cytotoxicity of CE was determined with a CCK-8 kit for L929 cells. An experimental varnish was fabricated, and 15 wt% CE was mixed with the varnish. Sprague Dawley rats (8-week-old, male) were divided into four groups; Negative control (NC), Positive control (PC), Varnish group(V), and Varnish with CE group(VCE). Periodontitis was induced by ligature of 4/0 silk to the maxillary second molar. In the NC group, the ligation was immediately removed. Then, the varnish was applied around the ligated teeth. After 14 days, the rats were sacrificed, and alveolar bone loss was evaluated using micro-CT. Inflammatory cytokines of the gingiva were analyzed by real-time qPCR.

Results: The MIC of CE was 31.3 ?g/mL, and the MBC was 62.5 ?g/mL. CE showed no cytotoxicity at 500 ?g/mL or less. The VCE group showed significantly lower alveolar bone loss than the PC group ($p<0.05$), but no significant difference from the V group ($p>0.05$). MMP-9 and IL-6 were significantly lower CEV varnish group than in the V group ($p < 0.05$).

Conclusions: CE was effective in inhibiting P. gingivalis and did not show any cytotoxicity at the antibacterial concentrations. VCE prevented alveolar bone loss in the rat and reduced the expression of inflammatory cytokines. Varnish with CE is regarded to be applied to teeth for the prevention of periodontitis.

https://doi.org/10.1016/j.dental.2021.12.117

P5

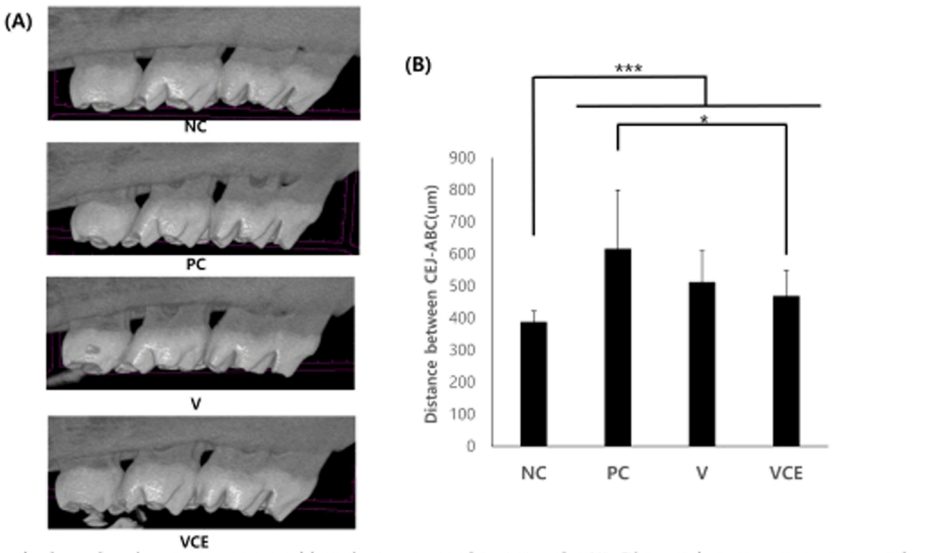
Photocatalytic Activity and Antibacterial Behavior of Polyaniline-Doped Titanium Oxide Layers

Aya Ali [1,*], A Janorkar [1], M Marquart [2], J Griggs [1], J. Bumgardner [3], M Roach [1]

[1] *Department of Biomedical Materials Science, University of Mississippi Medical Center*
[2] *Department of Microbiology and Immunology, University of Mississippi Medical Center*
[3] *Biomedical Engineering, University of Memphis*
[*] *Corresponding author.*

Purpose/Aim: The purpose of this study was to evaluate the effect of polyaniline doping of mixed anatase and rutile phase titanium oxide layers on the resulting photocatalytic activity (PCA) and antibacterial behavior.

Materials and Methods: Commercially pure titanium grade 4 (CPTi) samples were divided into three groups: (1) anodized in 0.5 M sulfuric acid (control); (2) electropolymerized using cyclic voltammetry in a mixture of 0.5 M sulfuric acid and 0.25 M aniline after anodization in 0.5 M sulfuric acid (ACV); and (3) anodized in 0.5 M sulfuric acid and 0.25 M aniline (AAn). SEM, XRD, and water contact angles were used to evaluate the surface morphology, oxide layer crystallinity, and hydrophilicity of the oxide layers (n= 3). The PCA was determined through methylene blue (MB) degradation assay using 365 nm UVA



Alveolar bone loss in rat was measured by micro-computed tomography (A). Distance between cementoenamel junction and alveolar bone crest (B). NC: Negative control, PC: Positive control, V: Varnish group, VCE: Varnish with *Colocasia esculenta* extract group. *$p < 0.05$ compared with PC, ***$p < 0.001$ compared with NC.

illumination (n= 7). The antibacterial behavior was evaluated by assessing the reduction in percentage of S.aureus attachment under three UVA lighting conditions: (1) a pre-illumination group in which samples were irradiated under UVA light for one hour prior to bacteria exposure; (2) direct illumination group in which samples were irradiated for one hour after bacteria exposure; and (3) a no illumination group in which the samples were kept in the dark for one hour after bacteria exposure (n= 5).

Results: SEM confirmed the presence of polyaniline on AAN and ACV group surfaces. XRD confirmed the presence of anatase and rutile peaks for all groups with lower peak intensities for the AAn group. AAn, with an average contact angle of 29.7°, showed significantly higher hydrophilicity (p= 0.041) compared to the ACV and control groups with average contact angles of 46.4° and 47.9°, respectively. AAn showed significantly higher MB degradation at 60 minutes when compared to ACV (p= 0.034). Bacterial testing showed no significance differences between the three groups. However, an increased trend of bacterial attachment reduction was shown for the AAn and ACV groups, averaging 90.7% and 87.7%, compared to the control group, averaging 72.7%, under direct UVA illumination.

Conclusions: Doping of polyaniline into the titanium oxide layer by direct anodization in sulfuric acid and aniline improves the hydrophilicity and photocatalytic activity of the titanium surfaces. Although polyaniline doped titanium oxide showed promising trends, no significant differences were shown in the antibacterial behaviors of the surfaces that were tested in this study. Additional studies using different concentration of aniline in the anodizing electrolyte are needed to attempt to improve photocatalytic activity and reduce bacterial attachment.

https://doi.org/10.1016/j.dental.2021.12.118

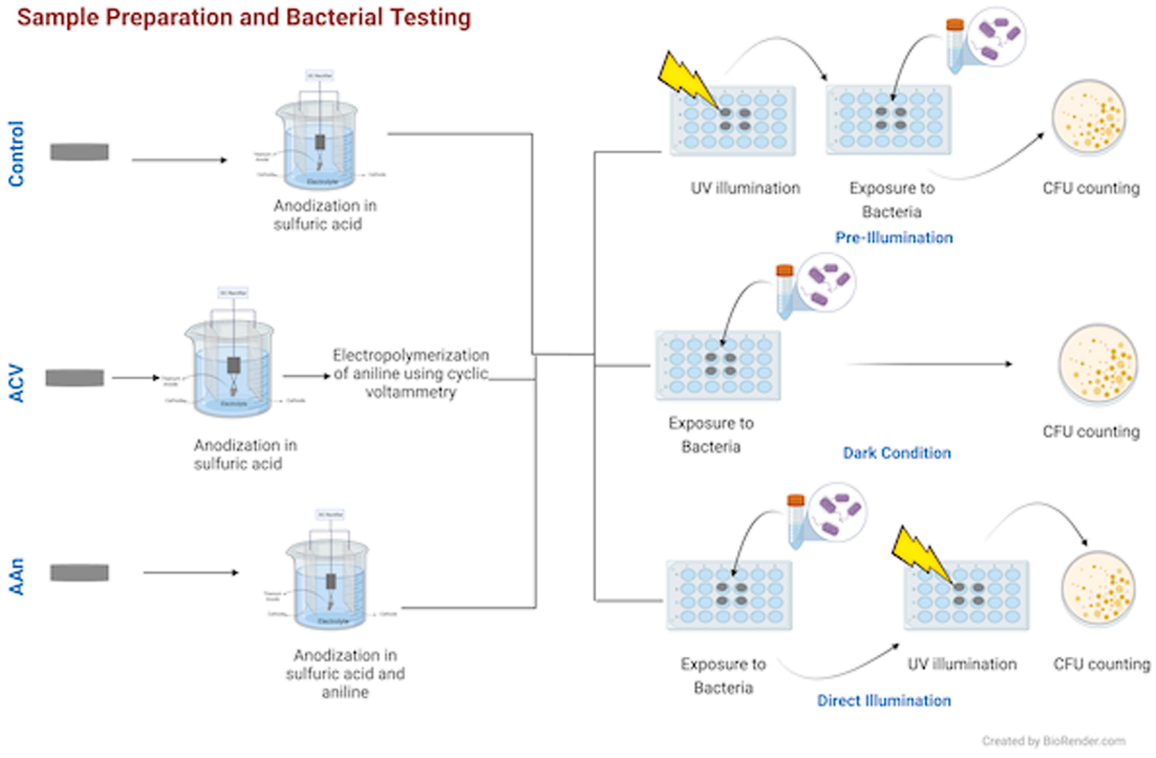
P6

Deterioration of composite restorations in tooth wear patients: translational approach

V.P. Lima [1,2,*], L.A.M.J. Crins [2], E.M. Bronkhorst [2], N.J.M. Opdam [2], Jan L. Ruben [2], Marie-Charlotte D.N.J.M. Huysmans [2], Bas A.C. Loomans [2], R.R. Moraes [1]

[1] *Federal University of Pelotas, Brazil*
[2] *Radboud University Medical Center, The Netherlands*
[*] *Corresponding author.*

Purpose/Aim: This study investigated the clinical deterioration of anterior resin composite restorations placed in



tooth wear patients after 36 months and later compared the ability of two chewing simulation devices in emulating in vitro the clinical deterioration observed in those restorations.

