UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

Sir John Walsh Research Institute

Research report 2023

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The Sir John Walsh Research Institute advances research and increases knowledge for the improvement of oral health in New Zealand.

As the research arm of the University of Otago's Faculty of Dentistry, ranked as one of the best dental schools in the world, the SJWRI provides a integral focus for dental research within New Zealand and internationally.

Our innovative, future-focused, interconnected research programmes cover the spectrum of oral health research, from the molecular, through biological systems to the health of populations.

Our members have well-established productive collaborations across the University and with other institutions in New Zealand and worldwide.

Our mission is to undertake research that underpins our teaching and clinical practice, and that translates discoveries into measurable health improvements for all New Zealanders.

The Institute is named after Sir John Walsh, Dean of the Otago Faculty of Dentistry from 1946 to 1971, who was a strong advocate for research in dentistry and oral health.

Our research programmes

Biomaterials, biomechanics and oral implantology
Understanding the oral environment

Clinical and translational research
Fostering research to improve patient care

Craniofacial research
Investigating dento-facial growth and jaw function

Dental education research
Understanding how students learn and fostering best practices in teaching

Dental epidemiology and public health
Population and dental health services research

Dental engineering and tissue regeneration
Finding new ways to repair and regrow tissue in the oral environment

Molecular microbiology
Preventing oral diseases caused by microorganisms

Oral molecular and immunopathology
Understanding diseases in order to improve diagnosis and treatment

Our people

Research expertise and interests of our academic and research staff (A-Z index)

Our highlights

News and events from the SJWRI

Research publications and outputs summary, 2023

Publication/output category	Total for 2023	
	PCs	UPCs
Chapter in Book - Research	18	17.33
Chapter in Book - Other	1	1.00
Journal - Research Article	289	252.13
Journal - Research Other	74	66.61
Journal - Professional & Other Non-Research Articles	20	20.00
Conference Contribution - Published proceedings: Abstract	54	45.53
Conference Contribution - Edited volume of conference proceedings	3	0.30
Conference Contribution - Poster Presentation (not in published proceedings)	3	1.60
Conference Contribution - Verbal presentation and other Conference outputs	41	35.97
Other Research Output	3	2.33
Awarded Doctoral Degree	29	29.00
Awarded Masters Degree	1	1.00
Total - Sir John Walsh Research Institute	**536**	**472.81**

PC Publication counts

UPC Unique publication counts

To avoid double counting, unique publication counts are used when a publication has authorship from more than one department; e.g. for a publication with authors from more than one department, each department's contribution is allocated proportionally.

All data courtesy the PBRF and Publications Office, Research Division, University of Otago, with thanks to Molly McCormick, Research Outputs Administrator.

All SJWRI publications

Listing includes all publications including authors with SJWRI or Faculty of Dentistry affiliations..

All data courtesy the PBRF and Publications Office, Research Division, University of Otago, with thanks to Molly McCormick, Research Outputs administrator.

Edited Book - Research

Seymour, G. J., Cullinan, M. P., Heng, N. C. K., & Cooper, P. R. (Eds.). (2023). *Oral biology: Molecular techniques and applications: Methods in molecular biology (Vol. 2588)* (3rd ed.). New York, NY: Springer, 528p. https://doi.org/10.1007/978-1-0716-2780-8

Chapter in Book - Research

Adam, L. (2023). Framing students' perspectives on academic integrity. In S. E. Eaton (Ed.), *Handbook of academic integrity*. (Online ed.) Singapore: Springer. https://doi.org/10.1007/978-981-287-079-7_187-1

Ali, M. A., & Gould, M. L. (2023). Opportunities, challenges and future of bioceramics. In M. E. Hoque, K. L. Goh & S. Sagadevan (Eds.), *Advanced bioceramics: Properties, processing, and applications*. (pp. 376-400). Boca Raton, FL: CRC Press. https://doi.org/10.1201/9781003258353-22

Arora, S., Ramachandra, S. S., Cooper, P. R., & Hussaini, H. M. (2023). Prospects of passive immunotherapy to treat pulpal inflammation. In M. T. Rahman, W. Teughels & R. J. Lamont (Eds.), *Immunology for Dentistry*. (pp. 202-214). Hoboken, NJ: John Wiley & Sons. https://doi.org/10.1002/9781119893035.ch14

Arora, S., Seo, B., Friedlander, L., & Hussaini, H. M. (2023). A cell culture method for the isolation and study of primary human dental pulp cells. In G. J. Seymour, M. P. Cullinan, N. C. K. Heng & P. R. Cooper (Eds.), *Oral biology: Molecular techniques and applications: Methods in molecular biology (Vol. 2588)*. (3rd ed.) (pp. 393-405). New York, NY: Springer. https://doi.org/10.1007/978-1-0716-2780-8_22

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Bhowmik, S., Agyei, D., & Ali, A. (2023). Application of nanochitosan in the preservation of fish and oil. In C. O. Adetunji, D. I. Hefft, J. Jeevanandam & M. K. Danquah (Eds.), *Next generation nanochitosan: Applications in animal husbandry, aquaculture and food conservation*. (pp. 447-474). London, UK: Academic Press. https://doi.org/10.1016/B978-0-323-85593-8.00031-X

Bhuiyan, M. H., Houlton, J., & Clarkson, A. N. (2023). Hydrogels and nanoscaffolds for long-term intraparenchymal therapeutic delivery after stroke. In V. T. Karamyan & A. M. Stowe (Eds.), *Neural repair: Methods and protocols: Methods in molecular biology (Vol. 2616)*. (pp. 379-390). New York, NY: Springer Nature. https://doi.org/10.1007/978-1-0716-2926-0_26

Chandravarnan, P., Agyei, D., & Ali, A. (2023). Innovative strategies to decontaminate Ochratoxin A in food and feed. In D. Nagaraju, S. M. Yanjarappa, P. N. Achar & A. M. Vaya (Eds.), *Anti-mycotoxin strategies for food and feed*. (pp. 59-82). Wiley. Retrieved from https://www.wiley.com/en-ca/Anti+Mycotoxin+Strategies+for+Food+and+Feed-p-9781394160822#description-section

De Silva, H. L., & Seo, B. (2023). Blue-purple lump on the lip: Haemangioma/vascular anomaly. In W. M. Tilakaratne & T. G. Kallarakkal (Eds.), *Clinicopathological correlation of oral diseases*. (pp. 129-140). Cham, Switzerland: Springer Nature. https://doi.org/10.1007/978-3-031-24408-7_12

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Hirschfeld, J., Chicca, I. J., Moonen, C. G. J., White, P. C., Ling, M. R., Wright, H. J., Cooper, P. R., … Chapple, I. L. C. (2023). Characterization, quantification, and visualization of neutrophil extracellular traps. In G. J. Seymour, M. P. Cullinan, N. C. K. Heng & P. R. Cooper (Eds.), *Oral biology:*

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Hussaini, H. M., Seo, B., & Rich, A. M. (2023). Immunohistochemistry and immunofluorescence. In G. J. Seymour, M. P. Cullinan, N. C. K. Heng & P. R. Cooper (Eds.), *Oral biology: Molecular techniques and applications: Methods in molecular biology (Vol. 2588)*. (3rd ed.) (pp. 439-450). New York, NY: Springer. https://doi.org/10.1007/978-1-0716-2780-8_26

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Loch, C., Fordyce, R. E., & Werth, A. (2023). Skulls, teeth, and sex. In B. Würsig & D. N. Orbach (Eds.), *Sex in cetaceans: Morphology, behavior, and the evolution of sexual strategies*. (pp. 51-64). Cham, Switzerland: Springer Nature. https://doi.org/10.1007/978-3-031-35651-3_3

Ratnayake, J., Camilleri, J., Haththotuwa, T. N., & Huang, J. (2023). In vitro biological testing of dental materials. In G. J. Seymour, M. P. Cullinan, N. C. K. Heng & P. R. Cooper (Eds.), *Oral biology: Molecular techniques and applications: Methods in molecular biology (Vol. 2588)*. (3rd ed.) (pp. 505-524). New York, NY: Springer. https://doi.org/10.1007/978-1-0716-2780-8_31

Ray, P. N., Hoque, M. E., & Ali, M. A. (2023). Sodium alginate nanoadsorbents for wastewater treatment: Synthesis and characterizations. In A. Ahmad, I. Ahmad, T. Kamal, A. M. Asiri & S. Tabassum (Eds.), *Sodium alginate-based nanomaterials for wastewater treatment*. (pp. 235-271). Amsterdam, Netherlands: Elsevier. https://doi.org/10.1016/B978-0-12-823551-5.00014-8

Tenuta, L. M. A., Nóbrega, D. F., & Mei, M. L. (2023). The use of fluorides in the control of coronal caries. In J. C. Carvalho (Ed.), *Monographs in oral science. Coronal caries: Evolving evidence and clinical practice (Vol. 31)*. Basel, Switzerland: Karger. https://doi.org/10.1159/000530564

Chapter in Book - Other

Cannon, R. D., Lyons, K. M., Chong, K., Newsham-West, K., Niimi, K., & Holmes, A. R. (2023). Adhesion of yeast and bacteria to oral surfaces. In G. J. Seymour, M. P. Cullinan, N. C. K. Heng & P. R. Cooper (Eds.), *Oral biology: Molecular techniques and applications: Methods in molecular biology (Vol. 2588)*. (3rd ed.) (pp. 131-156). New York, NY: Springer. https://doi.org/10.1007/978-1-0716-2780-8_9

Coates, D. E., Zafar, S., & Milne, T. J. (2023). Quantitative real-time gene profiling of human alveolar osteoblasts using a one-step system. In G. J. Seymour, M. P. Cullinan, N. C. K. Heng & P. R. Cooper (Eds.), *Oral biology: Molecular techniques and applications: Methods in molecular biology (Vol. 2588)*. (3rd ed.) (pp. 417-427). New York, NY: Springer. https://doi.org/10.1007/978-1-0716-2780-8_24

Godoy Zanicotti, D., Milne, T. J., & Coates, D. E. (2023). Culturing adipose-derived stem cells under serum-free conditions. In G. J. Seymour, M. P. Cullinan, N. C. K. Heng & P. R. Cooper (Eds.), *Oral biology: Molecular techniques and applications: Methods in molecular biology (Vol. 2588)*. (3rd ed.) (pp. 407-415). New York, NY: Springer. https://doi.org/10.1007/978-1-0716-2780-8_23

Journal - Research Article

Abdelmoneim, D., Porter, G., Duncan, W., Lim, K., Easingwood, R., Woodfield, T., & Coates, D. (2023). Three-dimensional evaluation of the cytotoxicity and antibacterial properties of alpha lipoic acid-capped silver nanoparticle constructs for oral applications. *Nanomaterials*, *13*, 705. https://doi.org/10.3390/nano13040705

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Ahmed, H., Ratnayake, J., Cathro, P., & Chandler, N. (2023). The effect of an additional application of sealer prior to backfilling in the Continuous Wave of Condensation technique. *Australian Endodontic Journal*, *49*, 344-350. https://doi.org/10.1111/aej.12658

Ajay Sharma, L., Ramesh, N., Sharma, A., Ratnayake, J. T. B., Love, R. M., Alavi, S. E., Wilson, M. J., & Dias, G. J. (2023). *In vitro* effects of wool-derived keratin on human dental pulp-derived stem cells for endodontic applications. *British Journal of Oral & Maxillofacial Surgery*. Advance online publication. https://doi.org/10.1016/j.bjoms.2023.08.240

Al Matrooshi, K., Al Raeesi, S., Tawfik, A. R., Khamis, A. H., Bain, C., Atieh, M., & Shah, M. (2023). Knowledge of physicians about the

interrelationship between diabetes mellitus and periodontitis in the United Arab Emirates. *European Journal of Dentistry*, *17*, 219-226. https://doi.org/10.1055/s-0042-1746413

Al-Jebori, R., Pg Hassim, I., & Thomson, W. M. (2023). The impact of the COVID-19 pandemic on general dental practitioners in New Zealand. *New Zealand Dental Journal*, *119*(2), 67-72.

AlAli, F., Atieh, M. A., Hannawi, H., Jamal, M., Al Harbi, N., Alsabeeha, N. H. M., & Shah, M. (2023). Anterior maxillary labial bone thickness on cone beam computed tomography. *International Dental Journal*, *73*, 219-227. https://doi.org/10.1016/j.identj.2022.03.007

Alsamahi, S., Milne, T. J., Hussaini, H. M., Rich, A. M., Cooper, P. R., & Friedlander, L. T. (2023). Effects of glycation end-products on the dental pulp in patients with type 2 diabetes. *International Endodontic Journal*, *56*, 1373-1384. https://doi.org/10.1111/iej.13966

Assy, Z., Thomson, W. M., Brand, H. S., Cha, S., Susam, M. M., Weisman, G. A., … Jager, D. H. J. (2023). The minimally important difference for the Xerostomia Inventory among Sjögren's disease patients. *Oral Diseases*. Advance online publication. https://doi.org/10.1111/odi.14841

Atieh, M. A., Al-Ali, B., Shah, M., Amir-Rad, F., Baqain, Z. H., Al-Suwaidi, S., & Alsabeeha, N. H. M. (2023). Enamel matrix derivative for alveolar ridge preservation: A randomized controlled trial. *Clinical Oral Implants Research*. Advance online publication. https://doi.org/10.1111/clr.14108

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Atieh, M. A., Shah, M., Hakam, A., Alghafri, M., Tawse-Smith, A., & Alsabeeha, N. H. M. (2023). Systemic azithromycin versus amoxicillin/metronidazole as an adjunct in the treatment of periodontitis: A systematic review and meta-analysis. *Australian Dental Journal*. Advance online publication. https://doi.org/10.1111/adj.12991

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Barron Hill, E., Mastny-Jensen, C., & Loch, C. (2023). Before and after: COVID-19 impacts on dental students' well-being, clinical competency and employment opportunities. *European Journal of Dental Education*. Advance online publication. https://doi.org/10.1111/eje.12977

Beckett, D. M., Vaz Viegas, S., Broadbent, J. M., Wheeler, B. J., Bērziņš, K., Fraser-Miller, S. J., Gordon, K. C., Drummond, B. K., Mahoney, E. K., & Loch, C. (2023). An exploration of mineral density, elemental and chemical composition of primary teeth in relation to cord-blood vitamin D, using laboratory analysis techniques. *Journal of Bone & Mineral Research*, *38*(12), 1846-1855. https://doi.org/10.1002/jbmr.4928

Bennani, V., Aarts, J. M., & Senthilkumar, A. (2023). Effect of a modified laminate veneer preparation design on absolute margin discrepancy and marginal overhang. *Journal of Prosthetic Dentistry*. Advance online publication. https://doi.org/10.1016/j.prosdent.2023.10.033

Bhowmik, S., Dewanjee, S., Islam, S., Saha, D., Banik, P., Hossain, M. K., … Mamun, A.-A. (2023). Nutritional profile and heavy metal contamination of nursery, grower, and finisher feeds of tilapia (*Oreochromis niloticus*) in Bangladesh. *Food Chemistry Advances*, *2*, 100235. https://doi.org/10.1016/j.focha.2023.100235

Bhuiyan, M. H., Clarkson, A. N., & Ali, M. A. (2023). Optimization of thermoresponsive chitosan/β-glycerophosphate hydrogels for injectable neural tissue engineering application. *Colloids & Surfaces B*. Advance online publication. https://doi.org/10.1016/j.colsurfb.2023.113193

Binkhorst, T. S., Tawse-Smith, A., Goh, R., Nogueira, G. R., & Atieh, M. (2023). Tomographic evaluation of alveolar ridge preservation using bone substitutes and collagen membranes: A retrospective pilot study. *Dentistry Journal*, *11*, 58. https://doi.org/10.3390/dj11030058

Boyd, D. H., Foster Page, L. A., Moffat, S. M., & Thomson, W. M. (2023). Time to complain about pain: Children's self-reported procedural pain in a randomised control trial of Hall and conventional stainless-steel crown techniques. *International Journal of Paediatric Dentistry*. Advance online publication. https://doi.org/10.1111/ipd.13059

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Towle, I., Hlusko, L. J., Martinéz de Pinillos, M., Modesto, M., Irish, J. D., & Loch, C. (2023). How enamel thickness, mineral concentra-tion and mechanical properties influence tooth wear and fractures in catarrhine molar crowns. *American Journal of Biological Anthropology*, *180*(S75), (pp. 177). https://doi.org/10.1002/ajpa.24731

Yin, X., Mei, M. L., & Chu, C. H. (2023). Tooth-binding graphene quantum dots silver nanoparticles for caries management. *International Dental Journal*, *73*(Suppl. 1), FC113. https://doi.org/10.1016/j.identj.2023.07.283

Edited volume of conference proceedings

Milne, T., Anwar, M., Burga, L., Harcombe, H., Garelja, M., Middleton, A., Ribeiro, D. C., Fleming, N., Ogbuehi, K., & Bahn, A. (Eds.). (2023). *Proceedings of the 265th Otago Medical School Research Society (OMSRS) Meeting: Summer Student Speaker Awards*. Dunedin, New Zealand: OMSRS. Retrieved from https://ourarchive.otago.ac.nz/handle/10523/12839.

