THE UNIVERSITY OF QUEENSLAND
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CREATE CHANGE

Research Day 2022

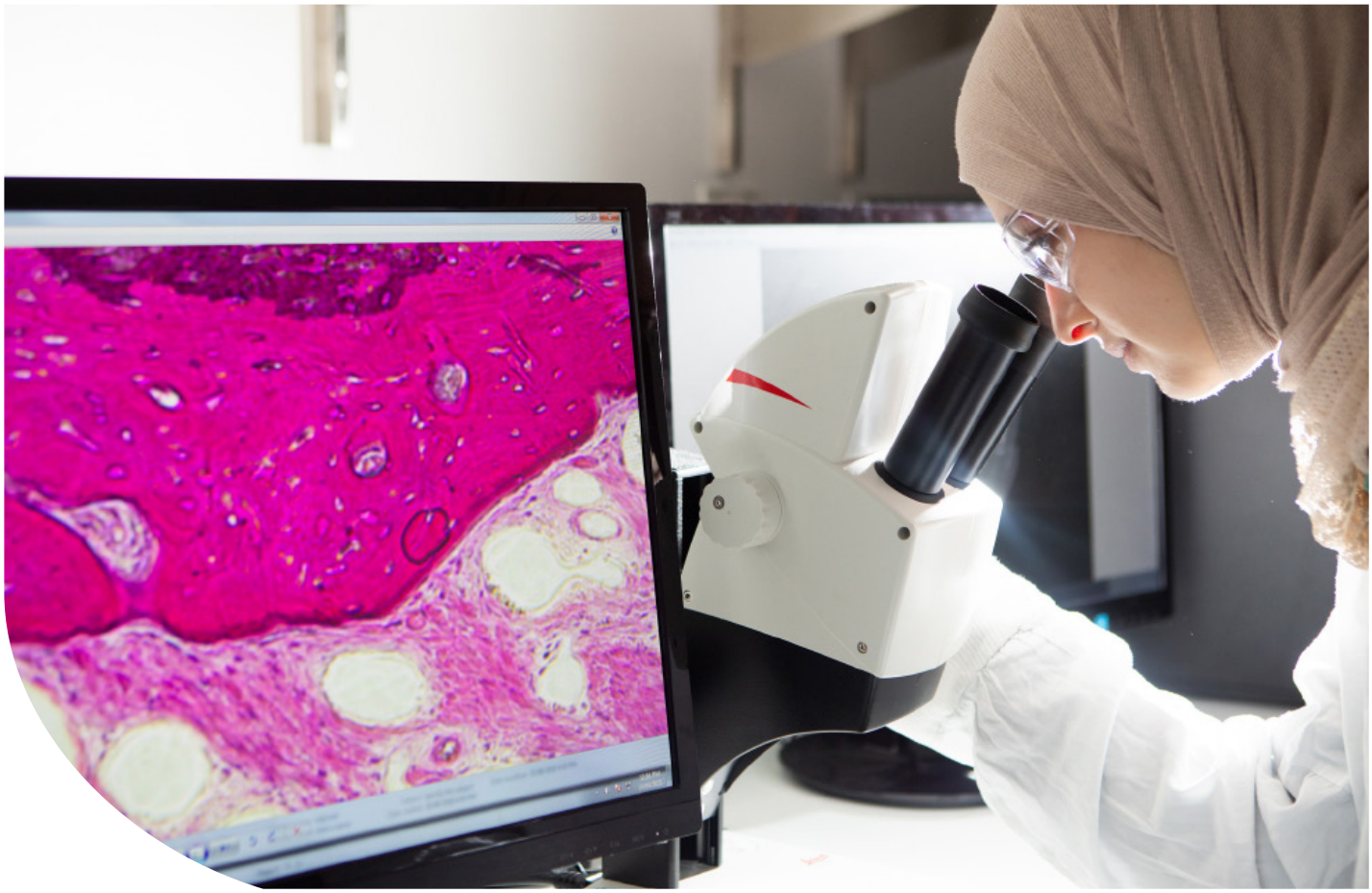
School of Dentistry

Dental discovery for translation and impact

Acknowledgements

The School of Dentistry gratefully acknowledges the support of One Dental, 3M and SDI for Research Day 2022

Thanks also to Colgate and the International Association for Dental Research.



Awards

The School of Dentistry recognises the achievements of our research students through the following awards for best student presentations and publications from the last year.