Materials and Methods: For the clinical observation, 270 anterior maxillary resin composite restorations in 47 patients were evaluated after 36 months of clinical service by using intraoral photographs and 3D scans to rate modified FDI scores and investigate the presence of degradation features. Multivariable logistic regression models were used to analyze the clinical data ($p<0.05$). For the in vitro approach, tooth wear was simulated in bovine incisors, which were restored with materials and techniques similar to those in the clinical observation. Incisal edges of the restorations were subjected to 960,000 cycles of either compressive loading (Biocycle-V2; 125 N; 2 Hz) or wear and mechanical loading (Rub&Roll; 30 N; 20 rpm). Surface degradation was rated using the modified FDI scores to compare the chewing devices (Fisher's test, ?=0.05).

Results: In the clinical observation, early degradation signs were present at 1 month: irregularities (41.5%) and ditching (7.4%) were observed at the surface and adhesive interfaces. The frequency of irregularities decreased in the 36-month follow up (37%), but ditching (12.2%) and fractures (10.7%) were more common. After 36 months, the most frequent esthetic deterioration was noticeable for staining (44%) and loss of luster (31%). For functional deterioration, in the 3D scans, wear (25%), marginal adaptation (24%), and surface irregularities (19%) were the most frequent forms. The simulation devices produced distinct degradation patterns: Biocycle-V2 generated deterioration not comparable to the clinical situation, including contact damage, minor wear, and localized roughening. The degradation caused by Rub&Roll was more similar to the in vivo situation, including wear facets, chipping, delamination, staining, and marginal ditching. The FDI scores differed between the chewing devices for staining, material/retention, and marginal adaptation (p?0.003).

Conclusions: The clinical observation revealed a continuous deterioration process in tooth wear patients with a progression of the deterioration until 36 months. The laboratory simulation of the deterioration showed that the Rub&Roll chewing device could emulate the clinical deterioration observed in anterior restorations in tooth wear patients and could be used as a mouth simulation method, contributing to translational research.

https://doi.org/10.1016/j.dental.2021.12.119

P7

Durability of Cell Adhesion Peptides Coatings for Dental Implants

J. He *, N. Fischer, C. Aparicio

Minnesota Dental Research Center for Biomaterials and Biomechanics, University of Minnesota, Minneapolis, USA
* *Corresponding author.*

Purpose/Aim: Various coatings have been investigated to prevent dental implant infection or peri-implantitis. Recent focus has shifted from hastening osseointegration to promoting soft tissue attachment as a promising anti-infective strategy. Two cell adhesion peptides derived from basement membrane biomolecules – Net1 and LamLG3 – have been shown to promote hemidesmosome (HD) formation surrounding dental implants. HDs are a transmembrane "link" between gingiva and teeth to form a protective barrier against bacterial invasion. Thus, dental implants with enhanced HD formation should facilitate soft tissue healing and prevent peri-implantitis. However, upon scale-up and distribution, implant coatings' manufacturing and shipping time may degrade their biological activity. Device coatings' abilities to function and remain effective over a long period are therefore a significant challenge. We aimed to simulate relevant degradative conditions for cell adhesion peptide coated implants to assess their retained activity.

Materials and Methods: Net1 and LamLG3 peptides and their fluorescent-tagged variants were coated onto glass disk surfaces. Coatings were excessively challenged by (1) immersion in artificial saliva for up to 8 weeks, (2) steam autoclaving up to 5 times, and (3) toothbrushing for up to 1.2 minutes using the MDRCBB toothbrush machine. Water contact angle, fluorescence, and X-ray photoelectron spectroscopy (XPS) were used to measure the peptide coating after challenges. Appropriate statistical analysis was performed.

Results: XPS data indicates 2 weeks in saliva, 1 autoclave cycle, and 1.2-minutes toothbrushing significantly degraded peptide coating on glass surfaces compared to non-challenged surfaces. After 7-week incubation in the saliva, LamLG3's XPS signal was decreased by 21.06% compared to Net1's 32.41%. On the other hand, 5 autoclaves cycles caused 31.48% and 48.41% loss of N1s/C1s counts relative to the control for Net1 and LamLG3 disks respectively. However, only 1.2 minutes of simulated toothbrushing eliminated 77.31% Net1 and 61.34% LamLG3 relative to their controls. XPS data is supported by water contact angle and fluorescence data.

Conclusions: The LamLG3 peptide implant coating is more resistant to degradative challenges than Net1. These

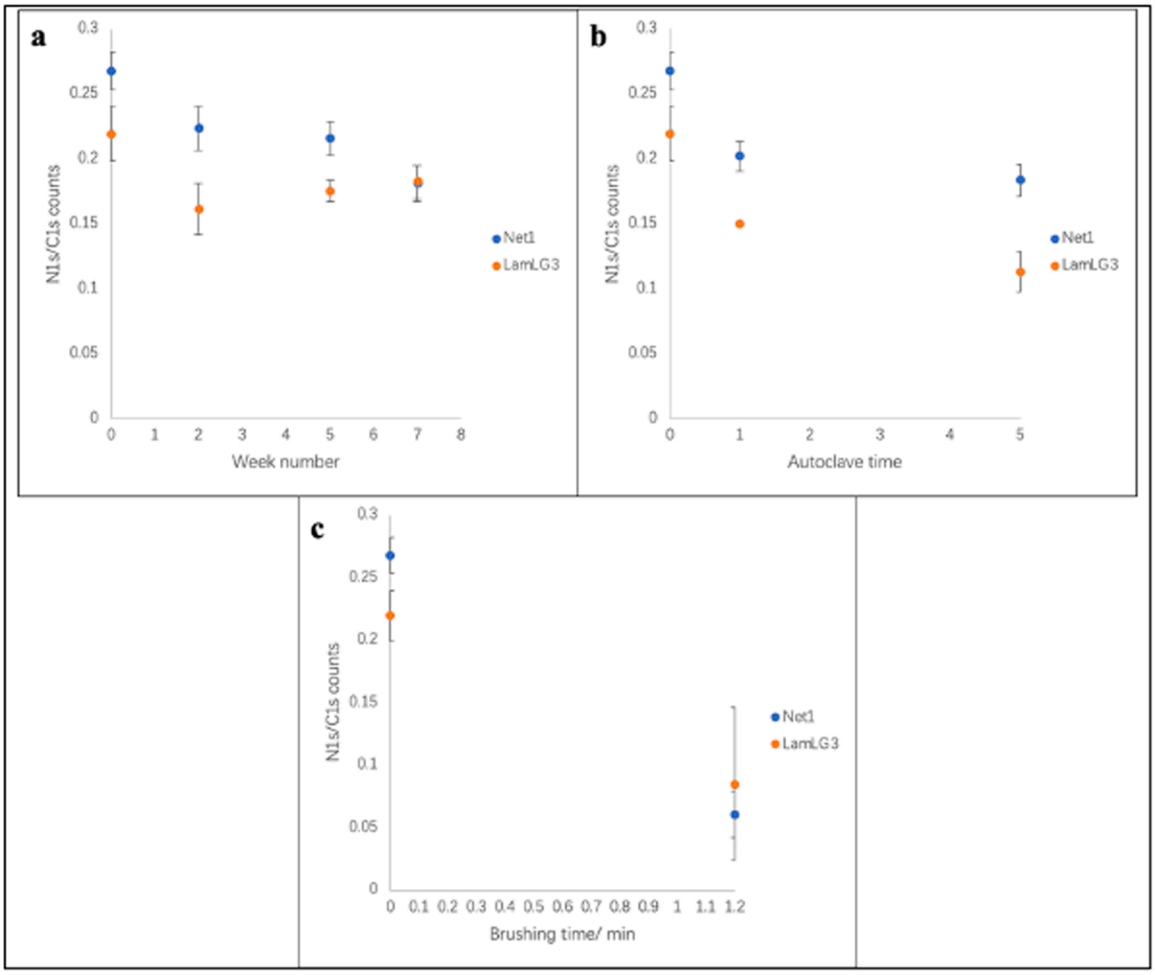


Fig. 1 – XPS results. a. N1s/C1s ratio changes on the Net1 and LamLG3 coated glass disks after 0, 2, 5, and 7 weeks in artificial saliva; b. N1s/C1s ratio changes on the Net1 and LamLG3 coated glass disks after 0, 1, and 5 times of autoclaving; c. N1s/C1s ratio changes on the Net1 and LamLG3 coated glass disks after 0, and 1 minute of toothpaste brushing.

findings may catalyze the creation of a generic model of peptide coatings' resistance to manufacturing and clinical challenges. (Fig. 1)

https://doi.org/10.1016/j.dental.2021.12.120

P8

Polycaprolactone/Nano-Hydroxyapatite Nanofibrous Scaffold as a Cell Homing-Based Therapy

I.P. Mendes Soares*, C. Anselmi, M.L. Leite, F.A. Kitagawa, R.A.O. Ribeiro, C.A. De Souza Costa, J. Hebling

School of Dentistry, São Paulo State University (Unesp), Araraquara, Brazil
* *Corresponding author.*

Purpose/Aim: This study investigated the behavior of human dental pulp cells (HDPCs) seeded on the surface of polycaprolactone/nano-hydroxyapatite nanofibrous scaffolds, aiming a dentin tissue engineering-based vital pulp therapy (VPT).

Materials and Methods: Polycaprolactone (PCL)-based solutions (10% w/v in 8:2 chloroform and dimethylformamide) containing nano-hydroxyapatite (nHA) particles (0.5; 1.0; or 2.0% w/v) were electrospun into nanofibrous scaffolds. PCL scaffolds without nHA were used as control. The scaffolds were blindly characterized for morphology and composition (SEM/EDS; n=12), solubility (n=6), the release of calcium/phosphate (n=6), and change of medium pH (n=6). A culture of HDPCs was obtained from sound third molars and characterized for the presence of a subpopulation of mesenchymal stem cells. Then, HDPCs were seeded on the surface of the scaffolds and evaluated for cell viability (alamarBlue; n=8), cell proliferation (Live/Dead assay; n=4), adhesion and spreading (F-actin; n=4), total protein content (TP; Lowry method; n=8), alkaline phosphatase activity (ALP; thymolphthalein assay; n=8), expression of odontogenic genes (RT-qPCR; DSPP, DMP1, COL1A1, and ALPL; n=6), and formation of a mineralized matrix (Alizarin Red staining; n=8). All experiments were repeated at least twice. Sample sizes were calculated using G-Power. Data were analyzed with confidence intervals and one- or two-way ANOVA followed by Tukey, Sidak, or Games-Howell post-hocs (?=5%).