Milne, T., Anwar, M., Burga, L., Harcombe, H., Garelja, M., Middleton, A., Ribeiro, D. C., Fleming, N., Ogbuehi, K., & Bahn, A. (Eds.). (2023). *Proceedings of the 266th Otago Medical School Research Society (OMSRS) Meeting: Research Staff Speaker Awards*. Dunedin, New Zealand: OMSRS. Retrieved from https://ourarchive.otago.ac.nz/handle/10523/12839.

Milne, T., Anwar, M., Burga, L., Harcombe, H., Garelja, M., Middleton, A., Ribeiro, D. C., Fleming, N., Ogbuehi, K., & Bahn, A. (Eds.). (2023). *Proceedings of the 267th Otago Medical School Research Society (OMSRS) Meeting: PhD Student Speaker Speaker Awards*. Dunedin, New Zealand: OMSRS. Retrieved from https://ourarchive.otago.ac.nz/handle/10523/12839.

Milne, T., Anwar, M., Burga, L., Harcombe, H., Garelja, M., Middleton, A., Ribeiro, D. C., Fleming, N., Ogbuehi, K., & Bahn, A. (Eds.). (2023). *Proceedings of the 268th Otago Medical School Research Society (OMSRS) Meeting: Masters/Honours/Postgraduate Diploma Student Speaker Awards*. Dunedin, New Zealand: OMSRS. Retrieved from https://ourarchive.otago.ac.nz/handle/10523/12839.

Poster Presentation (not in published proceedings)

Andimadam Madana Saravanan, J., Sinha, S., Gamble, A., Ali, A., & Katare, R. (2023, August). *Smart bioscaffolds for cardiovascular tissue engineering and regenerative medicine*. Poster session presented at the 17th New Zealand Medical Sciences Congress (MedSci), Queenstown, New Zealand.

Sinha, S., Ali, A., Gamble, A., Hook, S., & Katare, R. (2023, August). *Nano formulation incorporated nanomatrix for the treatment of diabetic wound*. Poster session presented at the 17th New Zealand Medical Sciences Congress (MedSci), Queenstown, New Zealand.

Verbal presentation and other Conference outputs

Abdelmoneim, D., Porter, G., Duncan, W., Lim, K., Easingwood, R., Woodfield, T., & Coates, D. (2023, July). *Three-dimensional evaluation of the cytotoxicity and antibacterial properties of alpha lipoic acid-capped silver nanoparticle constructs for oral applications*. Verbal presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Al Naasan, Z. (2023, November). *Tooth wisdom: Integrating cultural safety in dental practice for former refugees*. Verbal presentation at the Otago Global Health Institute (OGHI) 15th Annual Conference: Aotearoa New Zealand's Contribution to Global Health: Global Citizen versus Good Neighbour? Dunedin, New Zealand.

Ali, M. A. (2023, August). *Concept to clinic: Translating biomaterials into medical devices*. Verbal presentation at the 33rd Queenstown Molecular Biology Meeting (QMB), Queenstown, New Zealand.

Bakri, N. N., Smith, M. B., Broadbent, J. M., & Thomson, W. M. (2023, July). *Promoting oral health in the aged care workplace setting: Key informants' views*. Verbal presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Chao, H. C., Milne, T. J., Cathro, P., Cooper, P. R., & Friedlander, L. T. (2023, July). *Hyperglycaemia promotes mineralisation of human dental pulp cells: An exploratory in vitro study*. Verbal presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Chapman, R. A., Thomson, W. M., & Broadbent, J. M. (2023, July). *Validation of the Child Perceptions Questionnaire as a measure of oral health-related quality of life in young adults*. Verbal presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Coates, D. (2023, September). *Antimicrobial graft materials for bone engineering*. Verbal presentation at the 19th International Conference of Women Engineers & Scientists (ICWES): Shaping the Future, Auckland, New Zealand.

Elahi, A., Duncan, W., Li, K. C., & Coates, D. (2023, July). *Supercritical carbon dioxide processing with enzymatic post-treatment to yield mechanically and biologically optimal animal-derived bone block grafts for oral application*. Verbal presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Farella, M. (2023, July). *Unlocking the bite: Myths and facts about Class II Division 2 malocclusion*. Keynote presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Goh, R., Tawse-Smith, A., Ma, S., Atieh, M., Giraldo, D., & Li, K. C. (2023, July). *The effect of implantoplasty on fracture resistance and implant surface changes, an in vitro and finite element analysis study*. Verbal presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Hurst, C. (2023, July). *Lower incisor extraction: A contemporary treatment option or orthodontic no-go?* Verbal presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Jansen van Vuuren, L., Broadbent, J. M., Duncan, W. J., Jansen van Vuuren, W. A., & Waddell, J. N. (2023, July). *Dental occlusal stress*. Verbal presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Jin, C. (2023, July). *Unlocking the canine secret: All is well if the end(o) is well*. Verbal presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Jin, C., Mei, P., Farella, M., Brunton, P., & Gray, A. (2023, July). *Can orthodontic clear retainers be used for tooth whitening?* Verbal presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Khashashneh, M., Brunton, P., Lyons, K., Mei, P., & Choi, J. (2023, July). *The effect of 10% carbamide peroxide dental bleaching on the physical properties of Invisalign aligners*. Verbal presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Lintern, J., Thomson, W. M., De Silva, H., & Ling, G. (2023, July). *Hyperbaric oxygen: Who wants it? A case-series analysis of patients referred for hyperbaric oxygen in the prevention or management of osteoradionecrosis (ORN) in New Zealand*. Verbal presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Milne, T. (2023, September). *The yin and yang of alveolar bone remodelling*. Verbal presentation at the 19th International Conference of Women Engineers & Scientists (ICWES): Shaping the Future, Auckland, New Zealand.

Oliver, A. (2023, July). *Clinical outcomes of periodontal patients seen by Doctor of Clinical Dentistry students between 2015 and 2017: A retrospective study*. Verbal presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Patel, S., Milne, T. J., Hussaini, H. M., Cooper, P. R., & Friedlander, L. T. (2023, July). *Hyperglycaemia and the dental pulp: So what about angiogenesis?* Verbal presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Pretz, D., Heyward, P. M., Krebs, J., Gruchot, J., Barter, C., Silcock, P., Downes, N., Rizwan, M. Z., Boucsein, A., … Boer, G. A., Perry, N. B., & Tups, A. (2023, August). *From mechanistic biomedical research on hypothalamic inflammation to a dietary supplement for glucose support*. Verbal presentation at the 17th New Zealand Medical Sciences Congress (MedSci), Queenstown, New Zealand.

Pretz, D., Heyward, P. M., Krebs, J., Gruchot, J., Barter, C., Silcock, P., Downes, N., Rizwan, M. Z., Boucsein, A., Bender, J., Burgess, E. J., Boer, G. A., Perry, N. B., & Tups, A. (2023, August-September). *A dahlia flower extract has anti-diabetic properties by improving insulin function in the brain*. Verbal presentation at the Queenstown Molecular Biology (QMB) Hypothalamic Neuroscience & Neuroendocrinology Australasia (HNNA) Satellite, Queenstown, New Zealand.

Ruiz Conrads, B., Thomson, W. M., & Broadbent, J. M. (2023, July). *Childhood caries experience is associated with poorer physical health, mental health and ageing in midlife*. Verbal presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Tee, A. L. (2023, July). *Partial edentulism and Parkinson's disease*. Verbal presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Thorsnes, Q., Ali, A., & Cabral, J. (2023, July). *Novel additive manufacturing techniques for vascular bioscaffolds*. Verbal presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Wong, L., Farella, M., Firth, F., Fowler, P., & Jack, H. (2023, July). *Cleft project: The search for a confident smile*. Verbal presentation at the Faculty of Dentistry Clinical and Research Excellence Symposium, Dunedin, New Zealand.

Other Research Output

Inaugural Professorial Lecture

Tawse-Smith, A. (2023, September). *Foundations, foundations, foundations*. University of Otago, Dunedin, New Zealand.

Research Presentation

Al Naasan, Z. (2023, March). *Former refugees and oral health*. Migration: Past and Present. University of the Third Age, Dunedin, New Zealand.

Awarded Doctoral Degree

Abdelmoneim, D. (2023). *Silverbone-antibacterial bone regenerative scaffolds* (PhD). University of Otago, Dunedin, New Zealand. Retrieved from http://hdl.handle.net/10523/15401.

Ahmad Zainuddin, F. Z. (2023). *Measuring dry mouth in older people in residential care, in Dunedin* (DClinDent). University of Otago, Dunedin, New Zealand. Retrieved from http://hdl.handle.net/10523/15674.

Arora, S. (2023). *Effects of IL-23 blockade as a pulp immune-modulating agent in vitro and in vivo* (PhD). University of Otago, Dunedin, New Zealand. Retrieved from http://hdl.handle.net/10523/15107.

Benn, A. M. L. (2023). *Oral health and distinct oral biofilms in a birth cohort in mid-life* (PhD). University of Otago, Dunedin, New Zealand.

Retrieved from http://hdl.handle.net/10523/15976.

Bhuiyan, M. M. H. (2023). *Development and characterisation of a novel thermoresponsive hydrogel for brain tissue regeneration after stroke* (PhD). University of Otago, Dunedin, New Zealand. Retrieved from http://hdl.handle.net/10523/16234.

Chao, H. C.-H. (2023). *Hyperglycaemia and calcification within the human dental pulp* (DClinDent). University of Otago, Dunedin, New Zealand. Retrieved from http://hdl.handle.net/10523/16362.

Goh, R. Z. X. (2023). *Effect of implantoplasty on fracture resistance and implant surface* (DClinDent). University of Otago, Dunedin, New Zealand. Retrieved from http://hdl.handle.net/10523/16363.

Jansen van Vuuren, L. (2023). *Dental occlusal stress* (PhD). University of Otago, Dunedin, New Zealand. Retrieved from http://hdl.handle.net/10523/15075.

Jin, C. (2023). *Biomechanical properties of orthodontic vacuum-formed retainers* (DClinDent). University of Otago, Dunedin, New Zealand. Retrieved from http://hdl.handle.net/10523/16400.

Khashashneh, M. (. S. N. (2023). *The effect of 10% carbamide peroxide dental bleaching on the physical properties of Invisalign orthodontic aligners* (DClinDent). University of Otago, Dunedin, New Zealand. Retrieved from http://hdl.handle.net/10523/16370.

Krishnan, C. S. (2023). *Neutral-PH electrolysed oxidising water as a dental disinfectant* (PhD). University of Otago, Dunedin, New Zealand. Retrieved from http://hdl.handle.net/10523/16247.

Lintern, J. E. (2023). *'Hyperbaric oxygen: Who wants it?' A case-series analysis of patients referred for hyperbaric oxygen in the prevention or treatment of osteoradionecrosis (ORN) in New Zealand* (DClinDent). University of Otago, Dunedin, New Zealand. Retrieved from http://hdl.handle.net/10523/16358.

Oliver, A. O. (2023). *Clinical outcomes of postgraduate periodontal students' patients: A retrospective study* (DClinDent). University of Otago, Dunedin, New Zealand. Retrieved from http://hdl.handle.net/10523/16375.

Patel, S. P. (2023). *Hyperglycaemia and the dental pulp: So what about angiogenesis?* (DClinDent). University of Otago, Dunedin, New Zealand. Retrieved from http://hdl.handle.net/10523/16382.

Ruiz Conrads, B. d. P. (2023). *Childhood caries: An early indicator of poor oral and general health by midlife: Findings from two Aotearoa New Zealand birth cohorts* (PhD). University of Otago, Dunedin, New Zealand. Retrieved from http://hdl.handle.net/10523/15655.

Tee, A. L. (2023). *An in-vitro study of the effect of titanium surface treatments on the bonding between zirconia crowns and titanium bases* (DClinDent). University of Otago, Dunedin, New Zealand. Retrieved from http://hdl.handle.net/10523/16389.

Toepfer, S. (2023). *Experimental combination therapy against azole-based multidrug resistant Candida auris* (PhD). University of Otago, Dunedin, New Zealand. Retrieved from http://hdl.handle.net/10523/16185.

Tomiki, L. I. K. (2023). *The effect of complementary feeding on New Zealand's infants dental health* (DClinDent). University of Otago, Dunedin, New Zealand. Retrieved from http://hdl.handle.net/10523/16229.

Wong, L. H. M. (2023). *Beyond the cleft smile. Exploring dynamic smile characteristics and their relationship with clinical, biomechanical, and psychosocial factors* (DClinDent). University of Otago, Dunedin, New Zealand. Retrieved from http://hdl.handle.net/10523/16387.

Total publications (2023) for Sir John Walsh Research Institute/Faculty of Dentistry: 298

Research funding summary, 2023

Competitive and commercial research funding awarded in 2023 to projects led by SJWRI principal investigators, *totalled by funder/funding source.*

Funding is listed in New Zealand dollars, GST exclusive.

Data courtesy Lorraine Harris, Research and Enterprise, University of Otago.

Funding/contracting body	Total
Cancer Research Trust New Zealand	$130,000
Downie Stewart (Marjorie Fuller Trust)	$20,000
Foundation for Orthodontic Research & Education, NZ Association of Orthodontists	$3,893
Genesis Energy NZ	$38,863
GNS Science	$468,040
Kiwi Innovation Network Limited	$15,000
Maurice and Phyllis Paykel Trust	$16,000
MedTech - CMDT Research Acceleration Programme	$79,989
Ministry of Oral Health Research Fund (administered by the NZDRF)	$47,426
New Zealand Dental Research Foundation	$146,821
Progress in Science and Education with Ceramics	$9,259
Royal Society of New Zealand Te Apārangi	$934,000
Sir Thomas K. Sidey Trust	$19,996
University of Otago Research Grants	$82,828
Total - Sir John Walsh Research Institute	**$2,012,115**

Full listing of SJWRI research funding, 2023

Competitive and commercial research funding commencing or awarded in 2023, involving principal or other named investigators from the SJWRI.

Awards are presented in chronological order of start date, grouped by funder.
Funding is in New Zealand dollars, GST exclusive.

All affiliations are SJWRI/University of Otago unless noted otherwise.
Lead investigators are listed in **bold**. **Student investigators are asterisked.*

Data courtesy Lorraine Harris, Research and Enterprise, University of Otago.