Presentation Awards

Two awards will be made to students in the following categories.

1. Best presentation
2. Most innovative project

Publication Awards

Awards will be made to recognise the best student publications between 1 June 2021 and 1 June 2022, across the following categories.

1. Clinical Research
2. Dental Education and Public Health Research
3. Regenerative Dentistry Research

IADR ANZ/Colgate Student Awards

Two awards, in junior and senior categories, will be made to support students to attend the annual IADR ANZ annual scientific meeting, 2022.

Staff Supervision Awards

Awards will be made to recognise outstanding research supervision by School of Dentistry staff.

Welcome

Professor Sašo Ivanovski

Head of School

It gives me great pleasure to welcome you to the 2022 School of Dentistry Research Day. Despite the challenges of the COVID19 pandemic, our School has seen strong growth in our research program across our existing and emerging areas of strength. Research Day gives us an opportunity to come together to reflect on our research success, share our findings with a wider audience, and foster feedback and collaboration. It is also an opportunity to recognise and reward outstanding research by our students via a series of awards. We are proud that our dental and oral health research continues to be of the highest quality and contributes to the advancement of scientific knowledge both locally and internationally, helping to provide effective solutions to contemporary challenges in dentistry. I would like to express my warmest congratulations to the students and staff involved in this year's Research Day, and trust that you will enjoy learning about the outstanding research being conducted at the School of Dentistry.

Professor Loc Do

Director of Research

We would like to warmly welcome you to the School of Dentistry Research Day 2022. This year's theme 'Dental discovery for translation and impact' encapsulates our vision and strategy to ensure our research has real world impact. By focussing our research agenda through our three main research units - Population Health at UQ, the Centre for Orofacial Regeneration, Reconstruction and Rehabilitation (COR3) and our Clinical Research Units – we are producing world class outcomes that are providing solutions to today's global dental health challenges. We are fortunate to have two world-class keynote speakers at our Research Day, Professor Amanda Lee and Professor Simon Cool. Their speeches will no doubt inspire research ideas and potential collaborations. Our staff and students will also present on a wide range of research topics showcasing the depth, breadth and quality of the research being conducted at the School. There will also be displays of research materials by various research groups at the School. I would like to thank Dr Pingping Han, Dr Sobia Zafar, and Mr John Bertram, Senior Administration Officer (Research), for their efforts in organising this event. We thank our industry sponsors for supporting this important event.

Research Day Organising Committee

We welcome you to present, attend and interact at the School of Dentistry Research Day, with a focus on highlighting world leading dental research carried out by our Honours, DClinDENT, HDR students and staff. Research Day is an exciting forum for our school to come together and share our research findings with a wider audience, enabling feedback and collaboration. We will be giving awards for best student presentations and publications, as well as staff supervision awards, to recognise the outstanding achievements of our staff and students.

Dr Pingping Han

Dr Sobia Zafar

Mr John Bertram

Keynote speakers

Professor Amanda Lee

Amanda Lee is Professor of Public Health Policy in the School of Public Health at UQ. She has expertise in preventative health, public health nutrition, health policy, food systems and Indigenous health. Her major area of research is the development, implementation and evaluation of public health policy actions to prevent and manage non-communicable disease (NCD), with a focus on regulatory policy responses targeting obesity, poor diet and food insecurity. Her work takes a strong systems focus, underscored by the pillars of health and wellbeing; equity; environmental sustainability and prosperity.

Professor Simon Cool

Simon Cool is Professor of Bioengineering in the School of Chemical Engineering at the University of Queensland. He has a strong stem cell biomanufacturing and translational focus with experience in taking glycosaminoglycan (GAG)-based materials through discovery RnD on to pre-clinical and clinical testing. His areas of research expertise include the development of GAGs that control stem cell fate decisions and the application of GAG-based medical devices to bone and cartilage repair. He also has a collaborative programme on periodontal tissue regeneration and alveolar ridge augmentation, and a strong interest in entrepreneurial and licensing activities.

Venue information

Venue

UQ Oral Health Centre Auditorium
Level 4 (ground),
288 Herston Road
Herston QLD 4006

Zoom

Zoom link provided
upon registration

Date and Time

Friday 29 July 2022
8am–3pm

Trade and Research Displays

Please take the opportunity to visit the trade display from our sponsors One Dental, 3M and SDI, and displays of the School's research, located in the seminar rooms adjacent to the Lecture Theatre. Morning tea and lunch will also be served in the seminar rooms.