Results: All formulations generated randomly arranged fibers ranging from 600 to 900 nm in diameter. Higher nHA concentrations roughened the surface of the nanofibers, while PCL+2%nHA increased the interfibrillar spaces. PCL +1%nHA and PCL+2%nHA significantly released calcium/phosphate over a period of 28 days in comparison with PCL +0.5%nHA. Nonetheless, the medium pH was maintained below 8.0. HDPCs viability and proliferation were not affected by the incorporation of nHA, while cell adhesion/spreading was stimulated, especially for PCL+2%nHA. Higher total protein content and increased ALP activity were seen in the presence of nHA. PCL+1%nHA and PCL+2% nHA upregulated the expression of DSPP and DMP1 in 14 days; and COL1A1, ALPL, and DMP1 in 21 days. The formation of a mineralized matrix after 21 days was concentration-dependent, and it was about 9× higher for PCL+2%nHA formulation compared to control.

https://doi.org/10.1016/j.dental.2021.12.121

Marshall Awards Finalists

M1

Fracture Toughness and Fractal Dimension of Two Dental Glass-Ceramics

K.S. Jodha [1,*], N. Kaur [1], S.M. Salazar Marocho [1], J.J. Mecholsky Jr.[2], S.T. Lirette [3], Y. Duan [1], J.A. Griggs [1]

[1] *Biomedical Materials Science, University of Mississippi Medical Center, Jackson, USA*
[2] *Materials Science and Engineering, Herbert Wertheim College of Engineering, University of Florida, Gainesville, USA*
[3] *Data Science, University of Mississippi Medical Center, Jackson, USA*
[*] *Corresponding author.*

Purpose/Aim: Studies have reported the fractal dimensional increment of glass and glass-ceramic fracture surfaces. The objective of this study was to determine the relationship between fracture toughness and fractal dimensional increment of two types of dental glass-ceramics with different volume fraction of crystals and different fracture surface roughness.

Materials and Methods: Fifteen bar-shaped specimens were prepared from lithium disilicate (LDS) by sectioning the blocks (IPS e.max CAD, Ivoclar Vivadent). Ten beams were prepared by mixing and layering the nanofluorapatite (NFA) glass-ceramic powder (IPS e.max Ceram, Ivoclar Vivadent). One face of each of the specimens was indented using a Knoop diamond at 25 N (LDS) or 10 N (NFA) followed by loading in deionized water in 4-point, or 3-point flexure, respectively, until failure. Fracture surfaces were analyzed using scanning electron microscope (SEM). Fracture toughness (Kc) was calculated using the surface crack in flexure (SCF) technique (ASTM C1421). Epoxy replicas of the fracture surfaces were scanned using the atomic force microscope (AFM) followed by noise filtering. The FRACTALS software was used to determine the fractal dimensional increment (D*) by the Minkowski cover algorithm. In addition, surface roughness was computed from the AFM scans using the Gwyddion software.

Results: The median (25%, 75% quartiles) fracture toughness of LDS and NFA bars were 1.62 (1.59, 1.69) MPam1/2 and 0.68 (0.66, 0.74) MPam1/2, respectively. The median fractal dimension (D) value (25%, 75% quartiles) before and after noise filtering for LDS were 2.16 (2.15, 2.17) and 2.14 (2.14, 2.15), respectively, and for NFA were 2.29 (2.21, 2.38) and 2.17 (2.17, 2.18), respectively. The NFA follows the regression model (Y=1.99 X) between Kc and sqrt. D* for glasses as previous studies, but the LDS deviated from the model. The median (25%, 75% quartiles) surface roughness before and after noise filtering for LDS were 139 (119, 188) nm and 137 (118, 187) nm and for NFA were 7 (6, 15) nm and 7 (6, 15) nm, respectively.

Conclusions: Noise filtering successfully eliminated noise from the AFM scans of the material with smooth fracture surfaces (NFA), resulting in a decrease in measured fractal dimension. The LDS data deviated from the model because of toughening due to crack bridging. Fractal analysis with noise filtering can be used to estimate the fracture toughness of dental glass-ceramics that do not exhibit crack bridging.

https://doi.org/10.1016/j.dental.2021.12.122

M2

Fatigue-Crack Propagation in Thermosetting Polymers with Self-Healing Capability

A.P.P. Fugolin [*], M. Logan, J.L. Ferracane, C.S. Pfeifer

Oregon Health & Science University, Portland, USA
[*] *Corresponding author.*

Purpose/Aim: Thermal and mechanical stresses are responsible for inducing microcracks, which over time may lead to failure of the dental restoration. This study is aimed to synthesize and characterize an innovative microcapsule-based self-healing polymer containing a shape-memory compound as healing agent.

Materials and Methods: Healing agent systems consisted of TEGDMA-(T) mixed with 0, 20, 40, 60, or 80 wt% N,N-dimethylacrylamide-DMAM (D), 0.5 wt% BPO and 1 wt % DHEPT. Polymerization kinetics were assessed by near-IR spectroscopy (6165-6152cm-1) and rheological properties under oscillatory stress (1 Hz, 1% strain) for 30. Select systems were then encapsulated in (poly)urea formaldehyde microcapsules via double emulsion thermopolymerization. After vacuum filtration, capsules were characterized by extraction in acetone, thermogravimetric analysis (TGA), and optical and scanning electron microscopies. Capsules were then incorporated at 10 wt% in BisGMA:BisEMA:UDMA:TEGDMA (28:28:28:16 wt%, respectively), and 1 wt% BAPO. Photocuring procedures were performed with a mercury arc lamp (320-500 nm) at 1000 mW/cm2. These materials were tested for polymerization kinetics by near-IR spectroscopy and crack

propagation kinetics by double torsion fracture toughness (15 N initial load and 0.03 mm/s speed). Data was analyzed by Tukeys Test and one-way ANOVA (p=0.05).

Results: Regarding the healing agent systems, the maximum polymerization rate ranged from 2.85 to 2.13%.s-1 and the final conversion from 89.5 to 77.3%, with an incremental decrease as the DMAM concentration increased beyond 20 wt%. DMAM incorporation delayed the polymerization reaction between 1:38 min and 5:38 (for 80 T:20D and 20 T:80D, respectively) in comparison with 100 T. 80 T:20D showed the highest storage modulus (8.240.21 MPa) and 20 T:80D the lowest (0.470.03 MPa). The incorporation of DMAM resulted in increased G/G crossover time from 0.06 s (100 T) to 0.57 s (20 T:80D). The proper encapsulation of the DMAM-containing healing agents was confirmed by optical and scanning electron microscopies (Fig. 1A) and extraction in acetone which showed between 61.54.1 and 40.90.7 wt% of encapsulated healing agent. TGA demonstrated gradual curves shifting to the left as the DMAM increased (Fig. 1B). Finally, the addition of microcapsules slightly impacted the final conversion of the resins (averaging between 95.8 and 87.1%), reduced crack growth rate and delayed the catastrophic failure by up to 145 s. In addition, these systems showed an initial drop in post-healing stiffness and subsequent recovery, which was not seem in the control group (Fig. 1C).

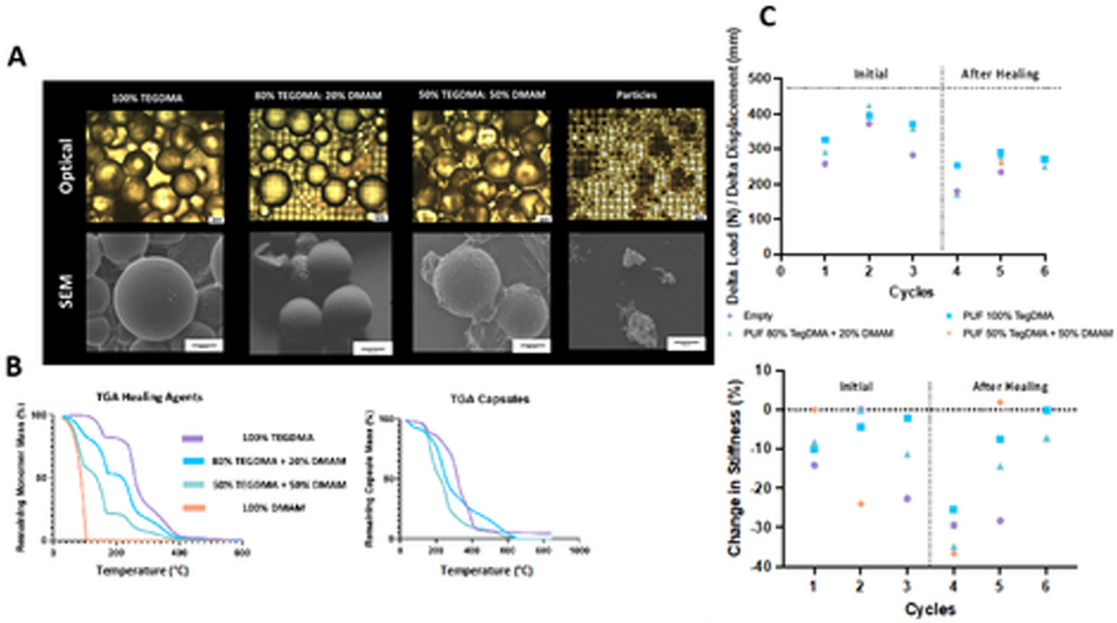


Figure 1. ***(A)*** Optical and scanning electron microscopies of the newly synthesized (poly)urea formaldehyde microcapsules and solid particles (negative control). It is possible to notice the differences between the filled and the empty particles. The appearance of bubbles inside de capsules as well as wrinkles on the shell wall indicate that the healing agents have been coated by (poly)urea formaldehyde shells. ***(B)*** Thermogravimetric analysis curves temperature (°C) as a function of remaining mass (%) for the healing agents' systems pure and encapsulated in (poly)urea formaldehyde microcapsules. ***(C)*** Delta load (N) divided by delta displacement (mm) and change in stiffness (%) over the load cycles at the virgin and post-healed double torsion fracture toughness bars.