Key:

Funding awarded in 2022, commencing in 2023

Funding awarded and commencing in 2023

Funding awarded in 2023, commencing in 2024

Funder/Award	Title	Duration	Award	Investigators
Ministry of Health Oral Research Fund	*Oral and maxillofacial surgeons' perspectives on workforce recruitment and retention in Aotearoa New Zealand*	1 Jan 23 - 31 Dec 23	$18,084	Moira Smith (Public Health, UOW), Murray Thomson
University of Otago Research Grants	*Mana o te Mamaku. Use of Mamaku (Cyathea medullaris) to treat oral disease, combining Kaupapa Māori Research Methodology with preclinical in vitro investigation*	1 Jan 23 - 31 Dec 24	$46,762	Warwick Duncan, Dawn Coates, Carolina Loch
University of Otago Research Grants	*Waste to Health: Development of a Hybrid nano-composite from natural Montmorillonite clay and waste bovine bone for dental restorative applications*	1 Jan 23 - 31 Jul 24	$36,189	Jithendra Ratnayake, Samuel Carrington, Peter Cathro, Paul Cooper, George Dias (Anatomy)
New Zealand Dental Research Foundation BDS HONOURS RESEARCH AWARDS	*Effects of different non-surgical debridement methods during active maintenance on the of CAD/CAM restorations*	1 Feb 23 - 31 Jan 24	$4,000	Sunyoung Ma, Denty Gozali*
New Zealand Dental Research Foundation BDS HONOURS RESEARCH AWARDS	*The effect of silver diamine fluoride on dentine caries under reduced saliva condition: an in vitro study*	1 Feb 23 - 31 Jan 24	$4,000	May (Lei) Mei, Belinda Yang*
New Zealand Dental Research Foundation BDS HONOURS RESEARCH AWARDS	*BRAF v600e mutation and MMP9 expression in ameloblastoma*	1 Feb 23 - 31 Jan 24	$4,000	Benedict Seo, Lauren Reynoldson-Ross*
Royal Society of New Zealand Te Apārangi MARSDEN FUND	*Membranes matter: how membrane lipids control Candida albicans Cdr1 structure and function*	1 Mar 23 - 28 Feb 26	$934,000	Richard Cannon, Erwin Lamping, Han Ting-Li (Chongqing), Isabelle Roullier (Melbourne)
Sir Thomas K. Sidey Trust SJWRI SIR THOMAS K. SIDEY START-UP GRANTS	*An international study of molar incisor hypomineralisation: its characteristics and association with other developmental dental anomalies*	1 May 23 - 30 Apr 25	$19,996	Noren Hasmun, Andrew Tawse-Smith

Funder/Award	Title	Duration	Award	Investigators
Kiwi Innovation Network Limited	*Explore the commercialisation opportunities of repurposed anti-inflammatory immunotherapy to locally treat dentistry procedures.*	1 May 23 - 31 Jan 24	$15,000	Haizal Hussaini
GNS Science	*Why is pounamu tough? Using materials science and mātauranga Māori to explain the special physical properties and uses of nephrite jade.*	1 Jul 23 - 30 Jun 26	$468,040	David Prior (Geology), Anne Ford (Archaeology), Kai Chun Li, Marshall Palmer (Geology)
Foundation for Orthodontic Research & Education, NZAO	*Nano- and micro-scale evaluation of human enamel treated with different orthodontic debonding protocols*	1 Oct 23 - 30 Sep 25	$3,893	Li Mei, Richard Cannon, Mauro Farella, Mauro Farella, Guangzhao Guan
MedTech - CMDT Research Acceleration Programme (Stage II)	*Screening and early diagnosis of gingivitis to prevent Periodontal disease*	1 Oct 23 - 31 Aug 24	$79,989	Warwick Duncan, Elora Low*
Ministry of Oral Health Research Fund	*Dental consequences of vitamin D deficiency during pregnancy and infancy*	1 Oct 23 - 30 Sep 25	$32,426	Deanna Beckett, Jonathan Broadbent, Keith Gordon (Chemistry), Carolina Loch, Sara Miller (Chemistry), Ben Wheeler (WCH)
Ministry of Oral Health Research Fund	*Type 2 diabetes and the dental pulp - Angiogenesis and the role of neuropeptides in response to caries and inflammation?*	1 Oct 23 - 30 Sep 25	$15,000	Lara Friedlander, Rishi Pavaskar*, Paul Cooper, Haizal Hussaini, Trudy Milne
New Zealand Dental Research Foundation NZDRF RESEARCH GRANTS	*Oral health to age 52: equipment grant application*	1 Oct 23 - 31 Dec 25	$15,000	Jonathan Broadbent, Mauro Farella, Wendy Jansen van Vuuren, Ludwig Jansen van Vuuren, Sunyoung Ma
New Zealand Dental Research Foundation NZDRF RESEARCH GRANTS	*Accuracy and bur wear of multiple milling machines for dental ceramics: A multi-centre study*	1 Oct 23 - 30 Sep 25	$15,000	Joanne Choi, Xiaoyun (Abby) Liu*, Nick Heng, Andrew Cameron (Griffith), Ketil Hegerstrøm (OsloMet)
New Zealand Dental Research Foundation NZDRF RESEARCH GRANTS	*Sleep and awake bruxism. Are they associated?*	1 Oct 23 - 30 Sep 25	$10,131	Mauro Farella, Daniel Waller*, Fiona Firth
New Zealand Dental Research Foundation NZDRF RESEARCH GRANTS	*The role of the Rho-associated kinase/ROCK signalling pathway in the nanocharacteristics and nano-mechanics of oral cancer cells*	1 Oct 23 - 30 Sep 25	$14,976	Guangzhao Guan, Richard Cannon, Dawn Coates, Li Mei
New Zealand Dental Research Foundation NZDRF RESEARCH GRANTS	*Thermo Scientific Heracell™ VIOS 160i Tri-Gas CO2 incubator with O2 control*	1 Oct 23 - 30 Sep 24	$14,279	Trudy Milne, Dawn Coates, Warwick Duncan
New Zealand Dental Research Foundation NZDRF RESEARCH GRANTS	*Inflammation and the unfolded protein reponse in the pathogenesis and treatment of oral lichen planus*	1 Oct 23 - 30 Sep 25	$15,000	Benedict Seo, Ayesha Sameera*, Paul Cooper, Haizal Mohd Hussaini, Alison Rich, Qing Sun

Funder/Award	Title	Duration	Award	Investigators
New Zealand Dental Research Foundation NZDRF RESEARCH GRANTS	*Fibroblasts in Oral Lichen Planus: Part 2 Gene Expression*	1 Oct 23 - 30 Sep 25	$13,535	Benedict Seo, Muhammad Aiman Mohd Nizar*, Paul Cooper, Haizal Mohd Hussaini, Alison Rich, Qing Sun
New Zealand Dental Research Foundation NZDRF RESEARCH GRANTS	*Efficacy of surgical and non-surgical implant surface decontamination methods and the impact of bony defect configuration: an in vitro study*	1 Oct 23 - 30 Sep 25	$14,900	Andrew Tawse-Smith, William Cho*, Kai Chun Li, Sunyoung Ma
Genesis Energy NZ	*Potential use of DAF as a wood pellet weatherproofing additive (Phase I)*	1 Nov 23 - 30 Jun 24	$38,863	Azam Ali, Maree Gould
New Zealand Dental Research Foundation RC TONKIN SUMMER STUDENTSHIP	*Effect of Clear Aligners on Awareness of Tooth Clenching: A Feasibility Study*	1 Nov 23 - 29 Feb 24	$6,000	Grace Francois*, Mauro Farella
New Zealand Dental Research Foundation SIR JOHN WALSH SUMMER STUDENTSHIP	*Digital Assessment of Non-Metric Dental Traits: Enhancing Clinical Dentistry using, Anthropological Tools*	1 Nov 23 - 29 Feb 24	$6,000	Isabela Manzano*, Angela Clark
Marjorie Fuller Trust FULLER SCHOLARSHIPS IN DENTISTRY	*A survey of the New Zealand public on their perceptions of orthodontic treatment provided by specialist orthodontists, general dentists or direct-to-consumer companies*	1 Nov 23 - 30 Nov 25	$4,000	Fiona Firth, Mauro Farella, Winifred Harding, Amal Aqilah Ajamain*
Marjorie Fuller Trust FULLER SCHOLARSHIPS IN DENTISTRY	*Nano and Micro-scale evaluation of human enamel treated with different orthodontic debonding protocols*	1 Nov 23 - 30 Nov 25	$4,000	Li Mei, Richard Cannon, Mauro Farella, Guangzhao Guan, Tian You Wu
Marjorie Fuller Trust FULLER SCHOLARSHIPS IN DENTISTRY	*A story to smile about - a tool to enhance oral health in preschool children*	1 Dec 23 - 30 Nov 25	$4,000	Jonathan Broadbent, Lisa Hanson*, Samuel Carrington, Noren Hasmun, Kate Morgaine
Marjorie Fuller Trust FULLER SCHOLARSHIPS IN DENTISTRY	*Remineralisation potential of self-assembling peptide and calciumphosphare based agents on demineralised enamel and shear bond strength of orthodontic brackets to remineralised enamel*	1 Dec 23 - 30 Nov 25	$4,000	Manikandan Ekambaram, Noren Hasmun, Kai Chun Li, May (Lei) Mei, Ranina Binti Mohd Rom*
Marjorie Fuller Trust FULLER SCHOLARSHIPS IN DENTISTRY	*Occlusal difference in hand-articulation and digital articulation in orthognathic surgery*	1 Dec 23 - 30 Nov 25	$4,000	Darryl Tong, Harsha De Silva, Rohana De Silva, Blake Moore*
Progress in Science and Education with Ceramics Research Grant	*Accuracy and bur wear of multiple milling machines for dental hybrid ceramics – A multi-centre study*	1 Dec 23 - 30 Nov 25	$9,259	Joanne Choi, Nicholas Heng
SJWRI DClinDent Research Grants	*Influence of pH and dynamic loading on the physico-chemical properties of two-piece zirconia implants*	1 Jan 24 - 31 Dec 24	$4,000	Sumaia Alsafadi*, Sunyoung Ma, KC Li
SJWRI DClinDent Research Grants	*A study to validate the use of a novel ultrasound device in early detection of gingivitis*	1 Jan 24 - 31 Dec 24	$4,000	Elora Low, Warwick Duncan, Sunyoung Ma

Funder/Award	Title	Duration	Award	Investigators
SJWRI DClinDent Research Grants	*Influence of using 3D printed scan bodies and auxiliary geometric devices on the accuracy and efficiency of full-arch implant intra-oral scanning – in vitro study*	1 Jan 24 - 31 Dec 24	$4,000	Tony Sun, Sunyoung Ma, KC Li
SJWRI DClinDent Research Grants	*Exploring adherence to long-term periodontal and peri-implant maintenance: A qualitative study*	1 Jan 24 - 31 Dec 24	$3,550	Jasmine Yeo*, Andrew Tawse-Smith, Lee Adam, Zeina Al Naasan
University of Otago Research Grants	*Envisioning Kaupapa Māori Principles in Tomorrow's Technologies*	1 Jan 24 - 31 Dec 24	$43,684	Angela Clark, Samuel Carrington, Karaitiana Taiuru (Taiuru & Assoc), Annabel Ahuriri-Driscoll (Canterbury), Heidi Baker (ESR)
University of Otago Research Grants	*Dental consequences of Vitamin D deficiency during pregnancy and early infancy – a longitudinal cohort study*	1 Jan 24 - 31 Dec 24	$39,144	Deanna Beckett, Jonathan Broadbent, Ben Wheeler (Womens & Childrens Health), Carolina Loch, Keith Gordon (Chemistry), Sara Miller (Chemistry)
Maurice and Phyllis Paykel Trust	*Gelatin methacryloyl/nanoclay microneedle patches for the treatment of oral cancer*	1 Jan 24 - 31 Dec 24	$16,000	Li Mei, Simon Guan, Jamie Marra*, Richard Cannon
Cancer Research Trust New Zealand POSTGRADUATE SCHOLARSHIP	*A gene expression based prediction model for perturbation response in Head and Neck Squamous Carcinoma*	1 Feb 24 - 31 Jan 27	$130,000	Jamie Marra*, Mik Black, Darryl Tong
New Zealand Dental Research Foundation BDS HONOURS RESEARCH AWARDS	*What are patients' experiences with tooth loss and the replacement with implants? - a qualitative study*	1 Feb 24 - 31 Jan 25	$1,000	Zeina Al Naasan, Lee Adam, Matthew Loh*
New Zealand Dental Research Foundation BDS HONOURS RESEARCH AWARDS	*Optical properties of 3D printed crown materials*	1 Feb 24 - 31 Jan 25	$3,000	Joanne Choi, Jasmina Singh*
New Zealand Dental Research Foundation BDS HONOURS RESEARCH AWARDS	*Hazards in dental practice*	1 Feb 24 - 31 Jan 25	$1,750	Jonathan Broadbent, Daniel Clemens*
New Zealand Dental Research Foundation BDS HONOURS RESEARCH AWARDS	*Awareness, confidence and knowledge of oral biopsies and oral pathology*	1 Feb 24 - 31 Jan 25	$1,000	Benedict Seo, Haizal Hussaini, Harsha Da Silva, Zina Awbi*
New Zealand Dental Research Foundation BDS HONOURS RESEARCH AWARDS	*Can antimicrobial peptide be the answer to pulp inflammation? – an in vitro study*	1 Feb 24 - 31 Jan 25	$2,000	May Mei, Haizal Hussaini, Abigail Thompson*
New Zealand Dental Research Foundation BDS HONOURS RESEARCH AWARDS	*Can novel immunotherapy be used as pulp medicament in primary teeth? – an in vitro study*	1 Feb 24 - 31 Jan 25	$1,250	Noren Hasmun, Haizal Hussaini, Buthaina Al Kindi*

Postgraduate research degree completions

Doctor of Philosophy (PhD) graduands, 2023

Listed by month of gradation

Student	Advisors (primary listed first)	Thesis title	Graduation
Shelly Arora	A/Prof Haizal Hussaini Dr Shakila Rizwan A/Prof Lara Friedlander Dr Benedict Seo Prof Alison Rich Prof Paul Cooper	*Effects of IL-23 blockade as a pulp immune-modulating agent in vitro and in vivo*	May
Ludwig Jansen van Vuuren	Prof Jonathan Broadbent Prof Warwick Duncan	*Dental occlusal stress*	May
Nurul Aida Ngah	A/Prof Haizal Hussaini Prof George Dias Prof Darryl Tong	*Collagen-bioglass-lyophilised platelet rich-fibrin scaffold for craniofacial regeneration*	May
Mina Rajabi	A/Prof Azam Ali A/Prof Jaydee Cabral Dr Michelle McConnell Dr Sarah Saunderson	*Chitosan-based 3D-printing scaffolds for bone tissue engineering*	May
Begoña Ruiz Conrads	Prof Jonathan Broadbent Prof Murray Thomson Dr Sandhya Ramrakha	*Childhood caries: An early indicator of poor oral and general health by midlife - Findings from two Aotearoa New Zealand birth cohorts*	August
Dina Abdelmoneim	Prof Warwick Duncan A/Prof Dawn Coates Dr Kai Li Dr Gemma Cotton	*Silverbone-antibacterial bone regenerative scaffolds*	December
Angela Benn	Prof Jonathan Broadbent A/Prof Nicholas Heng Prof Murray Thomson	*Oral health and distinct oral biofilms in a birth cohort in mid-life*	December
Minati Choudhury	A/Prof Geoffrey Tompkins Dr Jithendra Ratnayake Dr Daniel Pletzer Prof Paul Brunton Prof George Dias A/Prof Carla Meledandri	*Gold nanoparticles: A novel treatment strategy for oral mucositis*	December
Chitra Krishnan	Prof Richard Cannon Prof Karl Lyons A/Prof Geoffrey Tompkins	*Neutral-PH electrolysed oxidising water as a dental disinfectant*	December
Stephanie Toepfer	A/Prof Brian Monk Dr Mikhail Keniya A/Prof Michaela Lackner	*Experimental combination therapy against azole-based multidrug resistant Candida auris*	December

**Thesis publication embargoed*

Doctor of Clinical Dentistry (DClinDent) graduands, December 2023

Listed by clinical discipline

Student	Advisors (primary listed first)	Thesis Title	Endorsement
Farah Ahmad Zainuddin	Mr Graeme Ting Prof Murray Thomson Dr Simon Guan	*Measuring dry mouth in older people in residential care, in Dunedin*	Special Needs Dentistry
Howard Chao	A/Prof Lara Friedlander Dr Trudy Milne Prof Paul Cooper A/Prof Peter Cathro	*Hyperglycaemia and calcification within the human dental pulp*	Endodontics
Rayner Goh	Prof Andrew Tawse-Smith Prof Sunyoung Ma Dr Kai Li A/Prof Momen Atieh (Advisor)	*Effect of implantoplasty on fracture resistance and implant surface*	Periodontology
Chenyi Jin	A/Prof Li Mei Prof Mauro Farella Prof Paul Brunton Mr Andrew Gray	*Biomechanical properties of orthodontic vacuum-formed retainers*	Orthodontics
Majd Khashashneh	Prof Paul Brunton Prof Karl Lyons Dr Joanne Choi A/Prof Li Mei	*The effect of 10% carbamide peroxide dental bleaching on the physical properties of Invisalign orthodontic aligners*	Prosthodontics
Jack Lintern	Prof Murray Thomson A/Prof Harsha De Silva	*Hyperbaric oxygen: Who wants it?' A case-series analysis of patients referred for hyperbaric oxygen in the prevention or treatment of osteoradionecrosis (ORN) in New Zealand*	Special Needs Dentistry
Abigail Oliver	Prof Murray Thomson A/Prof Andrew Tawse-Smith Dr Getulio Nogueira	*Clinical outcomes of postgraduate periodontal students' patients: A retrospective study*	Periodontology
Shraddha Patel	A/Prof Lara Friedlander Dr Trudy Milne Prof Paul Cooper A/Prof Haizal Hussaini	*Hyperglycaemia and the dental pulp: So what about angiogenesis?*	Endodontics
Ai Lin Tee	Prof Sunyoung Ma Dr Joanne Choi Dr Suzanne Hanlin	*An in-vitro study of the effect of titanium surface treatments on the bonding between zirconia crowns and titanium bases*	Prosthodontics
Lesieli Tomiki	Assoc Prof Alison Meldrum Dr Lee Adam Prof Rachael Taylor	*The effect of complementary feeding on New Zealand's infants dental health*	Paediatric Dentistry
Lucinda Wong	Prof Mauro Farella Dr Fiona Firth Dr Peter Fowler (Advisor) Dr Hannah Jack (Advisor)	*Beyond the cleft smile. Exploring dynamic smile characteristics and their relationship with clinical, biomechanical, and psychosocial factors*	Orthodontics

Masters graduands, 2021-2022

Listed by graduation date, then by degree programme

MComDent Master of Community Dentistry

MDent Master of Dentistry

MDentTech Master of Dental Technology

MSc (Bioeng) Master of Science in Bioengineering

Student	Advisors (Primary listed first)	Thesis Title	Programme	Graduated
Rebecca Chapman	Prof Jonathan Broadbent Prof Murray Thomson	*Validation of the Child Perceptions Questionnaire as a measure of oral health-related quality of life in young adults*	MComDent	May
Amelia Horsnell	Mrs Wendy Jansen van Vuuren A/Prof Geoffrey Tompkins Prof Mauro Farella	*Biofilm accumulation on conventional and CAD/CAM orthodontic bands and its consequence on enamel demineralisation*	MDentTech	May
Tianyu Cai	A/Prof Azam Ali	*Improved Drug Release with a Multilayer Coating for a Biodegradable Drug-Eluting Stent*	MSc (Bioeng)	May
Quinn Thorsnes	A/Prof Azam Ali	*An Exploration of Melt-electrowriting and Fused Deposition Modelling for Tissue Engineering Blood Vessels*	MSc (Bioeng)	December
Kamal Hj Tasim	A/Prof Vincent Bennani Mr John Aarts Dr Jithendra Ratnayake	*Survival rates of multi-unit, tooth-supported bridges fabricated from fully digital, conventional and mixed workflow: a systematic review*	MDent (Aesthetic Dentistry)	December

Thesis research abstracts, 2023

Abstracts of postgraduate research theses from SJWRI / Faculty of Dentistry candidates published in 2023.

Abstracts are listed by degree, highest qualification first. Data extracted from ourarchive.otago.ac.nz.

Doctor of Philosophy (PhD) thesis abstracts

Dina Abdelmoneim

Abdelmoneim, D. A. E. F. (2023). Silverbone-antibacterial bone regenerative scaffolds

Advisors: Duncan, Warwick; Coates, Dawn; Li, Kc; Porter, Gemma

Keywords: Xenografts, GelMA, Silver nanoparticles, Rabbit cranial model

http://hdl.handle.net/10523/15401

Infection is a frequent complication of bone-grafted sites. Increasing bacterial resistance to antibiotics is a challenge associated with the prevention or treatment of such infections. Silver nanoparticles (AgNPs) are a potent alternative to antibiotics. We aimed to develop two antibacterial bone regenerative scaffolds with integrated AgNPs.

AgNPs were incorporated into both bovine bone particles (BBX) and light cross-linked gelatin methacryloyl (GelMA) hydrogel. Cubes of bovine bone were treated at temperatures between 100°C to 220°C at 30°C intervals and with pressures ranging from 1.01 to 24.58 Bar, producing five different groups. The samples were characterised topographically using scanning electron microscopy (SEM), and mechanically using atomic force microscopy (AFM) and compression testing. The chemical composition and the organic content were determined using Fourier-transform infrared spectroscopy (FTIR) and thermogravimetric analysis (TGA). The BBX was further characterised both pre- and post-chemical treatment (bleaching) and after terminal sterilisation by gamma irradiation. Metabolic activity of osteoblasts and osteoclasts on the constructs was investigated using Prestoblue®. For the GelMA, size and consistency of the constructs were optimised. Interaction and stabilisation of AgNPs in GelMA constructs were characterised using SEM, energy dispersive X-ray spectroscopy, and FTIR. Cell viability of encapsulated human gingival fibroblasts (HGFs) was determined by Prestoblue® assay and live/dead staining with confocal laser scanning microscopy. Transmission electron microscopy was utilised to study retention of AgNPs. AgNP release was measured by inductively-coupled plasma-mass spectrometry. Bacterial viability of encapsulated *Escherichia coli* and *Staphylococcus aureus* was determined using an assay for metabolic activity, and the antibacterial properties of the GelMA-AgNPs constructs were determined using disc diffusion. The safety and regenerative capacity of the optimised AgNPs functionalised BBX and GelMA was tested in a rabbit cranial model.

Increasing the deproteinisation temperature/pressure of the BBX was associated with decreased organic content and compressive strength and increased crystallinity and surface irregularities. Higher osteoblast differentiation and proliferation was obtained from treatments at temperatures below 190°C. Results showed that bleaching and gamma irradiation had limited effect on the surface texture but significantly reduced organic content. A significant decrease in collagen content was detected post-bleaching, and in carbonate content post-gamma irradiation. The presence of AgNPs appeared to enhance proliferation of osteoblasts *in vitro* compared to AgNP-free controls. Stiff hydrogel constructs showed superior AgNP retention, however high stiffness negatively impacted both handling properties and AgNP diffusion within the constructs. We also found that AgNPs at a concentration of 100 µg/ml inhibited bacteria with minimal adverse effects. Our rabbit model showed that both the optimised BBX at 160°C and 5%wt GelMA hydrogels were biocompatible and had similar regenerative capacity compared to a commercially available product (Bio-Oss®). There were no signs of inflammatory infiltrates, necrosis, or connective tissue encapsulation in the grafted sites.

In conclusion, increasing the processing temperature correlated with significant changes in the characteristics of the BBX, and the deproteinisation temperature can be adjusted to modify the graft properties for various applications. The incorporation of AgNPs in biomaterials ensured stabilisation of nanoparticles, particularly when encapsulated in GelMA hydrogel. A 100 µg/ml dose of AgNPs inhibited bacteria, with minimal adverse effects on the bone cells. Grafts functionalised with AgNPs can provide antibacterial protection and simultaneously act as a scaffold for attachment of bone cells.

Shelly Arora

Arora, S. (2023). Effects of IL-23 blockade as a pulp immune-modulating agent in vitro and in vivo

Advisors: Hussaini, Haizal; Cooper, Paul; Rich, Alison; Seo, Benedict; Friedlander, Lara; Rizwan, Shakila

Keywords: dental pulp stem cells; immune response; mesenchymal stem cells; tooth pulp

http://hdl.handle.net/10523/15107

Dental caries destroys the enamel and dentine of the tooth and as infection progresses can lead to pulpal inflammation, infection, and severe pain. An inflamed pulp is characterised by a high amount of cytokines including tumour necrosis factor (TNF)-a, interleukin (IL)-1a, IL-1b, IL-4, IL-6, IL-8, IL-17, and IL-23 resulting in a complex cellular immune response and uncontrolled inflammation. Subsequently, making it difficult for the pulp to heal and restore normal function. Pulp tissue has an innate capacity to heal if inflammation is mild, but in cases of severe inflammation the pulp inevitably becomes non-vital. Controlling the intensity of inflammation would enable the pulp to repair. Chronic inflammatory diseases such as psoriasis, inflammatory bowel diseases and rheumatoid arthritis are characterised by a dysregulated immune response with relatively high cytokine levels. Whilst IL-23 inhibitors have been successfully used in the treatment of these chronic inflammatory diseases, this approach is yet to be attempted in cases of pulp inflammation. This thesis aimed to investigate the ability of an IL-23 inhibitor to function as a dental pulp immunotherapeutic medicament *in vitro* and *in vivo*.

Ethical approval for the *in vitro* study was obtained from the University of Otago Human Ethics Committee (Health) and consultation with Māori has been undertaken through the Ngāi Tahu Research Consultation Committee. *In vitro*, human dental pulp cells (HDPCs) were isolated and cultured from both non-carious and carious teeth (n = 5, each) using the explant technique. Expression of vimentin was assessed using immunocytochemistry. Cell growth curve, colony forming unit and mineralisation assays were evaluated in both non-carious and carious HDPCs at passage 4. Gene expression of Toll-like receptors (TLR)-2, TLR-4,TLR-9, TNF-a, IL-1b, IL-6, IL-8, IL-17A, IL-17R, IL-23A, nuclear factor- kappa B (NF-kB1), mitogen activated protein kinase (MAPK1), dentine matrix protein (DMP)-1, dentine sialophosphoprotein (DSPP), sex determining region Y-box 2 (SOX2), MKi67 (marker of proliferation) and mesenchymal (vimentin, CD44 and CD105) genes were determined for non- carious and carious HDPCs using quantitative real-time reverse-transcription polymerase chain reaction. Further, we also assessed the gene expression of TLR-2, TLR-4, TLR-9, TNF-a, IL- 1b, IL-6, IL-8, IL-17A, IL-17R, IL-23A, NF-kB1, MAPK1, DMP-1, DSPP, MKi67 and SOX- 2 for non-carious and carious pulp tissue (n = 3, each). This group provided baseline data and served as a reference to observe the trend in the gene expression between primary cell culture (non-carious (nc) HDPCs and carious (c) HDPCs) findings and pulp tissue (non-carious and carious). Furthermore, HDPCs were seeded in a range of concentrations for the IL-23 inhibitor to evaluate cell viability using the MTS assay.

For *in vivo* studies, ethics was obtained through the Animal Ethics Committee, University of Otago. A Wistar rat pulp exposure model was used (n = 12, ~350 gms). Mechanically exposed pulps were capped with IL-23 inhibitor (n = 6) while controls received sterile saline (n = 6). After 1-, 15- and 30-days mandibular jaws were removed and prepared for histological analysis. The effect of IL-23 inhibitor on pulpal inflammation and healing in comparison to other therapies (MTA, Odontopasteâ) and untreated control in Wistar rat was also investigated.

Findings from the *in vitro* studies showed that both non-carious and carious HDPCs were successfully isolated and cultured from non-carious and carious human dental pulp tissue. Both HDPC types at passage 4 demonstrated a typical spindle morphology with positive vimentin expression. No statistical difference was observed in the growth characteristics and ability to differentiate into a mineralising phenotype between both non-carious and carious HDPCs. Statistically significant differences were found in colony forming efficiency between the two cell populations ($p < 0.05$). Significantly higher levels of TLR-2, TLR-4, TLR-9, TNF- a, IL-6, IL-8, IL-17R, IL-23A, NF-kB1, MAPK1, DMP-1, DSPP, SOX2, CD44 and vimentin were detected in carious HDPC cultures compared with ncHDPCs cultures ($p < 0.05$). We also found higher levels of TLR-2 and TLR-4, IL-6, IL-8, IL-17A, IL-23A, NF-kB1 and MKi67 in inflamed pulp tissue compared with non-carious pulp tissue ($p < 0.05$). IL-23 inhibitor (5 µg/mL) treatment enhanced the proliferation of carious HDPCs ($p < 0.05$).

Histological analysis of rat tissue at day one demonstrated inflammation and no mineralised tissue formation in the control and IL-23 inhibitor groups. On day 15, inflammation was observed in both the groups, but the presence of mineralised tissue was only observed in the IL-23 inhibitor

treatment group. On day 30, the IL-23 inhibitor group demonstrated the presence of mineralised tissue within the viable pulp with no evidence of inflammation while the control group exhibited inflammation and mineralised tissue. Furthermore, qPCR results demonstrated that inflammatory genes (IL-6 and IL-23A) were expressed at a lower level in the IL-23 inhibitor group compared to Odontopasteâ and MTA groups. Both DMP-1 and BSP genes were expressed at a higher level in IL-23 inhibitor and MTA groups.

In summary, the aforementioned results demonstrate that IL-23 blockade induced the proliferation of carious HDPCs with an inflammatory phenotype, and in a rat pulp exposure model treatment promoted mineralisation. Clinically, IL-23 inhibition has the potential to modulate inflammation and promote mineralisation.

Angela Benn

Benn, A. M. L. (2023). Oral health and distinct oral biofilms in a birth cohort in mid-life

Advisors: Broadbent, Jonathan; Heng, Nicholas; Thomson, William Murray

Keywords: Oral microbiology; oral bacteria; DNA-DNA hybridisation; DNA-DNA hybridization, epidemiology, bacteria, dental diseases, oral environment caries, oral biofilms, oral hygiene, periodontitis, life-course research; birth cohort

http://hdl.handle.net/10523/15976

Background: Microbial oral biofilms are ecologically diverse, complex, dynamic, and little understood. In health, biofilms comprise balanced microbial communities in symbiosis with their human host. However, environment- and lifestyle-associated ecosystem changes can perturb that balance, resulting in dysbiotic host-biofilm relationships, which support the development of caries and periodontitis. To date, microbial findings on distinct oral biofilms and the relative abundance of key oral bacteria in a prospective birth cohort have not yet been reported. Aims: This study aimed to: (1) identify and enumerate 30 ecologically- and clinically-important oral bacterial species in four distinct oral biofilms; (2) investigate associations between key oral species and caries and periodontitis; and (3) evaluate the importance (and possible influence) of putative host-modifying risk factors (such as long-term exposure to oral biofilms and smoking) on biofilm microbial composition.

Methods: Oral biofilm samples were collected from four habitats from 841 Dunedin Multidisciplinary Health and Development Study members at age 32. The resultant 4500 samples were analysed using checkerboard DNA-DNA hybridisation (CKB), focusing on 30 key oral bacterial species. The CKB data were used to describe habitat-specific biofilm species profiles and evaluate the importance of sex, smoking and oral hygiene. Associations of CKB data with caries at age 32 and caries increment between age 32 and age 45, were assessed using regression modelling. Longitudinal periodontitis extent data were used in the group-based trajectory modelling. This modelling assigned participants to periodontitis trajectory groups. Associations of CKB data with periodontitis trajectories were assessed using multinomial logit function.

Results: Habitat-specific biofilms, shaped by discrete microenvironments, varied widely among individuals. Each habitat biofilm had a distinct microbial profile which differed by sex, smoking status and oral hygiene, and with differing experience of caries and periodontitis. Higher averaged proportions of supragingival biofilm species—such as *Tannerella forsythia* and *Micromonas micros*, caries pathobionts and commensals—were associated with untreated caries at age 32 and with caries increment from age 32 to 45. Higher proportions of *Leptotrichia buccalis* in all the biofilms—and of health-associated species, periodontal and caries pathobionts in the posterior supragingival biofilm—were associated with periodontitis. Sustained poor oral hygiene through to age 32 was associated with greater caries experience by age 32 and with greater incidence of new caries from age 32 to 45 years. Environmental and lifestyle risk factors such as poor oral hygiene, smoking rate and duration, and low socio-economic status were associated with a higher likelihood of having periodontitis.

Conclusions: The shift from homeostasis to dysbiosis in cariogenic and periopathogenic biofilms is dynamic and variable, highlighting that they are more than the sum of their constituents. The study findings support the usefulness of contemporary CKB analysis data for characterising oral microbiota biofilms in a large-scale epidemiologic study. They also support the polymicrobial aetiology of caries, the polymicrobial synergy and dysbiosis periodontitis aetiological model, and the integrated hypothesis of caries and periodontitis. They reinforce the substantial effects that sustained poor oral hygiene, xerostomia, low socio-economic status and smoking exposure have on oral health and add to the understanding the natural history of caries and periodontitis.

Mozammel Bhuiyan

Bhuiyan, M. M. H. (2023). Development and characterisation of a novel thermoresponsive hydrogel for brain tissue regeneration after stroke

Advisors: Ali, Azam; Clarkson, Andrew

Keywords: Hydrogel; Stroke; Neuroregeneration; BDNF; VEGF; Chitosan

http://hdl.handle.net/10523/16234

Stroke is a devastating disease that affects millions of people every year worldwide. For those who survive after stroke, many live with lasting impairments in sensorimotor and cognitive functions. Unfortunately, to date, no regenerative therapies are available that can restore the lost functions after stroke. Therefore, it is necessary to find therapeutic interventions to promote recovery of the damaged brain following stroke.

Biopolymers are macromolecules that are either derived from living tissue or chemically synthesised to interact with biological systems for therapeutic or diagnostic purposes. In recent years, delivery of biopolymer hydrogels directly into the stroke cavity has been shown to remodel the hostile stroke microenvironment and enable persistent release of drugs and neurotrophic factors to the peri-infarct tissue surrounding the fully formed stroke. However, no biopolymer hydrogel has yet been approved for clinical trials in stroke patients. Successful clinical translation of biopolymer hydrogel-based treatments requires robust tuning of physicochemical properties and biodegradation kinetics to meet the specific requirements of the human stroke microenvironment. The overall aim of this thesis was to develop and characterise a novel thermoresponsive biopolymer hydrogel for brain tissue regeneration following stroke. Specifically, we aimed to develop and characterise a novel hydrogel by blending multiple polymers and evaluate the hydrogels with or without neurotrophic factor combinations to modulate reactive astrogliosis, inflammation, neurogenesis and functional recovery following stroke.