Conclusions: Regardless of the healing system, the presence of the microcapsules seems to impact the crack growth and propagation in thermosetting polymers. The healing agent released may be capable of reducing the crack tip stress intensity and the polymerized healing agent decreases the crack growth rate.

https://doi.org/10.1016/j.dental.2021.12.123

M3

Exploring the Inclusion of Photosensitive Compounds on Methacrylate-Based Resin Properties

P. Comeau *, J. Burgess, N. Malekafzali, N. Rezqi Qomi, A. Manso

University of British Columbia, Oral Health Sciences, Vancouver, Canada
* *Corresponding author.*

Purpose/Aim: Oral bacteria are directly linked to one of the most common chronic human diseases, specifically dental caries. However, not much has been accomplished with current resin-based dental materials to effectively improve their antimicrobial power and effectively manage this disease. To address this need, we propose the development of innovative photosensitive, antimicrobial dental materials that can significantly reduce oral pathogens directly linked to dental caries without compromising the physical and chemical properties inherent in unmodified methacrylates. The aim of this study was to conduct a preliminary investigation on the curability of dental resin blends following inclusion of either a natural photosensitizer (PS) or photocatalytic nanoparticles (NP) (both undisclosed).

Materials and Methods: To the first resin-blend, 50 150 nm NP (at 1, 5, 10, 15, 20, 25, 30, 35 or 40 wt%) was added. Meanwhile, to a second resin-blend PS (at 0.10, 0.20, 0.50, 1.0, 1.5, 2.0, 5.0, or 10 wt%) was added. The mixtures (NP-RB or PS-RB, respectively) were analyzed by FTIR for degree-of-conversion (DC) (30 or 60 s curing-time) (n=3). From these same mixtures 1mm-thick disks were fabricated with a ValoTM light curing unit. Data were subjected to a two-factor general linear model with post-hoc Tukey (p=0.05).

Results: The concentration of PS and NP independently added to respective resin blends were each found to significantly impact DC (Fig. 1A and B, p<0.001). However, only 10 wt% PS and more than 25 wt% NP detectably lowered DC below that for the 0% blend (p<0.001). The ability to fabricate 1mm-thick disks with the modified resin blend and a LED light curing unit similarly revealed a dependence on PS and NP (Fig. 1C and D, respectively). However, with increased sample depth to cure the success of disk fabrication (with complete cure) was more limited than for the FTIR film samples for PS-added resin blend. In fact, only up to 1.5 wt% PS and 20 wt% NP could be successfully added to the resin blend with complete-depth cure of fabricated disks after 2 min of light applied.

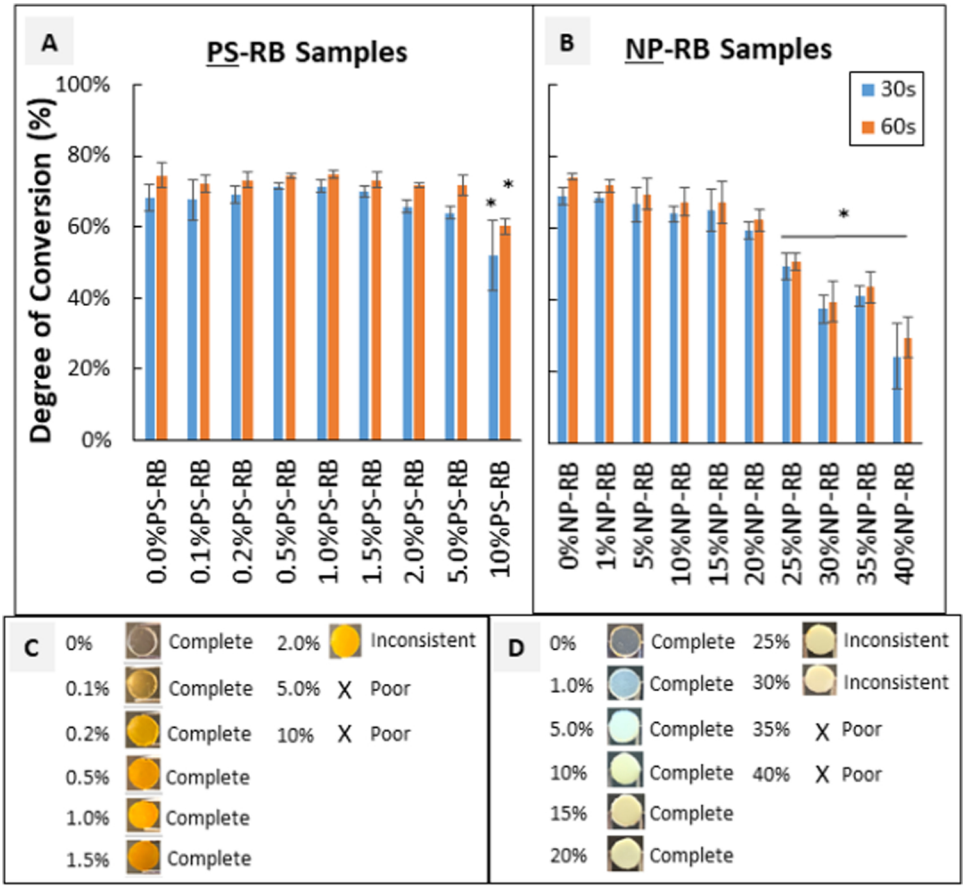


Figure 1: (A, B) DC, and (C, D) disk fabrication following addition of natural photosensitizer (PS) or photocatalytic nanoparticles (NP). *Indicates a detected drop in DC relative to the 0% blend (p<0.001).

Conclusions: This preliminary investigation was successful in determining the maximum PS and NP concentration that could be loaded into the respective experimental dental resin blends and still produce stable samples. The next stage of investigation will explore the impact of these concentrations on further chemical, mechanical, and antimicrobial properties.

https://doi.org/10.1016/j.dental.2021.12.124

Oral Abstracts Finalists

O1

Temperature Impacts on Streptococcus Mutans Growth and Substrate Utilization Kinetics

E. O Brien [1], K. Mondal [1], C.C. Chen [2], J.L. Drummond [3], L. Hanley [2], K. Rockne [1,*]

[1] *Dept of Civil, Materials, and Environmental Engineering*
[2] *Dept of Chemistry, University of Illinois at Chicago, Chicago, USA*
[3] *JLD Consulting, USA*
[*] *Corresponding author.*

Purpose/Aim: Streptococcus mutans has been studied as a model cariogenic bacterium for decades. In spite of myriad studies, growth and substrate utilization kinetics studies have been largely limited to human body temperature (37 C). This makes it difficult to quantitatively assess the impact of temperature on metabolic kinetics. The objective of this study is to evaluate the effect of temperature, substrate, and nutrient conditions on S. mutans biokinetic parameters to provide comparability between biokinetic studies.

Materials and Methods: S. mutans UA159 from ATCC (700610) was maintained on brain heart infusion (BHI) agar plates. S. mutans was grown in a chemostat fed BHI with either sucrose or glucose to calculate yield, maximal substrate utilization rate, endogenous decay, and half saturation constant from cellmass and substrate data assuming Monod kinetics. Pseudo-first order growth rates were determined in batch culture grown on sucrose or glucose with rich (100% BHI) and diluted (10% BHI) media at different temperatures (20-37 C). An Arrhenius plot was used to assess the impact of temperature on growth. Statistical significance was determined at the 95% confidence interval.

Results: Cell yield was statistically significantly greater on sucrose compared to glucose (0.2 g biomass/g sucrose compared to 0.1 g biomass/g glucose) at 37 C. The maximal substrate utilization rate was greater on glucose-amended media compared to sucrose. At lower temperatures, cell growth rate was statistically significantly greater on glucose compared to sucrose, but at 37 C, the growth rate was statistically significantly greater for sucrose-amended diluted media. This indicates that growth on sucrose is more strongly impacted by changes in temperature under nutrient-limited conditions, as confirmed by Arrhenius slope for S. mutans at 65 +/- 15 kJ/mol while growing on glucose and 84 +/- 20 kJ/mol on sucrose. Growth on glucose under nutrient rich conditions had the greatest Arrhenius slope of 132 +/- 8 kJ/mol.

Conclusions: These findings enhance the understanding of S. mutans biokinetics and provide useful data for comparing studies under different environmental conditions. S. mutans has a greater cell growth yield on sucrose compared to glucose. Further, growth at lower temperatures is more strongly dependent on having rich media regardless of substrate, as growth rate was approximately double in rich media compared to either sucrose or glucose in diluted media at 20 C. At greater temperatures, these nutritional requirements were less important, as kinetic rates were only 10-20% greater when grown in rich media at human body temperature.

Funding from NIH/NIDCR grant R01-DE027596.

Table I: Growth biokinetics as a function of temperature.

Substrate	K (hr^{-1})				E_A (kJ/mol)
	20 °C	25 °C	30 °C	37 °C	
100% BHI	0.045 +/- 0.003	0.163 +/- 0.014	0.349 +/- 0.009	0.384 +/- 0.011	132 +/- 8.4
10% BHI + 10mM glucose	< 0.025	0.112 +/- 0.003	0.296 +/- 0.010	0.328 +/- 0.008	65 +/- 15
10% BHI + 10mM sucrose	< 0.025	0.091 +/- 0.013	0.274 +/- 0.019	0.340 +/- 0.017	84 +/- 20

https://doi.org/10.1016/j.dental.2021.12.125

O2

Antimicrobial and Angiogenic Hybrid Scaffold for Regenerative Endodontics

N. Dubey [1,2,*], J.S. Ribeiro [1], J.A. Ferreira [1], J. Xu [1], E.A. Bordini [1], L. Qu [1], L. Mei [3], A. Schwendeman [3], M.C. Bottino [1]

[1] *School of Dentistry, University of Michigan, Ann Arbor, USA*
[2] *Faculty of Dentistry, National University of Singapore, Singapore*
[3] *College of Pharmacy and Biointerfaces Institute, University of Michigan, Ann Arbor, USA*
[*] *Corresponding author.*

Purpose/Aim: This study sought to engineer a hybrid antimicrobial and angiogenic scaffold comprised of both fiber and hydrogel components that is cytocompatible, biodegradable and provides sustained release of antimicrobial drugs for infection ablation and support angiogenesis.