We aimed to investigate the physicochemical properties including temperature-induced gelation, shear thinning, morphology, and biodegradation of chitosan (CS) / β-glycerophosphate (β-GP) hydrogels, consisting of 0.5 – 2% CS and 2 – 3% β-GP, in order to assess their suitability for injectable neural tissue engineering application. Furthermore, we tested the *in vitro* biocompatibility of CS/β-GP hydrogels using PC12 cells, an immortalised cell line with neuronal cell-like properties. The resulting CS/β-GP hydrogels showed a varying range of gelation temperatures and gelation times depending on their CS / β-GP blend ratio. Among those tested, 0.5% CS / 3% β-GP and 0.75% CS / 3% β-GP formulations underwent rapid gelation at physiological temperature (37°C) and pH (7.4). In addition, both formulations showed shear thinning properties, porous microstructure, biodegradation, and *in vitro* biocompatibility, which are crucial for injectable tissue engineering application. These two CS/β-GP hydrogels were then blended with silk fibroin (SF), polyvinyl alcohol (PVA) and polyvinyl pyrrolidone (PVP) in order to prepare hybrid hydrogel formulations. The physicochemical properties of the hybrid hydrogels, including gelation behaviour, morphology, biodegradation rate, and *in vitro* cytotoxicity were assessed. Based on the results of physicochemical characterisations and *in vitro* cytotoxicity, four hybrid hydrogel formulations, F1, F2, F3 and F6, were tested *in vivo* to determine their effect on post-stroke reactive astrogliosis, inflammation and neurogenesis in a mouse model of photothrombotic stroke. Interestingly, treatment with F1, F2, and F6 hydrogels decreased reactive astrogliosis in peri-infarct tissue and increased neurogenesis in the ipsilateral subventricular zone. In addition, both F2 and F6 hydrogels decreases inflammation in peri-infarct tissue.

Considering the results of *in vitro* and *in vivo* assessments, F6 hydrogel was then chosen to combine with two neurotrophic factors, brain-derived neurotrophic factor (BDNF) and liposome-encapsulated vascular endothelial growth factor (VEGF) to assess their therapeutic potential on behavioural function, reactive astrogliosis, inflammation, neurogenesis, and angiogenesis following photothrombotic stroke to the motor cortex in mice. Intracerebral administration of F6 + BDNF and F6 + VEGF either alone or in combination (F6 + BDNF + VEGF) improved motor function on both the grid-walking, and cylinder tasks. However, the combined delivery of BDNF and VEGF from F6 hydrogel improved motor function more rapidly and significantly than F6 + BDNF or F6 + VEGF alone. In addition, treatment with F6 hydrogel with or without neurotrophic factors decreased reactive astrogliosis (both 2- and 8-weeks post-stroke) and inflammation (2 weeks post-stroke) in peri-infarct tissue. Furthermore, administration of F6 hydrogel with or without neurotrophic factors induced neuronal proliferation in the subventricular zone and formation of new blood vessels in the peri-infarct tissue at both 2- and 8-weeks following stroke. Overall, this thesis has developed and optimised a hybrid hydrogel system by blending biopolymers CS, SF, PVA and PVP. In addition, this thesis has provided evidence that the developed hybrid hydrogels have potential to be used in concert with pharmacological interventions to promote post-stroke functional recovery.

Ludwig Jansen van Vuuren

Jansen van Vuuren, L. (2023). Dental occlusal stress

Advisors: Broadbent, Jonathan; Duncan, Warwick

Keywords: bite force; occlusal contact point, stress, periodontal ligament, tooth movement, all-ceramic dental restorations

http://hdl.handle.net/10523/15075

All-ceramic dental restorations are now regularly being used in clinical situations. Forces applied to ceramic dental restorations can result in failure due to cracking. Dental restorations may be subjected to significant loads in the mouth and small contact points between opposing teeth may result in markedly high stress when a high bite force is encountered. Today's clinician faces a complex decision when choosing a ceramic for a particular indication. The market offers an extensive palette of materials, and their selection is often based on material strength measured *in vitro*, which may not always predict the true performance characteristics a material will have when used *in vivo*. The proposed outcomes of this research comprised the development of a protocol for measuring and describing intra-oral stress. The objective was to provide a reference base for the design of restorations and the selection of the appropriate restorative material for patients.

The investigation followed a four–phase approach:

- Develop a bite force transducer suitable for measuring tooth to tooth bite forces in the posterior region of the mouth.
- Record the maximum voluntary posterior bite force and occlusal contact area in healthy human volunteers.
- Develop a device and method to record tooth movement.
- Establish the tooth movement of a sample of healthy human volunteers.

The bite force transducer was developed and utilised to record the maximum voluntary bite forces on the posterior teeth of 40 participants. Their inter-occlusal contact points were identified by digitally scanning the teeth and calculating the surface area by accompanying software. Bite forces from as low as 83.9 Newton (N) to the highest at 1642.8 N, with a mean of 430.4 N (Standard Deviation (SD) = 279.4) were recorded. Inter-occlusal contact points as small as 0.065 mm2 were measured. The resultant stress that 21.8% of the teeth tested may experience has been shown to potentially exceed the flexural strength of even the strongest dental ceramic available on the market.

Teeth are supported by the periodontal ligament which allows controlled movement of the tooth when a force is applied. A novel device capable of recording the vertical movement of a tooth was developed and utilised to record vertical tooth movement of the second maxillary premolars of 20 participants. A mean tooth displacement of 73.8 µm (sd = 22.5 µm) was recorded. The mean recovery to zero was 24.3 µm (sd = 17.1 µm). This mechanism of displacement and recovery may play a role in the protection of teeth during high stress, as during such events, teeth are initially moving rapidly to dissipate high stress concentrations.

To ensure a positive long-term outcome for all-ceramic restorations, the potential stress a restoration may experience should be an important consideration when material choices and design parameters are decided. If all-ceramic restorations are considered for implant-supported cases, the absence of the periodontal ligament and the resultant rigidity of the whole structure should be a consideration in material choice as well as inter-occlusal contact design.

Intra-oral stress is an important factor in the long-term survival of an all-ceramic restoration. The lower average bite forces of females and their higher rate of tooth displacement may provide a lower intra-oral stress environment. This widens the choice of all-ceramic materials to include the use of more translucent materials, with better aesthetics but lower strength for a wider range of teeth for female patients, if the contact point sizes are effectively controlled.

Chitra Krishnan

Krishnan, C. S. (2023). Neutral-PH electrolysed oxidising water as a dental disinfectant

Advisors: Cannon, Richard; Lyons, Karl; Tompkins, Geoffrey

Keywords: super-oxidised water; electrochemically activated water; Anolyte; hypochlorous acid; denture disinfection; Candida albicans; denture stomatitis; shelf-life; antimicrobial efficacy; antibiofilm efficacy; mechanism of action; transcriptional response; immersion disinfection; denture base resin; conventional heat polymerised polymethyl methacrylate; 3D-printed denture resin; CAD/CAM-milled denture resin; denture resin physical properties; colour; surface roughness; surface hardness; flexural strength; denture base resin mechanical properties

http://hdl.handle.net/10523/16247

Disinfection as a component of infection control is recognized as an essential consideration in

healthcare particularly in light of the risk from emerging pathogens and the increasing percentage of vulnerable, at-risk individuals in populations. This thesis begins by reviewing the principles and guidelines concerning disinfection in healthcare settings, and the requirements and methods to evaluate the effectiveness of chemical biocides. It discusses disinfection requirements in the dental healthcare settings as well as in home environments, focusing on acrylic removable dental prostheses (RDPs). While highlighting the need for research into the non-toxic, low-cost, and 'green' chemical biocide, electrolysed oxidising water (EOW), it was found that the inter-relationship and significance of EOW physicochemical properties determine its type, efficacy, and shelf-life. Moreover, research investigating the molecular mechanism of action of neutral-pH EOW on microbial cells, especially the opportunistic fungal pathogen *Candida albicans* (that causes denture stomatitis), is minimal. There is a lack of clarity on the specific gaps in knowledge regarding EOW use in dental healthcare and so a detailed scoping literature review was undertaken to map the published research. The scoping review revealed a paucity of data on ready-to-use (RTU), neutral-pH EOW pertaining to its shelf-life and effectiveness as a denture disinfectant as well as the effects of its repeated, long-term use on denture base resins. Most studies investigated 'point-of-use' produced EOW that requires installation and maintenance of generators, making it unsuitable for resource-challenged communities and home-disinfection needs of individuals.

This research aimed to investigate, *in vitro*, the storage-related stability and antimicrobial efficacy of RTU neutral-pH EOW and its suitability as a denture disinfectant by evaluating its effectiveness against *C. albicans* biofilms formed on denture acrylic resin, its molecular mechanism of action against *C. albican*s, and its long-term effects on denture base resins.

Sixty-four RTU neutral-pH EOW (Envirolyte, New Zealand) bottles (100 mL) that were procured in 13 batches were tested over five months from manufacture. Weekly evaluations of the RTU neutral-pH EOW properties (pH, redox, available chlorine content, hypochlorous acid (HOCl) concentration and antimicrobial efficacy against *Staphylococcus aureus* ATCC6538 and *C. albicans* ATCC10231) were performed over 28 days from bottle opening, for EOW samples that were stored at 4°C, room temperature (21°C) and 37°C. Minimum inhibitory concentrations (MIC90) of EOW-HOCl were determined against *S. aureus* ATCC6538 and *C. albicans* ATCC10231, SC5314 and recent human isolates. Antibiofilm efficacy against *C. albicans* ATCC10231 was determined by measuring the metabolic activity of biofilms formed on denture resin discs using a 2,3-bis (2-methoxy-4-nitro-5-sulfo-phenyl)-2H-tetrazolium-5-carboxanilide (XTT) assay. The EOW became moderately acidic with increasing storage duration. The [HOCl] decreased by 8% when stored at 21°C a reduction similar to storage at 4°C ($p = 0.1$); in contrast, [HOCl] decreased by 18% in samples stored at 37°C. A contact time of 1 min with EOW stored under any condition caused a >6 log10 reduction in *S. aureus* colony forming units (cfu) and >5 log10 reduction in *C. albicans* cfu, in line with British and European test standard requirements for chemical disinfectants and antiseptics. The mean MIC90 EOW-HOCl for a 5 min contact time was 37 ±10 μM against *S. aureus* and 54 ±13.7 μM against *C. albicans*. Furthermore, 5 min exposure to undiluted EOW caused an 87% reduction in the metabolic activity of *C. albicans* biofilms, a significantly greater reduction than that of a commercial denture cleaning tablet (DCT, 43%; $p < 0.05$).

Mid-logarithmic phase *C. albicans* SC5314 cultures were incubated with sub-inhibitory concentrations of RTU neutral-pH EOW for 60 min. Cells were harvested, and total RNA extracted. RNA-sequencing and transcriptomic analyses revealed that EOW induced a concentration-dependent stress adaptive response in *C. albicans,* further validated by qRT-PCR assays. At a moderate sub-inhibitory concentration (15 μM; 0.125x of MIC90 for a cell density of 1 x 107 cells/mL) EOW induced a significant upregulation (log2 fold change >2) of genes that respond to oxidative stress (EBP2, GAP6), weak organic acid stress (PRN1), and heat-shock (HSP21). This response indicates an adaptive mechanism to HOCl-based biocides in yeast, and which could be crucial for yeast survival, antimicrobial-resistance or biocide-tolerance, and pathogenicity. At a higher sub-inhibitory concentration (60 μM; 0.5x of MIC90) EOW caused a significant downregulation of most genes (notably, 1.9 to 3 log2 fold changes in SUT1, HNM3, STP4), a cessation of growth, and an upregulation of genes involved in ammonia transport, carbohydrate metabolism, endoplasmic reticulum unfolded protein response and apoptotic response pathway mechanisms (ATO2, IRE1).

Five min daily disinfection with undiluted neutral-pH EOW of conventional heat-polymerized, 3D-printed, or CAD/CAM-milled denture resin samples performed over the long-term (up to 3.0 y) was simulated in a customized cycling device and effects on resin properties (colour, surface roughness, surface hardness, flexural strength) were measured. Effects were compared with those caused by tap water and a commercial DCT. Resin properties were affected both by the type of denture

resin and the immersion agent. RTU neutral-pH EOW did not significantly change the colour (ΔE00), the surface roughness (ΔRa) or the flexural strength (MPa) of denture resins. Results were comparable to treatment with the DCT ($p > 0.05$), although the mean ΔE00 caused by the DCT for the heat-polymerized and the CAD/CAM-milled denture resins was above the perceptibility threshold (threshold where change in colour becomes perceivable). The mean surface hardness (Vickers; GPa) was not adversely impacted by either the EOW or the DCT treatments at 3.0 y, except for 3D-printed denture resins, where it decreased by 23% with both agents compared to the baseline ($p < 0.0001$), and when compared to a 13% decrease caused by tap water ($p<0.01$).

In summary, the research described in this thesis demonstrates RTU neutral-pH EOW to be stable for up to five months from manufacture and longer shelf-life can be achieved under refrigerated conditions. The effectiveness of RTU neutral-pH EOW against *C. albicans* test strains, recent human isolates and biofilms formed on denture resin surfaces, and the overall minimal effects on denture resin properties from long-term exposure, supports its use as a denture cleaner. Furthermore, the investigation revealed novel and informative data on the molecular mechanism of action of EOW and *C. albicans* adaptive responses that, with further investigation, will help to understand and expand its application. The results indicate that neutral-pH EOW is a suitable agent for studying HOCl-stress adaptive responses and resistance mechanisms in other fungal and bacterial species.

Begoña Ruiz Conrads

Ruiz Conrads, B. del P. (2023). Childhood caries: An early indicator of poor oral and general health by midlife - Findings from two Aotearoa New Zealand birth cohorts

Advisors: Broadbent, Jonathan M.; Thomson, W. Murray; Ramrakha, Sandhya

Keywords: Primary caries; General health; Mental health; ageing; longitudinal; Birth cohort; Public health; Dental epidemiology; Oral health; Cohort studies

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Oral health is important to overall health, yet it remains unclear whether poor childhood oral health is associated with future adult health. This thesis aimed to investigate whether childhood dental caries experience could be a useful marker of ill-health in adulthood, by examining associations between primary dentition at age 5 years and poorer self-reported health, physical health, mental health and ageing in midlife.

Participants were members of two ongoing Aotearoa New Zealand birth cohort studies: The Dunedin Multidisciplinary Health and Development Study, and The Christchurch Health and Development Study (hereafter referred to as the Dunedin and Christchurch Studies). Both cohorts are population-based samples that have been repeatedly assessed at multiple time points from birth to the fifth decade of life (to age 40 years for the Christchurch, and to age 45 years for the Dunedin studies, respectively). Data on childhood caries experience and adult self-reported health, physical health and ageing, and mental health were used in the five studies (Chapters 4 to 8) that comprise the empirical chapters of this thesis.

Chapter 4 presented oral health findings among 5-year-old children from the Dunedin and Christchurch cohorts. Gradients in caries experience by community water fluoridation (CWF), socio-economic status (SES) and maternal education were observed, and despite the caries decline observed in Aotearoa New Zealand over the decades, a considerable proportion of children experience socioeconomic disadvantage and higher rates of dental caries. Among the proportion of children that experience caries nowadays, dmft scores resemble those of the children in these two birth cohorts back in the 70s-80s.

Findings from Chapter 5 showed that 5-year-olds who were caries-free were more likely to have 'Excellent' self-reported health by ages 40 and 45 years than those who have had caries. In addition, Dunedin study findings suggested that poor parental ratings of their own or their child's oral health were associated with poorer self-reported general health by midlife.

Using Dunedin Study data, Chapter 6 described six distinctive dental caries experience patterns or trajectories across the lifecourse, assessed from ages 9 to 45 years. One low-, two moderate- and three high-caries-rate trajectories emerged from the data describing the different 'dental life pathways' that participants have followed by midlife. Early-life risk factors associated with those trajectories included higher dmfs scores at age 5 years, lack of exposure to CWF during the first five years of life, lower childhood cognitive function or IQ (intelligence quotient)—measured as a continuous score—and low childhood SES. Beyond clinical dental measures (dmfs), children whose parents gave poor ratings of their own or their child's oral health were more likely to follow the less favourable trajectories.

In Chapter 7, findings from Dunedin study data on biomarkers of poor health showed that children who had high caries experience at age 5 years (5+ caries-affected teeth) had higher risk for some metabolic abnormalities including BMI≥30, high waist circumference and being in the highest quartile for serum leptin by age 45 years. Furthermore, those who as children had high caries experience had aged more rapidly by midlife than those who had been caries-free.

Finally, findings from the Dunedin and Christchurch studies presented in Chapter 8 showed age-5 dental caries not to be associated with mental health disorders by midlife in either cohort. However, in the Dunedin study, cross-sectional associations were observed whereby participants with high caries experience at age 45 years were more likely to have externalizing disorders, thought disorders and tobacco dependence than those who had lower DMFS or who were caries-free. Interestingly, continuity in poor oral health (represented by study participants in the three less favourable permanent dentition caries trajectories identified in Chapter 6) was associated with a higher risk of mental disorders.