Materials and Methods: Minocycline- (MINO) and clindamycin- (CLIN) modified micro/nanofibers were processed via electrospinning. The fibrous meshes were subsequently grounded via cryomilling and embedded in methacrylated gelatin (GelMA) hydrogel to create injectable hybrid scaffolds. The processed electrospun fibers and cryomilled microparticles were characterized via scanning (SEM) and Fourier transform infrared spectroscopy (FTIR). The effects of microparticles on hydrogel degradability, swelling properties, drug release kinetics and antimicrobial

efficacy against oral pathogens were systematically assessed by agar diffusion assay, SEM, and confocal microscopy (CLSM) of the infected dentin specimens. Cytocompatibility was investigated using the tetrazolium reduction (MTS) assay using stem cells from human exfoliated deciduous teeth treated with extracts from hydrogel for up to 21 days. We analyzed the angiogenesis potential of the MINO and CLIN in vitro via capillary-like tube formation assay using human umbilical vein endothelial cells (HUVECs), as well as in vivo using a subcutaneous rat model.

Results: The SEM showed bead-free micro/nanofibers with average fiber diameter decreasing with presence of CLIN. The cryomilled electrospun microparticles were distributed in GelMA showing fibrous mesh and hydrated gel structure of the scaffold. The addition of 1% CLIN and 2.5% of MINO showed significant increase in the swelling ratio. All hydrogels were biodegradable, however, GelMA loaded with antibiotic microparticles degraded at different times depending on the antibiotics and their concentration. CLSM and SEM analyses revealed that after exposure to antibiotic-laden hybrid scaffolds, nearly complete elimination of viable bacteria on the dentin surface and inside the dentinal tubules was observed. Importantly, the presence of antibiotics inhibits bacterial growth with increased cell viability compared with GelMA hydrogel only. In culture, CLIN significantly enhanced the formation of capillary-like structures of HUVECs when compared with MINO. In vivo, subcutaneously implanted hybrid scaffold with CLIN stimulated greater vascular growth and recruited more von Willebrand factor than the control and MINO

Conclusions: Hybrid scaffolds with sustained release antibiotics for endodontic infection ablation and improved cell viability can be synthesized using the protocol outlined in this study. CLIN-loaded scaffolds demonstrated the ability to support endothelial cells and angiogenesis, which may have positive implications for the overall regenerative outcome.

https://doi.org/10.1016/j.dental.2021.12.126

O3

Water and Protein Content Influence Creep Behavior In Dental Enamel

J. Koldehoff [1,*], M.V. Swain [2], G.A. Schneider [1]

[1] *Institute of Advanced Ceramics, Hamburg University of Technology, Hamburg, Germany*
[2] *Faculty of Dentistry, University of Sydney, Sydney, Australia and Biomechanics and Biomaterials Lab, Don State Technical University, Rostov-On Don*
[*] *Corresponding author.*

Purpose/Aim: The mechanical behavior of biological materials, such as nacre and bone, has been shown to depend on the water content. While dental enamel's behavior has been shown to depend on organic content, less is known about the role of water. The aim of this study was to investigate the interplay of water and organic content.

Materials and Methods: The creep behavior of untreated and deproteinized dental enamel in dry and wet state was analyzed by nanoindentation. To avoid cracking and plastic deformation a 5 m spherical tip was used. Additionally, the influence of the loading speed was investigated by applying different load rates.

Results: Dry untreated and deproteinized dental enamel only showed minor creep over 100 s and deproteinization did not affect the dry enamels behavior significantly. With slower load rates some creep already occurs during the loading period, such that creep during the load hold is less than with faster load rates. Wet samples showed a very different behavior to dry samples. Wet untreated enamel showed significantly more creep compared to the wet deproteinized samples. The wet deproteinized samples also showed more creep compared to the dry ones.

https://doi.org/10.1016/j.dental.2021.12.127

O4

Silane Containing Universal Adhesive/ Cement for Bonding to Silica-Coated High-Translucent Zirconia

L. Nasiry Khanlar [1,*], A. Abdou [2], T. Takagaki [3], S. Mori [4], T. Nikaido [3], A Zandinejad [5], J Tagami [1]

[1] *Department of Cariology and Operative Dentistry, Tokyo Medical and Dental University, Japan*
[2] *Faculty of Dentistry, King Salman International University, El Tur, South Sinai, Egypt*
[3] *Department of Operative Dentistry, Asahi University, Japan*
[4] *Department of Chemical Science and Engineering, Tokyo Institute of Technology, Japan*
[5] *Department of Comprehensive Dentistry, Texas A&M University, USA*
[*] *Corresponding author.*

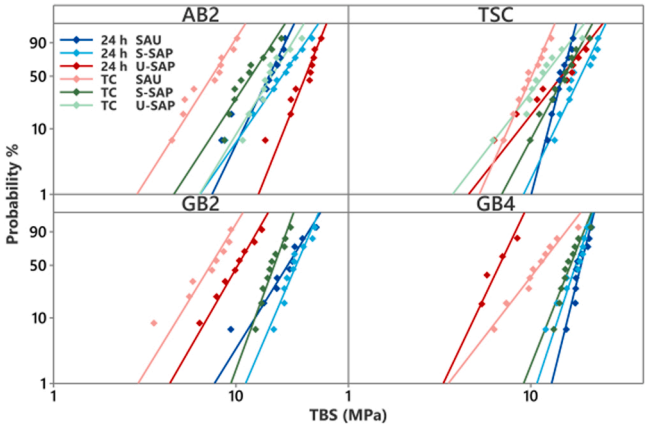
Purpose/Aim: The aim of this study was to evaluate the bonding performance of high-translucent zirconia when pretreated with glass beads and the efficiency of silane contained in self-adhesive resin cement and universal adhesive as chemical treatment for silica-coated high-translucent zirconia.

Materials and Methods: 240 fully sintered disk-shaped zirconia specimens (Y-PSZ, Zpex smile, Tosoh, Japan) were assigned to 4 groups according to mechanical surface pretreatment: alumina particles abrasion with 0.2 MPa pressure (AB2), tribochemical silica-coating with 0.2 MPa (TSC), and glass beads air-abrasion with

0.2 MPa (GB2) and 0.4 MPa (GB4). Each group was cemented with Panavia SA Universal (SAU), Rely X Ceramic Primer (3 M ESPE) + Panavia SA plus (Kuraray Noritake Dental) (S-SAP), and Clearfil Universal Bond Quick + SAP (U-SAP). Tensile bond strength (TBS) was measured at crosshead speed of 2 mm/min after 24 h or 10000 thermocycling (TC) followed by the failure modes analysis (n=10). Surface morphology and surface elemental composition of the abraded zirconia surface analyses were examined under SEM/EDS. Survival analysis was done for TBS data (P = 0.05).

Results: After TC, there was a significant decrease in bond strength all groups except TSC and GB4 treated with S-SAP. S-SAP showed highest TBS with TSC, GB2, and GB4. AB2 indicated the highest TBS with U-SAP. SAU showed higher TBS with GB4 compared to GB2. GB4 represented the highest Si content compared to TSC and GB2.

Conclusions: Sailanization of glass beads air-abraded zirconia ceramic is mandatory step for successful adhesion to resin cement. Silane containing self-etch adhesive cement was more effective than universal adhesive for glass beads treated zirconia especially with higher air-pressure, but both are less efficient than pure silane treatment. While universal adhesive is efficient pretreatment on tribochemical silica-coating surface and the most effective on alumina-blasted zirconia ceramic.



https://doi.org/10.1016/j.dental.2021.12.128

O5

Self-Adhesive Luting Composites: Effect of Curing-Mode and Storage on KIc

A. Woeschler, R. Belli, U. Lohbauer, A. Petschelt, J. Zorzin *

Dental Clinic 1- Department for Operarive Dentistry and Periodontology, Friedrich-Alexander-University Erlangen-Nuernberg, Germany

* *Corresponding author.*

Purpose/Aim: The aim of the present study was to investigate the influence of curing-mode (dual or self-curing) and storage time (24 h, 14 d, 60 d) on the fracture toughness (KIc) of self-adhesive luting composites (SALCs).

Materials and Methods: The KIc of four different SALCs (RXU2, RelyX Unicem 2, 3 M ESPE; GCLA, G-Cem LinkAce; GC-Corporation; iCEM, iCem Self Adhesive, Kulzer; PAN, Panavia SA Universal Cement, Kuraray Noritake) was measured using the Chevron-Notched Beam method. From each material, 30 samples were prepared in dual-curing mode (20 s @ 1200 mW/cm2, 8 mm light-tip) and 30 samples in self-curing mode (curing-time according to manufacturer). All specimens were stored in artificial saliva in the dark at 37 C. KIc was measured after 24 h, 14 and 60 d (n=10 per material, curing-mode and storage time). Statistical analysis was performed with a t-test of independent samples and a single factor ANOVA (alpha=0.05).

Results: The curing mode had a significant influence on KIc, within the same material and storage time ($p<.05$), with exception of RXU2, GCLA and iCEM after 60 d. In general, the KIc of dual-cured specimens was significantly higher, except for RUX2 in self-cure mode after 24 h ($p>.05$). After 60 d of storage all materials, independently of the curing-mode, had a significant decrease in KIc ($p<.05$). Only PAN had any decrease in KIc. Under the same curing-mode and storage time, GCLA showed the significantly highest KIc ($p<.05$), whereas iCEM the lowest, with exception of the its 24 h dual-cure group.

Conclusions: Within the limits of this study, it can be concluded that the mechanical stability of the SALCs under investigation, in terms of KIc, is influenced by curing-mode and storage time. The extent of mechanical deterioration is material dependent. The in-vitro measured decays in KIc

could lead in-vivo to deterioration of the adhesive interface and in consequence to restoration loss or fracture. The long-term resilience to water degradation and chemical curing of SALCs show potential of improvement.

KIc (Mean ± Standard Deviation) [MPa$\sqrt{m}$]						
	Dual-Cure			Self-Cure		
	24 h	14 d	60 d	24 h	14 d	60 d
RUX2	0.756 ± 0.029 C, a	0.743 ± 0.128 C, a	0.507 ± 0.042 B, b	0.854 ± 0.083 B, a	0.553 ± 0.094 B, b	0.507 ± 0.042 B, b
GCLA	1.297 ± 0.135 A, a	1.381 ± 0.102 A, a	0.720 ± 0.108 A, b	1.117 ± 0.226 A, a	0.898 ± 0.141 A, b	0.805 ± 0.082 A, b
iCEM	1.037 ± 0.124 B, a	0.837 ± 0.084 B, C, a	0.384 ± 0.077 B, c	0.534 ± 0.053 C, a	0.296 ± 0.079 C, b	0.343 ± 0.065 D, b
PAN	0.847 ± 0.093 C, a	0.970 ± 0.171 B, a	0.829 ± 0.214 A, a	0.646 ± 0.048 C, a	0.498 ± 0.086 B, b	0.619 ± 0.087 B, a

Mean fracture toughness KIc (MPa$\sqrt{m}$) and standard deviation of the materials under investigation after different storage time (24 h, 14d, 60d, at 37°C in artificial saliva) and curing mode (dual curing or self-curing). Upper case letters indicate statistically homogenous subsets within the same column, lower case letters indicate statistically homogenous subsets within the same row and curing mode (p>.05).

From all variables, the substrate influences the final ceramic shade more, followed by the ceramic thickness and the L*, a* and b* of the ceramic. It was found that the thickness is influence by the sigmoid function of the variable ΔE00 of the substrate vs. ceramic colors (Adjusted-R2 = 0.915, p = 0.014). The mathematical models were able to generate functions to predict the shade of the ceramic restoration according to the substrate shade, ceramic shade and thickness.

Conclusions: Different substrates, ceramic shades, and ceramic thicknesses influence the L*, a* and b* coordinates of the final restoration. From all variables, the substrate influences the final ceramic shade the most, followed by the L*, a* and b* coordinates of the ceramic and the ceramic thickness. The influence of the ceramic thickness on the final color depends on the difference between ΔE00 of the substrate and the ceramic. The algorithm developed in the study can predict the final colors of the ceramic restorations made with Empress CAD HT and LT, based on the color of the substrate and different thicknesses.

https://doi.org/10.1016/j.dental.2021.12.129

O6

Algorithm to Predict the Final Color of Leucite-Reinforced Ceramic Restorations

C. Kose [1,2], D. Oliveira [1], J.F. Roulet [1], P. Pereira [1], M.G. Rocha [1,*]

[1] *College of Dentistry, University of Florida, Gainesville, USA*
[2] *School of Dental Medicine, Tufts University, Boston, USA*
[*] *Corresponding author.*

Purpose/Aim: The aim of this study was to develop an algorithm to predict the final color of leucite-reinforced glass-based ceramic veneer restorations based on the substrate shade, ceramic shade, thickness, and translucency.

Materials and Methods: Leucite-reinforced glass-ceramics (IPS Empress CAD) in 4 different shades (A1 HT, A3 HT, A1 LT and A3 LT) were sectioned in thicknesses of 0.3, 0.5, 0.7 and 1.2 mm using a precision saw machine. The CIELab coordinates of each specimen were obtained over four different backgrounds (black, white, A1 and A3) interposed with an experimental translucent resin-based cement with a refractive index of 1.5229 and without photoinitiators to reproduce the optical properties of the ceramic-cement and cement-substrate interfaces. A calibrated spectrophotometer (CMD-700, Konica Minolta) with a D65 illuminant and target mask sensor-opening diameter of 3 mm was used for the data collection. The color change (ΔE00, CIEDE2000) values and all the CIELab values for each of the experimental groups were submitted to a multivariate linear regression. The regression model was adjusted according to the weights of each dependent variable to achieve the model best-fitting. All functions were programmed into an excel spreadsheet to execute the algorithm automation to the predicted final shade of the ceramic restoration.

Results: Different substrates, ceramic shades, and thicknesses influenced the L*, a* and b* of the final restoration.

https://doi.org/10.1016/j.dental.2021.12.130

O7

Synthesis and Incorporation of Quaternary Ammonium Silane Antimicrobial into Self-Crosslinked Type I Collagen Scaffold: A hybrid formulation for 3D Printing

U. Daood [1,*], R.A. Bapat [1], S.K. Muthusamy [2], P. Sidhu [1], K.-K. Mak [3], A. Parolia [1], M.R. Pichika [3], L.L. Seow [1], T. Cao [2]

[1] *School of Dentistry, International Medical University Kuala Lumpur, Kuala Lumpur, Malaysia*
[2] *Faculty of Dentistry, National University of Singapore, Singapore*
[3] *School of Pharmacy, International Medical University Kuala Lumpur, Kuala Lumpur, Malaysia*
[*] *Corresponding author.*

Purpose/Aim: To construct a novel 3D-biomaterial scaffold having a combination of a new quaternary ammonium silane (k21) antimicrobial impregnated in three-dimensional

3D collagen printing cross linked with Riboflavin in presence of d-alpha-tocopheryl poly(ethyleneglycol)-1000-succinate as a potential scaffold.

Methods: Groups of 0.1 and 0.2% k21, and 0.1% and 0.2% CHX were prepared. k21/CHX with neutralized collagen was printed with BioX™. Riboflavin was photo-activated and examined using epifluorescence for *Aggregatibacter actinomycetemcomitans* (7-days). Collagen was examined using TEM and measured for porosity, and shape-fitting. Raman and Tandem Mass/solid-state were performed with molecular-docking and circular dichroism. X-ray diffraction were conducted with rheological tests, contact angle and ninhydrin assay.

Results: k21 samples demonstrated collagen aggregates while 0.1%CHX and 0.2%CHX showed irregularities. Porosity of control and 0.1% and 0.2% k21 scaffolds showed no differences. Low contact angle, improved elastic-modulus, rigidity, and smaller strain in k21 groups were seen. Bacteria were reduced and strong organic intensities seen in k21 scaffolds. Simulation showed hydrophobicity and electrostatic interaction. Crosslinking was observed in 0.2% CHX/79%±9.9 and 0.2%k21/80%±12.3. Circular dichroism for k21 were suggestive of triple helix. XRD patterns appeared at d=5.97, 3.03, 2.78, 2.1 and 2.90 A°.

Conclusion: 3D-printing of collagen impregnated with quaternary ammonium silane produced a promising scaffold with antimicrobial potency and structural stability.

https://doi.org/10.1016/j.dental.2021.12.131

O8

Controlled Drug Delivery in Metronidazole-Containing Bioactive Endodontic Cements

G. De Souza Balbinot*, V.C.B. Leitune, K.C. Zatta, T. Benin, F. Visioli, S. Staniscauski Guterres, F.M. Collares

School of Dentistry, Universidade Federal Do Rio Grande Do Sul, Porto Alegre, Brazil
* *Corresponding author.*

Purpose/Aim: This study aims to formulate metronidazole liquid nanocapsules (MTZLNC) and evaluate their effect on the physical-mechanical and biological properties of calcium silicate-based bioactive endodontic cements.

Materials and Methods: The MTZLNCs were formulated by deposition of preformed polymer and characterized by laser diffraction and high-performance liquid chromatography (HPLC). Calcium silicate (CS) particles were synthesized via the sol-gel route and mixed to 10 wt% $CaWO_4$ as a radiopacificant. Cements were formulated by mixing the CS/CaWO4 powders with a liquid containing MTZLNC at two different concentrations: 0.3 mg/ml and 0.15 mg/ml. Cements were prepared with distilled water as the liquid was used as a control. The cements radiopacity, setting time and flow were evaluated following ISO 6876 recommendations. The compressive strength analysis was conducted according to ISO 9917. pH was evaluated after immersion in water, while mineral deposition on the surface of the sample was analyzed at up to 28-days immersions in SBF. Cell behavior was evaluated by the viability of cells by SRB and MTT, and the antibacterial activity against Enterococcus faecalis was analyzed immediately and after nine months of water storage.

Results: MTZLNCs were successfully formulated with a 157 nm diameter and 83.44% encapsulated drug. The cements radiopacity was not affected by the presence of MTZLNCs and all groups reached the requirements of ISO 6876. An Increased flow was obtained with the two MTZLNCs concentrations, and all values were within the requirements of ISO 6876. The setting of cements was detected at 20 minutes for the control group and 18 minutes for 0.30 mg/ml concentration, without statistically significant difference between groups. Lower strength values were found when MTZLNCs were used. The incorporation of MTZLNCs maintained the ability of cements to increase pH media and promote mineral deposition over the samples. Pre-osteoblastic cell viability drops to around 80% with the 0.3 mg/ml concentration and at the same concentration, a reduction in E. faecalis CFU was observed both immediately and after nine months in water storage.