This thesis showed that individuals who had experienced dental caries by the age of five years were more likely to have poorer oral health, self-reported general health, some metabolic abnormalities, and were ageing at a faster rate by midlife than those who had been caries-free. Having dental caries at age five years was not associated with mental disorders in midlife, however, continuity in poor oral health across the lifecourse was associated with higher risk for mental disorders. These longitudinal associations between childhood caries experience and poor health by midlife reinforce the importance of child oral health for later adult health and wellbeing. Taken collectively, these findings suggest that early childhood dental caries experience should be recognised as a useful marker for poor oral and general health in adult life.

Stephanie Töpfer

Toepfer, S. (2023). Experimental combination therapy against azole-based multidrug resistant *Candida auris*

Advisors: Monk, Brian; Keniya, Mikhail; Lackner, Michaela

Keywords: Candida; auris; combination; therapy; Saccharomyces; cerevisiae; heterologous; expression; system; antifungal; efflux; pump

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Infectious diseases are a major challenge for modern medicine, especially those caused by emerging multidrug resistant pathogens. In particular, limited treatment options make invasive fungal infections challenging. Compared to the numerous classes of antibiotics marketed for the treatment of bacterial infections, only five antifungal drug classes are currently used in the clinic. This is partly because similarities between fungal and mammalian cells narrow the range of targets available for antifungal treatment. There is also an increasing incidence of antifungal resistance due to extended antifungal prophylaxis and antifungal overuse. It is therefore important to develop novel treatment strategies that improve therapeutic outcomes. This requires better understanding of the biology of individual fungal pathogens and the development of robust screens to identify new drug candidates. *Candida auris* is an emerging pathogenic yeast that causes severe infections, especially in intensive care and healthcare settings. Since its discovery in 2009, it has been found to cause nosocomial outbreaks across the globe. These have been difficult to eliminate because *C. auris* persists on many surfaces and most clinical isolates are highly resistant to one or more of the current antifungal drugs. This highlights the need to discover new drugs for the treatment of *C. auris* infections.

The objectives of this work were to (i) Functionally express selected *C. auris* genes involved in resistance to azoles in a *Saccharomyces cerevisiae* model, (ii) Validate this platform by quantitatively assessing the resultant phenotypes at the physiological and biochemical levels, (iii) Use the platform to screen for compounds that circumvent drug efflux-mediated resistance (iv) Use combinations successfully tested in the model platform against clinical isolates of *C. auris*.

The *C. auris* Erg11 protein (CauErg11), its mutants Y132F and K143R, and the efflux pumps CauMdr1 and CauCdr1 were successfully constitutively overexpressed in a S. cerevisiae expression host that is hypersensitive to azole drugs. The resultant phenotypes were evaluated for standard azoles and the tetrazole VT-1161. Overexpression of CauErg11 Y132F, CauErg11 K143R, and CauMdr1 conferred resistance exclusively to the short-tailed azoles Fluconazole and Voriconazole. While CauErg11 Y132F increased VT-1161 resistance, K143R had no impact. Strains overexpressing the Cdr1 protein were pan-azole resistant, additionally conferring resistance to long-tailed azoles such as Itraconazole and Posaconazole. Type II binding spectra showed tight azole binding to the affinity purified recombinant CauErg11 protein. Use of Nile Red as a drug efflux substrate confirmed the efflux functions of CauMdr1 and CauCdr1, which

were specifically inhibited by MCC1189 and Beauvericin, respectively. CauCdr1 also exhibited an ATPase activity that was diagnostically inhibited by Oligomycin.

Clorgyline and six of its analogs were screened using a *C. auris* clade I strain resistant to the azole drugs Voriconazole and Posaconazole. Two of the analogs (M19 and M25) appeared to inhibit growth of a clade I *C. auris* strain in the presence of the azole drugs. In a secondary screen, M19 and M25 were then found to act synergistically with azoles against recombinant *S. cerevisiae* strains overexpressing *C. auris* efflux pumps. Nile Red assays with the recombinant strains showed M19 and M25 inhibited the activity of CauCdr1 and CauMdr1 efflux pumps identified from phenotypic analysis as variously contributing to azole resistance in *C. auris* clades I, III, and IV. Clorgyline, M19 and M25 also uncoupled the Oligomycin-sensitive ATPase activity of Cdr1 from *C. albicans* and *C. auris.* Checkerboard assays quantitatively confirmed the synergistic effects of M19 and M25 in combination with azoles against multidrug resistant clinical isolates of *C. auris* clade I. The synergy of M19 and M25 with azoles appeared specific for *C. auris* but not *C. albicans* cells. As the susceptibility to Posaconazole is essentially unaffected by the CauErg11 Y132F and K143R mutations and because the efflux activity in clade I clinical isolates is dominated by CauCdr1, the combination of Posaconazole with M19 or M25 provides the basis for an experimental therapy that may be expanded to include other *C. auris* clades.

The *S. cerevisiae* platform developed in this work, which functionally express key proteins involved in *C. auris* drug resistance, not only provides insight into the nature of drug resistance in this pathogen but will also enable screens for novel azoles using phenotype- and ultimately structure-based approaches. Further, the experimental combination therapy developed in this work is a promising starting point to combat multidrug resistance in the emerging fungal pathogen *C. auris*. Despite a paucity of clinical guidelines and limited data available on the efficacy of treating fungal infections with combination therapy targeting both the azole drug target and drug efflux, the development of this approach could be used to extend the longevity of azole drugs and minimize pressure on current antifungals. Our finding suggest that the strategic use of such combination therapy could be a key to combatting multidrug resistant pathogens. However, more research is needed to understand the mode of action and broader efficacy of compounds M19 and M25.

Doctor of Clinical Dentistry (DClinDent) thesis abstracts

Farah Zainuddin

Ahmad Zainuddin, F. Z. B. (2023). Measuring dry mouth in older people in residential care, in Dunedin

Advisors: Thomson, Murray; Ting, Graeme; Guan, Guangzhao (Simon)

Keywords: dry mouth; xerostomia; salivary gland hypofunction; older people; residential care homes

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Older people living in residential care may have multiple co-morbidities and polypharmacy, which may cause dry mouth and reduce the quality of life. There are a few reports of the relationship between objective, subjective measurement and clinical oral dryness and their effects on oral health-related quality of life among older people.

The study's objectives are to investigate the association between salivary gland hypofunction, xerostomia, and oral clinical dryness symptoms in older people living in residential care facilities in Dunedin.

The methods included a clinical examination survey and saliva sampling involving 50 older people (80% females) living in residential care in Dunedin. Medications were recorded and analysed. Extra-oral and intraoral examinations were performed using a modified World Health Organisation (WHO) clinical examination protocol. The five-item Summated Xerostomia Inventory-Dutch Version (SXI-D) was used to assess xerostomia in the participants. The unstimulated flow rate was measured. The Challacombe scale was used to measure the clinical manifestations of oral dryness.

The results included participants ranging in age from 65 to 99 years (mean age = 83.0; SD 9.1). The prevalence of xerostomia was 34.8%; for salivary gland hypofunction (SGH), it was 26.1%. Only 13.0% had both conditions, and 52.2% had neither. The SXI-D score and salivary flow rate were only weakly and negatively correlated (r=-0.2), but a moderate positive correlation (r = 0.55) between the Challacombe scale and the SXI-D. There was a moderate negative correlation between the Challacombe scale and the flow rate (r = -0.47).

As a conclusion, dry mouth is common among older people in residential care, and the relationship between the signs and symptoms of oral dryness is complex and not as clear-cut as may be assumed.

Howard Chao

Chao, H. C.-H. (2023). Hyperglycaemia and calcification within the human dental pulp

Advisors: Friedlander, Lara; Milne, Trudy; Cooper, Paul; Cathro, Peter

Keywords: dental pulp; Type 2 diabetes; calcification; histology; gene expression; tissue culture; endodontics; qPCR; mineralisation; alizarin red S staining; human dental pulp cells

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Type 2 Diabetes (T2D) is a chronic metabolic condition characterised by hyperglycaemia. Patient numbers are increasing exponentially and the disease is associated with significant co-morbidities involving multiple bodily sites. Tissue calcification is not uncommon in the pulp space and its presence creates challenges for clinicians increasing the risk of procedural errors when removing residual pulp tissue and this may obstruct access to root canals. Tissue calcification associated with T2D has not yet been fully characterised and a further understanding of their involvement is needed. Most studies investigating T2D and dental pulp mineralisation have used animals models, so there remains a gap in our understanding of the effect hyperglycaemia has on human dental pulp cells (hDPCs). This research examined the histological differences within the dental pulp space of clinically normal and non-carious molar teeth from T2D and non-T2D patients, and the development of an *in vitro* T2D cell culture model to study hDPC mineralisation over an extended time period.

In part 1, clinically normal, intact, non-periodontally compromised molars were collected from well-controlled T2D patients (n=5) and non-T2D patients (n=5). The specimens were decalcified, paraffin-embedded and serial sections cut at 4 µm intervals for histological and special staining analysis. Qualitative analysis showed an increase in the presence of diffuse, amorphous, bone-like calcifications in the pulp chambers of T2D samples compared with non-T2D samples. These areas of calcification were commonly found in the peripheral and central pulp with some extending into the coronal third of the root canals. This finding has significant clinical implications for endodontic treatment planning. In part 2, non-T2D hDPC primary cell lines (n=4) obtained using the explant technique were cultured in normoglycaemic (5.5 mM D-glucose), pre-diabetic (12.5 mM D-glucose) and hyperglycaemic (25 mM D-glucose) conditions up to 21 days. In pre-diabetic and hyperglycaemic conditions, the cell viability of hDPCs reduced over time. In cell culture, formation of calcified nodules were observed using alizarin red S staining and these increased over time in higher D-glucose concentrations and with osteogenic supplements. Multiple gene expression analysis revealed the complexity of the pathways of calcification, the high potential of hDPCs to mineralise in a favourable environment and further validated the *in vitro* T2D model.

Clinical competence entails recognition of the effects of systemic diseases to individualise treatment plans for every patient. This study has enhanced our understanding of the effects of T2D on the dental pulp and the effects of hyperglycaemia on the behaviour of hDPCs.

Rayner Goh

Goh, R. Z. X. (2023). Effect of implantoplasty on fracture resistance and implant surface

Advisors: Tawse-Smith, Andrew; Ma, Sunyoung; Li, Kai Chun; Duncan, Warwick; Atieh, Momen

Keywords: Implantoplasty; Dental; implants; Peri-implantitis

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Peri-implantitis can be managed successfully by surgical debridement and mechanical removal of the exposed implant thread in certain scenarios to facilitate implant maintenance and home care. However, one of the side effects of this procedure is the reduction of the implant diameter, which may affect the fracture resistance of the dental implant.

Objectives: This thesis aimed to explore the effect of implantoplasty on the fracture resistance of dental implants. This includes a literature and systematic review on dental implant fracture after implantoplasty, as well as *in vitro* and finite element analysis experimentswhich evaluated the effect of various degrees of implantoplasty on fracture resistance.This study also investigated the surface changes of dental implants after implantoplasty.

Methods and Materials: For the systematic review, appropriate keywords related to implantoplasty and fracture resistance were used to search for relevant articles in three electronic databases (MEDLINE, Scopus, and Embase) up to August 29, 2021. This identified all studies that assessed the effect of implantoplasty on the fracture resistance of dental implants. Guidelines provided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and Cochrane Collaboration were followed. This systematic review addressed a focused question: Will implantoplasty affect the fracture resistance of dental implants? using

the PICO method.The *in vitro* study included 80 standard diameter dental implants, which were divided into control (without implantoplasty) and test groups (with implantoplasty). Further division was based on the height of the simulated bone loss (3 mm and 5 mm) and the degree of bone loss (semi-circumferential and circumferential). Implantoplasty was carried out by one operator (R.G.) using tungsten carbide finishing burs made specifically for this procedure. Changes in the implant after instrumentation were assessed using four methods. Weight changes were measured using a microscale while surface roughnesswas quantified using a profilometer. Optical microscopy was done to evaluate the implant surface and three-dimensional analysis was done to quantify the changes in the volume of each implant after implantoplasty. Finite element analysis was also carried out to assess the distribution of stress amongst the abutments and implants under loading.

Results: For the systematic review, ten studies which evaluated the effect of implantoplasty on the fracture of dental implants were identified and analysed. As there were multiple confounding factors such as the difference in implant diameter, connection design, and extent of bone loss between studies, the exact influence of implantoplasty on fracture resistance was still uncertain. However, the available evidence indicated that narrow diameter implants with an internal hexagon connection may be more likely to fracture after implantoplasty. Factors that lead to an increase in implant strength include implants made of titanium-zirconia alloy and implants with bone level design.The present *in vitro* study found significant differences in weight and volume between circumferential and semi-circumferential implantoplasty ($p = 0.001$ and 0.003). Statistically significant associations between volume and weight and fracture resistance were detected for all groups. Overall, implantoplasty reduced the fracture resistance of dental implants regardless of the degree of implantoplasty and defect morphology, apart from the group with 3 mm of circumferential bone loss ($p = 0.123$). Implants with 5 mm of simulated bone loss fractured with less force compared to implants with 3 mm of simulated bone defect before and after implantoplasty in both circumferential and semi-circumferential groups ($p < 0.001$). In the semi-circumferential implantoplasty group, only implants with 5 mm of bone loss experienced a significant decrease in fracture resistance compared to circumferential implantoplasty ($p < 0.001$), which was not observed in the 3 mm bone loss group ($p = 0.482$). Implant surface roughness decreased significantly ($p = 0.000931$) following implantoplasty. Finite element analysis demonstrated the reduction of maximum stress exerted on the abutments and implants after implantoplasty.

Conclusions: Possible characteristics of dental implants which can lead to significantly reduced fracture resistance after implantoplasty included narrow diameter implants and implants with internal hexagon connections. Implantoplasty on 4.2 mm diameter dental implants with 3 mm and 5 mm of circumferential and semi-circumferential simulated bone loss significantly reduced the fracture resistance. The only group of dental implants which did not experience a statistically significant reduction in fracture resistance had 3mm of circumferential bone loss. A greater amount of exposed implant threads and implantoplasty led to a decrease in fracture resistance. Dental implants presenting with a semi-circumferential pattern of bone loss were also more resistant to fracture after implantoplasty compared to those with circumferential bone loss, especially in implants with a greater amount of bone loss. As all available studies on this topic are *in vitro* in nature, there is still no evidence to suggest that implantoplasty increases the risk of dental implant fracture in patients due to the various limitations of *in vitro* studies. The type of suprastructure connected to the implants, degree of edentulism and presence of parafunctional habits will affect the magnitude and direction of stress on dental implants. To ascertain the clinical impact of implantoplasty on the fracture resistance of dental implants, clinical studies to identify its prevalence are required.

Carrol Jin

Jin, C. (2023). Biomechanical properties of orthodontic vacuum-formed retainers

Advisors: Mei, Li; Farella, Mauro; Brunton, Paul; Gray, Andrew

Keywords: orthodontic; retention; biomechanical property; orthodontic retainer

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Objectives: Vacuum-formed retainers (VFRs) are commonly used for orthodontic retention. Some patients use their VFRs for tooth whitening, but the presence of whitening agents may potentially affect the biomechanical properties of VFRs. The aims of this study were: (1) To investigate the effect of tooth whitening (10% carbamide peroxide) on the biomechanical properties of VFRs, and (2) To evaluate the change in tooth colour when using VFRs as the whitening tray.

Methods: Using a split-mouth, randomised

controlled trial design, thirty participants were randomly allocated to receive whitening of either the upper or the lower arch using 10% carbamide peroxide for two weeks. Biomechanical properties (hardness, tensile strength, and surface roughness) and tooth colour change were assessed two weeks after whitening was completed.

Results: Tensile strength of VFRs in the whitening arch (mean ± standard deviation = 40.93 ± 3.96 MPa) was significantly lower than that of the control arches (47.40 ± 5.03 MPa) (difference 6.47 MPa, 95% CI 4.51–8.42, $p < 0.001$). The hardness and internal roughness of VFRs in the whitening arch (VHN = 14.63 ± 2.29 N/mm2 and Ra = 1.33 ± 0.35 µm, respectively) were significantly greater than those of the control (VHN = 12.22 ± 1.86 N/mm2 and Ra = 0.96 ± 0.29 µm, respectively) (differences 2.41 N/mm2, 95% CI 1.56–3.25, $p < 0.001$ and 0.37 µm, 95% CI 0.23–0.51, $p < 0.001$, respectively). The whitening arch showed greater tooth colour change (ΔE = 6.00 ± 3.32) than the control (ΔE = 2.50 ± 1.70) (difference 3.49, 95% CI 2.43–4.56, $p < 0.001$) over the entire trial period.