Conclusions: The successful formulation of MTZLNCs allowed the development of antibacterial calcium silicate based-cements with suitable physicochemical properties and bioactivity. The 0.3 mg/ml concentration in cements liquid promoted effective and sustainable antibacterial activity.

https://doi.org/10.1016/j.dental.2021.12.132

O9

Fatigue Analysis of Restored Teeth Longitudinally Cracked Under Cyclic Loading

F. Lin [1,*], A. Fok [2], R. Ordinola-Zapata [3], N. Ye [2], Y.C. Heo [2]

[1] *Department of Cariology and Endodontology, Peking University School and Hospital of Stomatology, Beijing, China*
[2] *Minnesota Dental Research Center for Biomaterials and Biomechanics, School of Dentistry, University of Minnesota, Minneapolis, USA*
[3] *Division of Endodontics, Department of Restorative Sciences, School of Dentistry, University of Minnesota, Minneapolis, USA*
[*] *Corresponding author.*

Purpose/Aim: To investigate the fatigue behavior of restored teeth, in particular the mechanisms of longitudinal dentinal cracking under cyclic mechanical loading, using finite element analysis (FEA) and the stress-life (S-N) approach.

Materials and Methods: Ten root-filled premolars restored with resin composites were subjected to step-stress cyclic loading to produce longitudinal cracks. Fracture loads and number of cycles completed at each load level were recorded. Finite element analysis (FEA) was used to predict the stress amplitude of each component under the global cyclic load. Both intact and debonded conditions were considered for the dentin-composite interface in the FEA. The predicted stress concentrations were compared with the fracture patterns to help elucidate the failure mechanisms. The stress-life approach was further used to predict the lifetimes of the different components in the restored teeth. Cumulative fatigue damage was represented by the sum of the fractions of life spent under the different stress amplitudes.

Results: Longitudinal cracks were seen in ~50% of the samples with a mean fracture load of 77045 N and a mean number of cycles to failure of 3229712624. The longitudinal dentinal cracks seemed to start near the line angle of the cavity, and propagated longitudinally towards the root. The sum of fractions of life spent for the dentin-composite interface exceeded 1 after ~7000 cycles when that for dentin was much lower that 1, indicating that interfacial debonding would occur prior to dentin fracture. This was confirmed by micro-CT images showing widened interfacial space in the cracked samples. In the debonded tooth, FEA showed dentinal stress concentrations at the gingival wall of the cavity, which coincided with the longitudinal cracks found in the cyclic loading test. The sum of fractions of life spent for dentin was close to 1 at ~30000 cycles, similar to the experimental value.

Conclusions: Debonding of the dentin-composite interface occurred prior to longitudinal cracking of dentin in root-filled teeth under cyclic loading. The approximate time of occurrence for these events could be estimated using fatigue analysis with stresses provided by FEA.

https://doi.org/10.1016/j.dental.2021.12.133

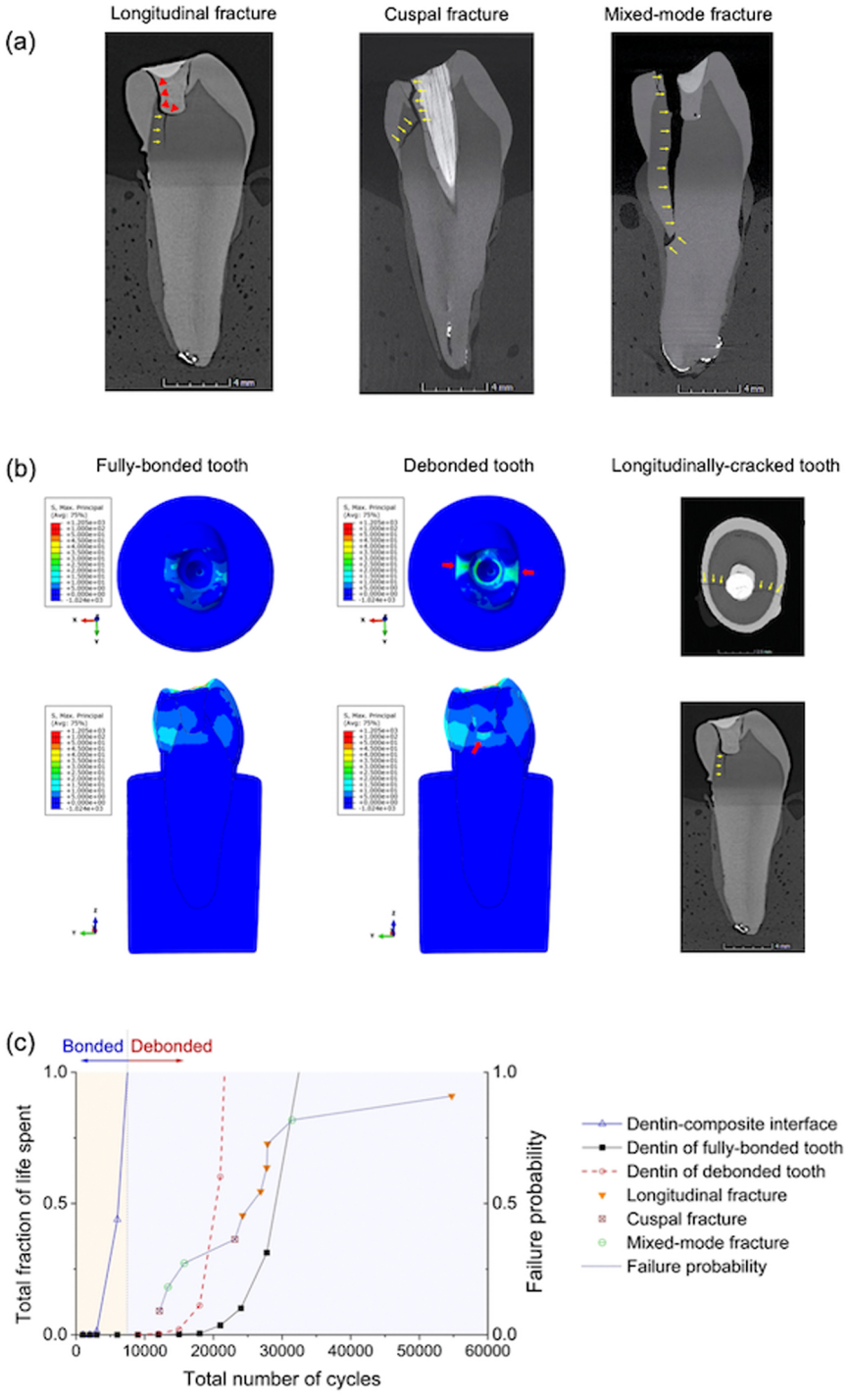


Figure 1

(a) Micro-CT images showing longitudinal, cuspal and mixed-mode fractures. The yellow arrows point to the positions of fractures.

(b) Stress distributions of fully-bonded and debonded tooth compared with longitudinally-cracked tooth from cyclic loading test.

(c) The predicted total fraction of life spent and experimental failure probability against total number of cycles for dentin and the dentin-composite interface.

(10)

Validation of Model Dental Restoration for Failure Prediction

W. Aregawi*, A. Zhang, R. Chen, B. Lima, C. Aparicio, J. Rudney, A.S.L. Fok

School of Dentistry, University of Minnesota, USA

* *Corresponding author.*

Purpose/Aim: The aims of this study were to: (1) validate the dentin-composite disc as a model for assessing interfacial degradation of dental restorations, and (2) assess its ability to predict the clinical failure of resin-composite dental restorations when tested under accelerated cyclic fatigue.

Materials and Methods: Dentin rings, resin-composite rings and dentin-composite discs (5-mm outer diameter, 2-mm inner diameter and 2-mm thick) made from bovine incisor roots and two commercial restorative materials were subjected to diametral compression under cyclic fatigue with a continuously increasing load amplitude. Prior to testing, the samples (n = 30) were stored in either PBS or a lactic-acid solution of pH 4.5 for two different durations (24 and 48 hours) to simulate ageing. The survival probability of the samples were calculated as a function of the number of cycles to failure. For calibration, the numbers of cycles to failure for the dentin-composite discs of one material were plotted against the clinical times to failure and linear regression of the data was performed. The time-conversion factors thus obtained were then used to predict failure for the other material and comparison made with the clinical data for validation purposes.

Results: While the low pH significantly reduced the survival probability of the dentin-composite discs (Fig. 1c and e, P = 4E-5 0.01), it did not do so with the resin-composite (Fig. 1a, P = 0.28) or dentin rings (Fig. 1b, P = 0.81), which confirmed that the adhesive interface was the weakest link in the dentin-composite disc under chemical challenge. The low pH reduced both the Weibull modulus (from 6.5 to 5.9) and mean number of cycles to failure (from 6950 to 6100) of the dentin-composite disks under accelerated cyclic loading. A strong linear relationship was found between the number of laboratory cycles and clinical times to failure for all 3 groups (R2 = 0.6 to 0.9); see Fig. 1d. Low-pH data provided better predictions for clinical failure (Fig. 1f)

Conclusions: The dentin-composite disc is a viable model for testing interfacial degradation. When used with accelerated cyclic fatigue, it can correctly predict the clinical times to failure resin-composite restorations.