Conclusions: Marked tooth colour change was achieved by whitening with VFRs as the whitening trays, but this changed the VFRs' biomechanical properties, including a decrease in the tensile strength and increases in the hardness and internal roughness.

Majd Khashashneh

Khashashneh, M. Moh'd S. N. (2023). The effect of 10% carbamide peroxide dental bleaching on the physical properties of Invisalign orthodontic aligners

Advisors: Brunton, Paul; Lyons, Karl; Choi, Joanne; Li Mei, Peter

Keywords: Invisalgn; bleaching; peroxide; Invislaign; dental; bleaching; carbamide; peroxide; physical; properties; tensile; strength; hardness

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The high aesthetic demands of patients have increased their requests to align their teeth using clear aligners, including Invisalign. Patients also want to have their teeth whitened for the same purpose; the use of Invisalign as a bleaching tray at night has been reported in few studies. However, whether 10% carbamide peroxide affects the physical properties of Invisalign is unknown. Therefore, the objective of this study was to evaluate the effect of 10% carbamide peroxide on the physical properties of Invisalign when used as a bleaching tray at night. Twenty- two unused Invisalign aligners (Santa Clara, CA, USA) were used to prepare 144 specimens to test their tensile strength, hardness, surface roughness, and translucency. The specimens were divided into four groups: a testing group at baseline (TG1), a testing group after application of bleaching material at 37°C for 2 weeks (TG2), a control group at baseline (CG1), and a control group after immersion in distilled water at 37°C for 2 weeks (CG2). Statistical analysis was conducted using a paired t-test, Wilcoxon signed rank test, independent samples t-test, and Mann–Whitney test to compare samples in CG2 to CG1, TG2 to TG1, and TG2 to CG2. Statistical analysis showed no statistically significant difference between the groups for all physical properties, except for hardness (p-value < 0.001) and surface roughness (p-value $= 0.007$ and p-value < 0.001 for the internal and external surface roughness, respectively), which revealed a reduction in hardness values (from 4.43 ± 0.86 N/mm² to2.2 ± 0.29 N/mm²) and an increase in surface roughness (from 1.6 ± 0.32 Ra to 1.93 ± 0.28 Ra and from 0.58 ± 0.12 Ra to 0.68 ± 0.13 Ra for the internal and external surface roughness, respectively) after 2 weeks of dental bleaching. Results showed that Invisalign can be used for dental bleaching without excessive distortion or degradation of the aligner material. However, future clinical trials are required to further assess the feasibility of using Invisalign for dental bleaching.

Jack Lintern

Lintern, J. E. (2023). 'Hyperbaric oxygen: Who wants it?' A case-series analysis of patients referred for hyperbaric oxygen in the prevention or treatment of osteoradionecrosis (ORN) in New Zealand

Advisors: Murray, Thomson; Harsha, De Silva

Keywords: Hyperbaric Oxygen; HBOT; Osteoradionecrosis; New Zealand; ORN

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Hyperbaric oxygen therapy (HBOT) has been a longstanding treatment option for the prevention or management of ORN; however, in recent times, its efficacy has been questioned. In New Zealand, only Auckland and Christchurch have HBOT facilities, and although in Auckland HBOT is still used routinely to enable dental extractions from a highly irradiated site, anecdotal reports suggest that HBOT is not used regularly elsewhere in the country. HBOT is time-consuming, and inconvenient for patients, and can have a number of associated side-effects. Patients who have

undergone treatment for head and neck cancer already have a high treatment burden involving multiple treatment modalities. These treatments can have serious oral health related side-effects, and commonly result in a dental extraction being required post-radiotherapy despite regular dental assessments and pre-radiotherapy dental treatment. Accordingly, the risk of osteoradionecrosis (ORN) will always be an important consideration for clinicians in this patient group. Hence, it is crucial that as a speciality, dentists find a balance between reducing the burden associated with a patient's cancer treatment, while still mitigating against the risks of ORN development. Since the introduction of modern radiotherapy techniques, and improved implementation of dental care and prevention by hospital dental specialists, rates of ORN have reduced. Because of this, and with recent literature questioning whether HBOT is still justified, it was important to determine whether clinicians in New Zealand may be referring patients for an outdated treatment, with little benefit, which could be causing additional burden to an already vulnerable patient group. Currently, limited research has been completed on patients referred for HBOT in New Zealand. A comprehensive, retrospective audit of patients who have been referred for HBOT will add crucial information about the treatment modality itself, and the patients commonly referred for it. This will help determine if patients are being referred unnecessarily, and whether HBOT still has a place in modern ORN prevention.

Abigail Oliver

Oliver, A. O. (2023). Clinical outcomes of postgraduate periodontal students' patients: A retrospective study

Advisors: Thomson, Murray; Tawse-Smith, Andrew; Nogueira, Getulio

Keywords: Periodontitis; New Zealand; University; periodontal treatment; treatment outcomes

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Background: Periodontitis is a chronic, inflammatory disease that has increased in prevalence by 24% over the last 19 years (1990 to 2019) (WHO, 2023). Arising from a dysbiotic relationship between the plaque biofilm and host response, it is characterised by the loss of periodontal supporting structures. According to the 2017 World Workshop of Periodontology Classification, a patient is diagnosed as having periodontitis if they have detectable interdental clinical attachment levels (CAL) at ≥2 nonadjacent teeth or CAL ≥3mm and probing pocket depths (PPD) >3mm buccally at ≥2 teeth. Different periodontal parameters are key components of the final classification of periodontitis. These periodontal parameters have been commonly used to diagnose periodontal patients, and they assist in the clinical decision-making process.

The two main treatment options for periodontal disease are either non-surgical or surgical (with or without adjunctive options). Both have been shown to be effective for periodontal patients, but patients' adherence to good oral hygiene maintenance can affect their treatment outcomes. Non-surgical treatment involves debridement of affected root surfaces with powered devices or hand curettes. Different surgical approaches have been developed over the years for different indications.

Clinical outcomes can be defined and used as a measurable change in clinical parameters to determine the endpoint of treatment and determine the effectiveness of treatment (National Institutes of Health, 2023). When measuring the clinical outcomes of periodontal disease and its response to treatment, a measurable endpoint should be used. This endpoint is commonly determined by measuring the loss or gain in periodontal parameters (CAL, PPD and gingival inflammation).

Many studies have been conducted in a university setting but they do not commonly assess the clinical outcomes of patients treated by the postgraduate periodontal students. In published studies, it is more common for them to be examining specific treatments or interventions and how they affect the outcomes. By contrast, the current study described the clinical characteristics of patients seen in the postgraduate periodontology discipline and investigated their clinical outcomes.

Methods: This study was completed retrospectively in the Periodontology discipline at the University of Otago, Dunedin, New Zealand. Patients seen by Periodontology Doctor of Clinical Dentistry (DClinDent) students between 2015 and 2017 had their notes examined and data extracted for analysis. They were included if they had been diagnosed with periodontitis and received at least one round of periodontal treatment from one of the postgraduate students seen during that time. The patients were identified by examining the postgraduate students' assigned patient lists and their submitted logbooks. Detailed data were extracted from the patients case notes and their recorded advanced periodontal charting. Overall, the information collected included their demographic characteristics, dental status, periodontal status, and treatment details. This information was recorded numerically on an Microsoft Excel spreadsheet and was systematically

analysed using SPSS IBM Corporation Version 20. The analysis assessed the extent and severity of patients' disease, and how the parameters recorded changed over the study period. It also assessed whether the patients improved, showed no change or worsened, and whether the treatment they received affected their outcomes. Effect sizes were computed to measure the magnitude of change between periodontal parameters recorded at baseline and those following treatment (at follow-up), by dividing the change in clinical score by the standard deviation of the baseline score. The data were also compared with estimates from the most recent national oral health survey (Ministry of Health, 2010).

Results: Baseline data were available for 218 patients; there were slightly more females than males (N = 121, 55.5% and N = 97, 44.5% respectively). There were more 45-to-54-year-olds (N = 84, 38.4%) and those aged 65+ years (N = 38, 17.4%). More patients were former smokers (N = 96, 44.0%) than never or current smokers (N = 70, 32.1% and N = 45, 20.6% respectively). More females than males were never or current smokers. There were more non-diabetics (N = 201, 92.2%) than diabetics (N = 17, 7.8%) and of those that were diabetic, more were males than females. Pocket depth (PD) of 5+mm involved approximately one-fifth of sites (mean = 17.3%, standard deviation (SD) =15.0) and one-third of sites measured had 5+mm clinical attachment levels (CAL) (mean =32.6%, SD = 21.2). Males had a higher extent and severity of CAL and class II or III furcation involvement than females.

The extent and severity of periodontal parameters decreased between baseline and follow-up. The extent of PD of 5+mm showed the largest improvement from baseline (mean = 18.1% of measured sites affected, SD = 15.6) to follow-up (mean = 6.3%, SD = 7.3), with the greatest effect size (0.8, indicating a large effect). Moderate effect sizes were seen with the extent of bleeding on probing (BoP) and suppuration from baseline to follow-up. Those that were followed-up over a longer period saw more improvements in all periodontal parameters. Both surgical and non-surgical periodontal therapy showed improvements in the periodontal parameters. However, furcation-involved teeth showed more improvement from surgery (mean = 3.0, SD = 3.6) than if the patient did not undergo surgery (mean = 1.7, SD = 2.1). In comparison, non-surgical treatment showed more improvements in tooth mobility than did surgical procedures.

The findings from the current study were compared with the findings of the 2009 national survey of the New Zealand population. This showed those seen by the periodontology discipline at The University of Otago had a considerably higher extent of PD and CAL 5+mm and 6+mm than those in the general population.

Conclusions: Patients treated by DClinDent students between 2015 and 2017 had much more severe and extensive periodontitis than the general population, but showed marked improvement in their periodontal parameters after treatment. Both surgical and non-surgical modalities showed improvements and have shown to be viable treatment options for periodontitis patients.

Shraddha Patel

Patel, S. P. (2023). Hyperglycaemia and the dental pulp: So what about angiogenesis?

Advisors: Friedlander, Lara; Milne, Trudy; Hussaini, Haizal; Cooper, Paul

Keywords: Dental pulp; Angiogenesis; Type 2 diabetes; Human teeth; Gene expression; Tissue culture; qPCR; Histology; Immunohistochemistry; Human dental pulp cells; Prestoblue assay; Crystal violet assay; Endodontics; Hyperglycaemia model

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Type 2 Diabetes (T2D) is a chronic metabolic disorder characterised by hyperglycaemia and is associated with micro and macrovascular complications. Vascularity and angiogenesis of the pulp are essential for healing and while international guidelines recommend the use of vital pulp treatment (VPT) for deep caries and some pulp exposures the influence of hyperglycaemia on angiogenesis is unclear. Angiogenesis is a tightly regulated process and occurs via the interaction of angiogenic growth factors and their corresponding receptors. Currently, we have an increasing understanding of pulp angiogenic processes in health, however we need to better understand how systemic disease influences this important process. Understanding of the pulpal response in patients with T2D would inform prognosis and treatment planning.

This study had two aims 1) to investigate the influence of type 2 diabetes (T2D) on the histomorphology and angiogenic protein expression within the coronal pulp chamber; and 2) to evaluate the influence of hyperglycaemia on cell viability, metabolic activity and angiogenic gene expression using an *in vitro* human dental pulp cells (hDPCs) model to mimic T2D.

In part 1, healthy permanent molars were collected

from T2D (n=5) and non-T2D (n=5) participants, decalcified in 10% EDTA and paraffin embedded. Sections were stained with Haematoxylin and Eosin; Verhoeff-Van Gieson stain; and immunohistochemistry (IHC) with anti-CD34 and anti-VEGFR2 was used to evaluate protein expression within the tissues prior to qualitative analysis.

In Part 2, coronal pulp tissue was excavated from extracted healthy permanent molars and the explant culture technique was used to establish primary hDPC lines (n=4). hDPCs were cultured with D-glucose at a range of concentrations (normoglycaemic 5.5mM (control), 12.5mM (prediabetes) or 25mM (T2D)) for 24, 48 and 72 hours (h). Cell viability was evaluated with Prestoblue™ and crystal violet assay. RNA expression levels for the angiogenic-associated genes VEGFA, KDR, FLT1, FGF2, ANGPT1, ANGPT2, TIE1, and TEK were analysed using quantitative real-time polymerase chain reaction (qPCR) and normalised to the reference gene GAPDH. For statistical analysis, student's t-test, ANOVA and Tukey's post-hoc tests were used at a significance level of $p<.05$. (Ethical approval H21/080).

Histological analysis showed that T2D dental pulps were less cellular and less vascular with thickened blood vessel walls. Qualitative analysis of anti-CD34 confirmed reduced vascularity in T2D compared with non-T2D pulps. Immunopositive staining of VEGFR2 was noted in the odontoblast region and scattered throughout the central pulp of non-T2D samples but was not observed in T2D samples. Cell culture studies found that hDPCs cultured with 25 mM D-glucose showed an increase in relative cell count with time when compared with 5.5 mM at 48 h ($p=.067$) and 72 h ($p=.061$). At 24 hours, when 25mM and 5.5mM were compared there was a significant difference in relative cell count ($p=0.023$). Cell metabolic activity was highest at 72 h with the 25mM D-glucose concentration group, compared with the 5.5mM exposure however this difference was not significant ($p=.274$). There was no significant change in hDPC expression of angiogenic-associated genes over the culture period. However, there was relatively high expression of VEGFA, FGF2, and ANGPT1. TEK, ANGPT2 and TIE1 expression levels fluctuated across glucose concentrations and KDR was undetected.

Within the limitations of this study, T2D may result in morphological changes in the dental pulp. In an unstressed normoxic environment, hyperglycaemia may increase hDPC viability and alter metabolic activity over time but may have limited influence on angiogenic-associated gene expression over 72 hours of culture.

Ai Lin Tee

Tee, A. L. (2023). An *in vitro* study of the effect of titanium surface treatments on the bonding between zirconia crowns and titanium bases

Advisors: Ma, Sunyoung; Choi, Joanne; Suzanne, Hanlin

Keywords: Zirconia; titanium; bonding; surface treatment; two-piece abutment; titanium abutment; titanium base

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Background: Zirconia crowns bonded to prefabricated titanium (Ti) bases represent a popular and innovative approach in modern restorative dentistry for implant-supported restorations. This combination leverages the superior aesthetics and strength of zirconia with the convenience and reliable stability of prefabricated titanium bases, providing patients with durable and aesthetically pleasing dental prostheses. There is limited research on the bonding between zirconia crowns and Ti bases. Therefore, this study aims to investigate the retention force between zirconia crowns and Ti bases using different surface treatments.

Materials & methods: One hundred and sixty 5Y-PSZ crowns (Lava™ Esthetic, 3M™) were fabricated according to a standardised maxillary central incisor shape to fit Ti bases (Straumann Variobase™, Institute Straumann AG). These were divided into two groups based on the Ti base design (Standard: n = 80; Angled Solution: n = 80). The crowns were cemented to the Ti bases following one of four treatment protocols (n = 20 per group): no treatment, sandblasting only, new generation bonding agent application only, and sandblasting and new generation bonding agent application. The crowns were bonded to the Ti-bases using a resin cement (RelyX™ Universal Resin Cement, 3M™). Half of each surface group (n = 10 per group) was subjected to artificial ageing (10,000 cycles, 5°C/55°C) using a thermocycler (Proto-tech, Dental Research Instruments, USA). Each sample was connected to an implant analogue mounted on a metal jig. The retention forces between the crowns and Ti bases were measured with a pull-off test. The treatment protocols were compared using one-way analysis of variance (ANOVA), followed by Tukey post hoc tests ($p < 0.05$). Some samples were further analysed under the scanning electron microscope (SEM) to assess the mode of failure.

Results: Retentive forces for standard Ti bases (474.6 ± 91.9 N) were significantly greater than Angled Solution Ti bases (280.2 ± 70.4 N) ($p < 0.001$). No significant differences were found

between different surface treatment groups of the same Ti base designs.

Conclusions: Standard Ti bases showed greater retention with zirconia than Angled Solution Ti bases. Within the limitations of this study, the different surface treatments used and thermocycling did not have an impact on the retentive forces.

Lesieli Tomiki

Tomiki, L. I. K. (2023). The effect of complementary feeding on New Zealand's infants dental health

Advisors: Meldrum, Alison; Adam, Lee; Taylor, Rachael

Keywords: baby food pouches, baby-led weaning, infant oral health, early childhood dental caries, complementary feeding, commercial infant food, dental photography

http://hdl.handle.net/10523/16229

Introduction: This research describes a secondary outcome for the First Foods New Zealand (FFNZ) study. The FFNZ study aims to determine the relationship between the infants' feeding patterns (which include baby-led weaning and a 'novel feeding method' such as baby food pouches) with dental health, growth, nutrition, food, and eating behaviours.