https://doi.org/10.1016/j.dental.2021.12.134

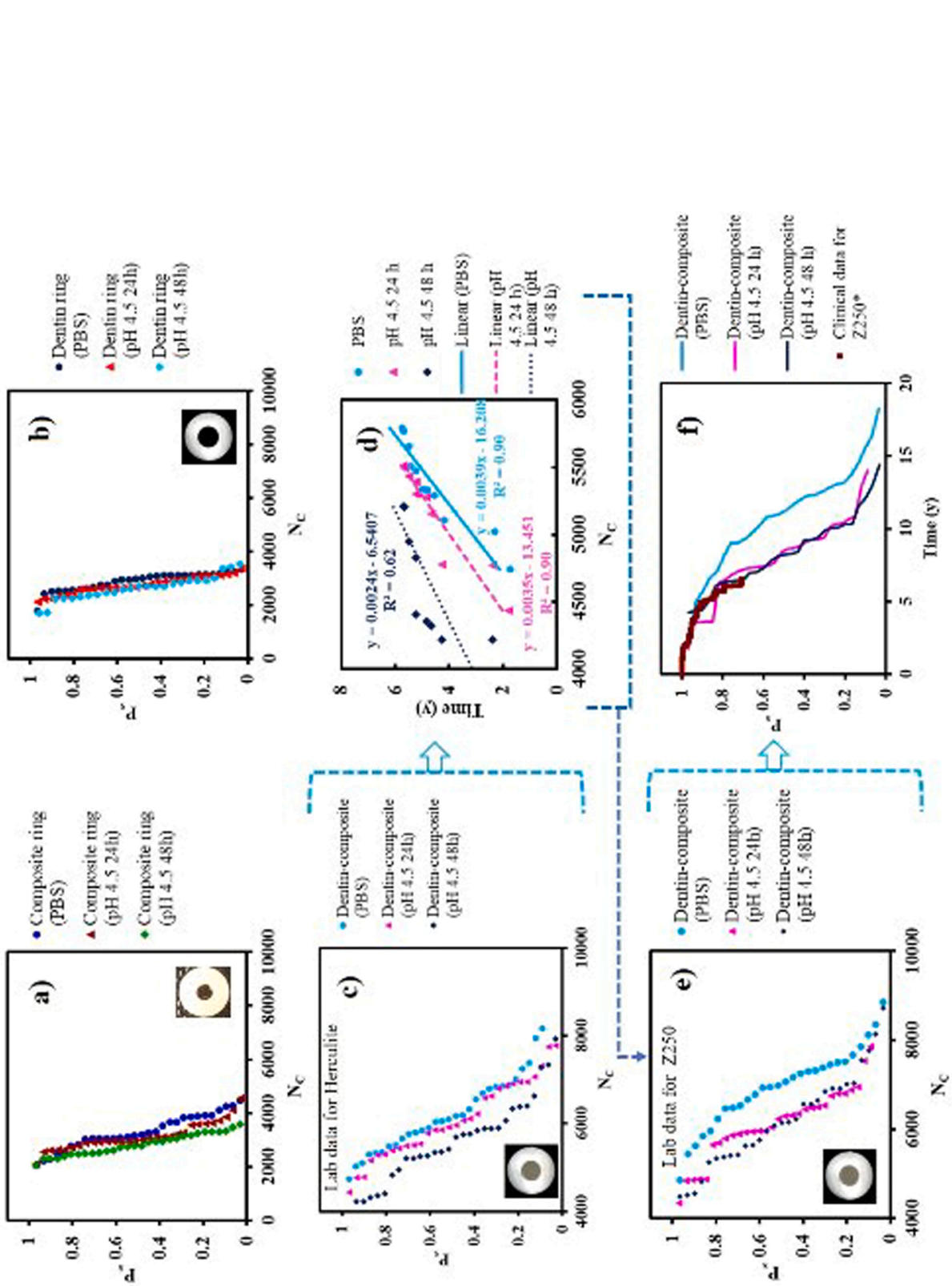


Fig. 1 – (a) survival probability for accelerated fatigue of composite rings with Z250, (b) survival probability for accelerated fatigue of dentin rings, (c) Laboratory accelerated-fatigue data of dentin-composite discs made with Herculite, (d) Correlation between number of lab cycles and clinical time for composite system Herculite*, (e) survival probability for accelerated fatigue of dentin-composite disc specimens with Z250, and (f) survival probability for transformed lab cycles and clinical data on Class-II restoration for composite system Filtek Z250*. *Kopperund SE, Tveit AB, Gaarden T, Sandvik L, Espelid I. Longevity of posterior dental restorations and reasons for failure. Eur J Oral Sci 2012(6);120:539–48.

ACADEMY OF DENTAL MATERIALS

www.academydentalmaterials.org

General information:

The Academy of Dental Materials is a body composed of individuals interested in the science of dental materials. The Academy of Dental Materials exists solely for the purpose of advancing the science and technology of dental biomaterials. This is accomplished by sponsoring annual scientific meetings, conferences, an international journal, transactions of scientific proceedings, awards for students, awards for outstanding scientists, and the confirmation of Fellowship for special members.

Membership information and instructions:

Membership dues are kept at a minimal level to encourage membership (US$ 149 Regular and Fellow, US$ 40 Student, US$ 55 Post-Doctoral, and US$ 2000 Corporate). These rates include an online subscription to the *Dental Materials* journal. Regular and ADM Fellow members can choose to additionally receive a hard copy of the journal for an additional US $26 (or UD$ 175 total). Academy members receive a discounted registration fee for the annual ADM meeting. ADM meetings are conducted using a style that promotes interaction among participants. The opportunity for student and faculty presentations is afforded through poster presentations during meeting days. For membership application forms, meeting information, and general instructions, please contact: Dr.Ricardo M. Carvalho, DDS, PhD, FADM, Email: rickmc@dentistry.ubc.ca

Corporate membership information:

As a Corporate Member, the company will be recognized in the *Dental Materials* journal (circulation approximately 1,800). The corporation name and logo will appear on a special page (in each issue of the journal) acknowledging the Corporate Members. In addition, a complimentary online and hard-copy subscription to *Dental Materials* will be sent to the corporate contact during the year of membership. Meeting sponsorship is independent of corporate membership. The Corporate Member fee is US$ 2000 per year. For corporate membership information, please contact: Lynn Reeves, Executive Manager, E-mail: admin@academydentalmaterials.org, Phone: (858) 272-1018 FAX: (858) 272-7687

Fellowship and Student Award information:

Academy members in good standing may apply for Fellowship in the Academy. Applications must include a current c.v. and two letters of recommendation from current Fellows of the Academy. The criteria to apply for Fellowship are (1) achievement of advanced degrees: at least a master's degree and preferably a Ph.D., Odont Dr., or equivalent degree; (2) publication of at least ten peer-reviewed, scientific articles in refereed journals of which the candidate should be first author on one-half of the articles; (3) at least five years of leadership through research, training, service, and/or education beyond formal education; and (4) normally at least five years membership in the Academy.

University Student Award

Each year, the members of the Academy of Dental Materials affiliated with various Dental Schools around the world, present awards to their most outstanding students or student researchers in the field of dental materials.

For information regarding Fellowship in the Academy and annual dental student awards, please contact: Prof. Ricardo Carvalho E-mail: rickmc@dentistry.ubc.ca.

Student Travel Award

The ADM offers Student Travel Awards to facilitate attendance and participation in the ADM annual meeting by outstanding students currently enrolled in an education program in areas relevant to the mission of the ADM.

Paffenbarger Award

Students pursuing graduate studies in dental materials or biomaterials sciences and dental students who have conducted research in dental materials or biomaterials sciences are encouraged to compete in the **Paffenbarger Award** competition at the annual meeting of the Academy. The winner of the award competition receives a prize of US$ 1,750, the second- place winner receives US$ 1,250, and the third-place winner receives US$ 1,000. All 3 students also receive free registration for the next ADM Meeting. In addition to the Paffenbarger Award, the Academy presents an annual award at each dental school to the student who has demonstrated outstanding academic achievement in dental materials science. For information regarding the Paffenbarger Award competition, please contact: Dr. Arzu Tezvergil-Mutluay E-mail: arztez@utu.fi

Marshall Postdoctoral Award

The ADM offers the **Marshall Postdoctoral Award** to recognize and encourage excellence in dental biomaterials research performed by individuals in the transitional post-doctoral stage of their careers. The winner of this award competition receives US$ * and free registration to the following year's ADM annual meeting.

Founder's Award information:

The ADM has initiated an award to honor Dr. Evan Greener in recognition of his contributions to the Academy. The **Founder's Award** will be given to an ADM Member who is nominated by one or more fellow ADM members as exhibiting excellence in dental materials research and in service to the Academy. Nominations should document the contributions of the individual and should be sent to the President of the Academy: Prof. Dr. Ulrich Lohbauer E-mail: ulrich.lohbauer@fau.de. The nominations will be reviewed by the Board of Directors for acceptance. This is an honorary award, not a cash award, but up to US$ 1000 will be provided to the awardee for expenses in attending the annual Academy meeting to receive the award in person.

MEMBERSHIP APPLICATION

Complete all blank lines Please print or type

— — — — — — — — — — — — — — — — **PROFESSIONAL INFORMATION** — — — — — — — — — — — — —

LAST NAME:_____ FIRST NAME: _____

INSTITUTION/COMPANY/UNIVERSITY: _____

DEPARTMENT: _____

STREET ADDRESS: _____
(please note that journal will be sent to this address)

CITY: _____ STATE:_____

COUNTRY: _____ ZIP: _____

PHONE#:_____ FAX #: _____

E-MAIL: _____

IMPORTANT NOTE: STUDENTS AND POSTDOCTORAL APPLICANTS MUST SEND A CONFIRMATION LETTER OF STUDENT/POSTDOCTORAL STATUS FROM EITHER A SPONSORING MEMBER OR THEIR LEARNING INSTITUTE.

— — — — — — — — — — — — — — — — **FILING INFORMATION** — — — — — — — — — — — — —

MEMBERSHIP: Please check one of the following categories and see reverse side for information:

☐ MEMBER - option 1 US$175/year (includes **printed** and online journal) (US$100 for first year only).
☐ MEMBER - option 2 US$149/year (includes only the **online** journal) (US$74 for first year only).
☐ STUDENT MEMBER* US$40/year (includes only the online version journal).
☐ *STUDENT MEMBER – I do **not** have a PhD title
☐ *STUDENT MEMBER – I **am** enrolled in a Masters, PhD or dental degree program

☐ POSTDOCTORAL MEMBER* US$55/year (includes only the online version journal).
*Confirmation Letter of Student/Postdoctoral Status required to accompany application
☐ *POSTDOCTORAL MEMBER*I have **not** been a PhD member in the ADM for longer than 4 years

PAYMENT: Please check one of the following:

☐ Check ☐ Money Order ☐ Visa ☐ MasterCard ☐ Discover TOTAL: US$_____

Account or Card No.: _____ 3-digit security code: _____

Expiration date: _____ Cardholder's Name: _____

Signature: _____

SIGNATURE OF THE APPLICANT: _____DATE: _____

SEND FORM AND PAYMENT TO:

Academy of Dental Materials
Attn: Lynn Reeves
4425 Cass Street, Suite A
San Diego CA 92109 USA
Email: Lynn@RES-Inc.com
Phone: +01-858-272-1018
FAX: +01-858-272-7687