Aim of research: To describe the age when the first tooth erupts, teeth cleaning habits, demographics, and ethnicity of the involved infants aged 7.0 months to 10.0 months. Also, this study assessed the association between the dental status of the participants and their eating frequency, drinks frequency, pouch use, and baby-led weaning.

Methods: Infants aged 7.0 months to 10 months from Auckland and Dunedin were recruited. Infants and their caregiver attended two appointments. During the first appointment caregivers completed a digital questionnaire about their infant's oral status and feeding methods. Demographic information about the infant and their caregiver was also collected. During the second appointment, clinical dental photographs were taken of the participating infants. Photographs were assessed following an oral health assessment form using validated indices for dental caries, developmental defects of enamel, gingival status, eruption phase and intervention urgency. Descriptive statistics were used to summarise the questionnaire data.

Results: A total of 625 infants were recruited and of these, 438 infants completed the dental photographic assessment. No caries was observed in any of the infants' erupted teeth assessed, and only two infants had a tooth with demarcated opacities. Individuals who regularly practiced Baby-Led Weaning (BLW) or consumed baby food pouches with a nozzle were found to have a higher likelihood of having partially or fully emerged teeth compared to those who did not frequently use pouches or follow the Traditional Spoon-Feeding (TSF) method.

Conclusion: This observational study found no association between eating frequency, drinks frequency, pouch use, and BLW with dental caries and developmental defect of enamel on New Zealand infants aged between 7 -10 months. The association between feeding methods and tooth eruption requires further investigations.

Lucinda Wong

Wong, L. H. M. (2023). Beyond the cleft smile. Exploring dynamic smile characteristics and their relationship with clinical, biomechanical, and psychosocial factors

Advisors: Farella, Mauro; Firth, Fiona; Fowler, Peter; Jack, Hannah

Keywords: Cleft Lip; Smiling; Quality of Life; Cleft Scar; Myotonometry; Nasolabial Aesthetics; New Zealand; Orthodontics

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Introduction: This multi-centre observational study explored the impact of unilateral cleft lip conditions on the features of smiles and their relationship with a clinical outcome, biomechanical properties of lips, and psychosocial factors.

Methods: Adolescents and adults (N=42) were recruited from around New Zealand and formed two study groups: a unilateral cleft lip group (N=21) and a non-cleft control group (N=21) matched for age, gender, and ethnicity. All study participants watched an amusing video while their facial expressions were recorded. Smile episodes were automatically detected via software to measure six variables: frequency of smiles, mean duration of smiles, relative smile time percentage, smile genuineness, smile intensity, and tooth show. The cleft clinical outcome was assessed using the Asher-McDade (AM) nasolabial score based on facial photographs. Biomechanical properties of the perioral muscles and cleft scar were measured using myotonometry. Smile Esthetics-related Quality of Life (SERQoL), Orofacial Esthetics Scale (OES), and personality (IPIP-NEO-60) questionnaires were assessed in all study participants.

Results: The features of smiles and personality traits did not differ between the two study groups. Participants in the cleft group exhibited higher stiffness (+44.2%; Cohen's d = 1.6) and tone (+22.6%; Cohen's d = 1.9) at the cleft site, along with increased decrement (inverse of elasticity; +8.5%; Cohen's d = 0.8) at the adjacent perioral site. AM scores and decrement of the cleft scar were both negatively correlated with duration of smiles ($R = -0.52$ and $R = -0.44$; $p < 0.05$) and relative smile time percentage ($R = -0.50$ and $R = -0.49$; $p < 0.05$). Participants in the cleft group had lower scores for the OES as well as higher impacts in the SERQoL in the domains of social contacts and dental self-confidence.

Conclusions: Individuals who have completed treatment for cleft lip exhibit similar smile behaviour as their cleft-free peers - at least in non-social settings. Cleft clinical outcomes and biomechanical properties of lips are associated with propensity to smile. Cleft conditions negatively impact smile-related quality of life, as well as an individual's perception of their facial appearance in the long term.

Masters thesis abstracts

Master of Dental Techology (MDentTech)

Amelia Horsnell

Horsnell, A. (2023). Biofilm accumulation on conventional and CAD/CAM orthodontic bands and its consequence on enamel demineralisation

Advisors: Jansen van Vuuren, Wendy; Tompkins, Geoffrey; Farella, Mauro

Keywords: CAD/CAM; Biofilm; Orthodontic; Bands; Demineralisation

http://hdl.handle.net/10523/15142

Background: The wearing of orthodontic bands during treatment may increase the risk of caries, or white spot lesions (WSLs), due to prolonged biofilm accumulation around the bands. Using computer-aided design/computer-aided manufacturing (CAD/CAM) it is now possible to design accurate, custom-made bands, which may reduce biofilm-related adverse effects. The objective of this study was to compare the accumulation of biofilm and associated acid production and enamel demineralisation on conventional orthodontic bands and CAD/CAM (Sintron) bands.

Method: The study involved both *in vivo* and *in vitro* components. During the *in vivo* phase, twenty-one participants were requested to wear a custom appliance for 48 hours. Each appliance contained bovine enamel discs in six different positions (three per side). Each disc position was randomly allocated a tile from one of the following specimen groups (one of each on each side): Band tile, Sintron tile, and control (with no tile). The participants submerged the appliances in a 10% (w/v) sucrose solution for five minutes, five times per day. The discs were then incubated in a glucose/PBS solution for 24 hours. The biofilm accumulated *in vivo* was quantified and compared by digital photography. Biofilm acid production was estimated by measuring changes in pH of the glucose/PBS following the incubation period. The resulting enamel demineralisation was measured and compared by determining the calcium released into the glucose/PBS during the incubation period.

Results: There were no significant differences in the area (%) of biofilm coverage on exposed enamel between the specimen types or different position on the appliances. The pH of the control group was significantly higher than both Band and Sintron groups, but it did not differ between the Band and Sintron groups. There were no significant differences in acid production between specimen

positions on the appliance. Significantly more calcium was released from the control group than from the Sintron group, but the calcium release did not differ between Band and Sintron groups, or in calcium released from biofilms developed at different positions on the appliances.

Conclusion: This study revealed there were no difference in the accumulation of biofilm, associated acid production or enamel demineralisation between conventional orthodontic bands and CAD/CAM bands.

Master of Science (MSc)

Tianyu Cai

Cai, T. (2023). Improved drug release with a multilayer coating for a biodegradable drug-eluting stent

Advisors: Ali, Azam

Keywords: Drug-Eluting Stent; Multilayer Coating; Drug Release; Biodegradable material

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The current study aimed at exploring the effect of non-uniform drug distribution and diffusivity in drug eluting stent (DES) coating and to use this strategy to optimize the drug release profile. In this study, the film casting method was assessed and optimized to fabricate monolayer films down to 3 μm thickness. Through the adsorption between the ultra-thin films, a multilayer film with a total thickness of approximately 10 μm stacked by three layers was fabricated. Since the thickness of the multilayer film is similar to the drug-loaded coating of commercial stents, the drug release based on this multilayer film has the potential for practical applications. By casting and loading the three-layer films separately, a customizable multilayer Poly (lactic acid) (PLA) film was fabricated to explore the effect of the distribution of different drugs and Poly (ethylene glycol) (PEG) on the drug release kinetics. In addition to investigating the release profiles of different configurations of multilayer film, scanning electron microscopy was applied to measure the film thickness and surface morphology, optical coherence tomography was used to observe the cross section of multilayer film, differential scanning calorimetry was applied to further investigate the causes of changes in release behavior, and a biological characterization using human keratinocyte was also performed to assess the biocompatibility. To ensure the accuracy of the release test, four generations of sealing devices that can seal the multilayer film were designed. The sealing device (G4-seal ring), which was used in the final drug release test, was examined in the sealing test based on the hydrophilic Ponceau 4R-loaded multilayer film to ensure that the release medium did not directly contact the middle layer or inner layer within 25 days. The G4-seal ring has the advantages of easy assembly, stable sealing effect, low production cost, and it can be applied to other polymer film-based drug release tests. Turmeric was used as a model drug in this thesis study. In the turmeric release test, it was found that the initial burst release of the samples with all three layers containing 5% PEG was inhibited, suggesting that a small amount of PEG could limit the drug release. In addition, amongst the 11 configurations, the configuration with two layers of release barrier (5% PEG in PLA) and all drugs distributed in the inner layer (sample-10) provided the lowest burst release and the highest n value of the Korsmeyer-Peppas model, which means the configuration of sample-10 significantly improved the release kinetics of turmeric. Besides this, the configuration with a single-layer release barrier (5% PEG in PLA) and gradient distribution of the drug in the middle and inner layers (sample-9) provides n values very close to sample-10. At the same time, the turmeric release of sample-9 between day 1 and day 10 was greater than sample-2 (uniform drug distribution and no PEG content). In addition, this study also summarized information about the effect of drug and PEG distribution on the drug release behavior of multilayer films from the results of the turmeric release test. By applying the configuration of sample-9 and -10 to the everolimus (EVR) release test, it was known that the release barrier significantly inhibited the release of EVR within 25 days. The results of cell experiments based on HaCaT cells showed that the drug release medium from EVR release rate-limited samples reduced the negative impact of EVR on cell viability (no significant difference from untreated group-Cell only control), whereas the release medium from EVR uniformly distributed sample-ND resulted in a significant drop in cell viability. The results of this study enhance our understanding about drug release mechanism in a multilayer system, and also demonstrate that non-uniform drug distribution and diffusivity in drug-loaded coating can effectively improve drug release profile and biocompatibility of drug-loaded coating.

Quinn Thorsnes

Thorsnes, Q. (2023). An exploration of melt-electrowriting and fused deposition modelling for tissue engineering blood vessels

Advisors: Ali, Azam; Cabral, Jaydee

Keywords: Fused Deposition Modelling; melt-electrowriting; Tissue Engineering; Tissue Engineering Blood Vessels; Additive Manufacturing; bioengineering; scaffold; Dynamic Mechanical Analysis; Stereology; Mould; normal human dermal fibroblast; FDM; MEW; TEBV; AM; DMA; nHDF; Tissue engineering vascular grafts; TEVG

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There are many ways in which blood vessels can be damaged, resulting in the need for replacement vessels. Traumatic injury to surrounding tissue, diseases that degrade the elasticity or other features, and life-style choices that lead to blockages are all examples of how damage can occur. Surgical treatment for damage blood vessels typically involves replacing the damaged section. Self-donated vessels guarantee compatibility with the patient, but many patients cannot self-donate. Additionally self-donating requires additional surgeries and results in impaired functionality at the donor site. The creation of multiple wounds increases the risk of infection. Synthetic grafts do exist in clinical use, but they tend to be short term solutions as a result of insufficient biocompatibility. This low biocompatibility can lead to immune rejection and may leading to the graft becoming blocked.

In this research, a potential design and manufacturing basis for tissue engineering blood vessels is explored. A novel combination of meltelectrowriting and fused deposition modelling was used to generate scaffolds via moulds. This allowed for increased scaffold design freedom not attainable with either additive manufacturing technology alone. The primary material used for these scaffolds was polycaprolactone. This is an FDA-approved synthetic polymer well-established to possess excellent compatibility with both biological systems and other materials. This compatibility with other materials allows for both the biological and material properties of scaffolds to be customised for their specific uses.

The moulds used in this study were created using a varied of materials from glass to conductive polylactic acid. This latter material, polylactic acid with graphite added to improve electrical conductivity, was found to be an excellent moulds material in its compatibility with standard fused deposition modelling to make moulds of nearly any shape while still concentrating the electric field in melt-electrowriting and allowing the scaffolds to be removed from the mould without difficulty or residue.

This study characterised the pure polycaprolactone scaffolds both mechanically and biologically. The biological characterisation consisted of seeding the scaffolds with normal human dermal fibroblasts, similar in size to endothelial cells, and culturing them over the course of a month. This indicated that the manufacturing process did not introduce any factors that negatively impacted cell growth. Further, the mechanical characterisation, in conjunction with simulation, validated previous research and identified potential means for accurate simulation for future scaffold development.

Dynamic mechanical analysis was used to characterise the mechanical properties of the scaffolds, giving both the viscous and elastic properties of the scaffolds. The scaffolds were also physically simulated in different potential pore structures using the finite element method and theoretical values predicted by literature and observed strand sizes. The results showed that the mechanical properties of the scaffolds could be well approximated through three-dimensional Voronoi tessellation. This means that future scaffold designs made with melt-electrowriting may have their mechanical performance predicted without needing to consume materials and even when their geometries would prohibit direct testing.

Master of Community Dentistry (MComDent)

Rebecca Chapman

Chapman, R. (2023). Validation of the Child Perceptions Questionnaire as a measure of oral health-related quality of life in young adults

Advisors: Thomson, Murray; Broadbent, Jonathan

Keywords: New Zealand; Oral health-related quality of life; OHRQoL; Child Perceptions Questionnaire; Young Adults; Oral Health; CPQ; Oral Health Impact Profile; OHIP-14

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Background: The recognition of oral health as a subjective state has led to a significant body of research into oral health-related quality of life (OHRQoL). OHRQoL is a dynamic construct, susceptible to change according to age and different life stages, and so it is important to understand

how OHRQoL changes throughout the life course. To date, there are no studies that have investigated OHRQoL throughout the transition from adolescence to young adulthood, which is partly due to the fact that no OHRQoL index has been validated in both adult and child populations. This presents a significant challenge when measuring OHRQoL changes from adolescence to young adulthood, as scores between different measures cannot be compared directly.

The Child Perceptions Questionnaire (CPQ11-14) is one of the most commonly used OHRQoL measures for children, validated for use from 6 to 14 years. It has been widely used in OHRQoL research in New Zealand and internationally, with New Zealand researchers playing a key role in the measure's epidemiological validation. While originally developed alongside two other age-specific questionnaires (CPQ6-7 and CPQ8-10), subsequent validation studies demonstrated that CPQ11-14 was valid in younger children, removing the need for the three age-specific questionnaires. With its sound theoretical basis and history of field use, it is possible to consider that the age range of the CPQ11-14 could be extended in the other direction, making it the first OHRQoL measure to be validated in both the child and adult population. This would be an important step towards longitudinal research across the transition from adolescence to young adulthood, bringing with it valuable information to oral health researchers, policy makers and clinicians.

With this in mind, the current study aimed to investigate whether the Child Perceptions Questionnaire was a valid measure for OHRQoL in a young adult population by comparing it to the Oral Health Impact Profile (OHIP-14).

The objectives of this study were:

1. To determine whether the CPQ11-14 is a valid and reliable measure for OHRQoL in young adults aged 18-30 years;

2. To compare the performance of the CPQ11-14 and the OHIP-14 as measures of self-reported OHRQoL in a sample of New Zealand young adults aged 18-30 years;

3. To describe self-reported OHRQoL, and its influences in a sample of New Zealand young adults aged 18-30 years; and

4. To examine the ability of self-rated general health measures to identify differences in self-reported oral health.

Methods: A cross-sectional study of young adults in New Zealand aged 18 to 30 years was undertaken. The questionnaire was advertised using social media, where participants were invited to complete the questionnaire through the online platform RedCap. Data were collected on sociodemographic characteristics, oral hygiene habits and dental service usage, dental anxiety, personality, and three separate measures of OHRQoL (CPQ11-14, OHIP-14, and global items). A total of 968 participants completed the survey.

Results; The overall prevalence of 1+ impacts was 62.7% for the CPQ11-14, and 68.7% for the OHIP-14. The mean score was 15.8 (SD=9.7) for the CPQ11-14, and 24.1 (SD=10.1) for the OHIP-14. Both the CPQ11-14 and the OHIP-14 demonstrated acceptable construct validity as assessed by Locker's global oral health item. The internal consistency reliability was high for both the CPQ11-14 and the OHIP-14, with Cronbach's alpha scores of 0.87 and 0.92 respectively. The Pearson correlation coefficient between the CPQ11-14 and the OHIP-14 measures was 0.8, representing a strong correlation. Ordinal logistics regression modelling demonstrated that the CPQ11-14 had a slightly better fit, and explained more variance than the OHIP-14. Individuals who identified as being dentally anxious reported poorer OHRQoL. Associations were also noted between aspects of personality (positive and negative affect) and OHRQoL. The self-rated general health item was not as discriminative for differing oral health states as the other oral-specific global items.

Conclusions: This study provided evidence of validity and reliability of the CPQ11-14 in a young adult population. Further epidemiological validation studies should be completed to confirm the findings in a representative sample.

SJWRI Research Report 2023

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PhD graduates Dina Abdelmoneim, Chitra Krishnan, Minati Choudhury and Angela Benn, December 2023.