Continuing and Professional Development (CPD)

The University of Queensland's School of Dentistry Research Day showcases some of the latest research findings and innovations in dental science from staff and students of one of the most research-intensive dental schools in Australia. Attendees will receive certification of 4 hours of scientific CPD.

Recordings

For those who are unable to attend, videos of the presentations will be made available on the School of Dentistry website..

Program

7.30-8.00	Registration and networking	30 mins
8.00-8.05	Welcome address – Head of School **Professor Sašo Ivanovski**	5 mins
8.05-8.10	Welcome address – Director of Research **Professor Loc Do**	5 mins

Keynote speaker

8.10-8.50	**Professor Amanda Lee** *Increasing the impact of dental research on policy and practice*	40 mins

SESSION ONE

8.50-9.00	**Tianqi Guo** *Decoupling the Topography and Chemistry of Nano-Engineered Titanium Implants towards Bioactivity Enhancements*	10 mins
9.00-9.10	**Pengcheng Chen** *Orifice barriers for the prevention of coronal microleakage: Systematic review and meta-analysis*	10 mins
9.10-9.20	**Jonathan Lam** *Efficiency of clear aligner therapy with and without Dental Monitoring: a randomised controlled trial*	10 mins
9.20-9.30	**Nicholas Jin** *Comparing the dental caries experience of five-year-old children whose mothers were born in Australia versus overseas*	10 mins
9.30-9.40	**Kexin Jiao** *3D bioprinted extracellular vesicles for in vitro cell attachment*	10 mins
9.40-9.50	**Karissa Shieh** *Dentinal tubule penetration and bond strength of 2 novel calcium silicate-based root canal sealers*	10 mins
9.50-10.00	**Caitlin Stephens** *Clinical expression of programmed mandibular canine rotation using various attachment protocols and 1- vs 2-week wear protocols with Invisalign® SmartTrack® aligners*	10 mins
10.00-10.20	Morning tea	20 mins

Keynote speaker

10.20-11.00	**Professor Simon Cool** *Developing glycosaminoglycan-based implantable devices for periodontal regeneration*	40 mins

Program

SESSION TWO

11.00-11.10	**Huan Dai** *Bioinspired mesoporous silica nanoparticles for local plasmid delivery for bone regeneration*	10 mins
11.10-11.20	**Jiwon Choi** *Automatic Metric Comparison of Access Cavities in a Preclinical Setting: Novel Teaching and Feedback Tool*	10 mins
11.20-11.30	**Thomas Hogerheyde** *Paediatric Crowns - Biocompatibility and Acid Resistance Studies*	10 mins
11.30-11.40	**Anjana Jayasree** *Gallium-doped Therapeutic Dental Implants*	10 mins
11.40-11.50	**Maribelle Georgei** *Identifying factors that affect dental students' attitudes towards participation in rural and remote clinical outplacements in Australia*	10 mins
11.50-12.00	**Chun Liu** *Using 3D scaffolds to detect salivary immune response after mRNA vaccine*	10 mins
12.00-12.10	**Yunjoo Hur** *Effects of the COVID-19 pandemic on the final year dental clinics*	10 mins
12.10-13.10	Lunch and trade display	60 mins

SESSION THREE

13.10-13.20	**Manal Masood** *Investigation into metal composition of oral piercings and rate of metal dissolution under acidic challenge*	10 mins
13.20-13.30	**Mervin Liang** *Understanding the building blocks of UQ School of Dentistry Undergraduate curriculum*	10 mins
13.30-13.40	**Philip Chien** *Experimental and finite element analysis of nickel-titanium endodontic instruments*	10 mins
13.40-13.50	**Gurek Nahal** *Evaluating parental source of information for their child's oral health*	10 mins
13.50-14.00	**Zhaoyun Grace Chen** *Students' perception of undergraduate education and training in Special needs dentistry at an Australian dental school*	10 mins
14.00-14.10	**Enmao Xiang** *Surface Modification of Biodegradable Zinc by Acid Etching: Enhanced Corrosion Rates, Biocompatibility, and Antibacterial Characteristics*	10 mins
14.10-14.25	**Conclusion**	15 mins

Awards presentation

14.25-14.40	**Awards presentation**	15 mins

Abstracts

Decoupling the Topography and Chemistry of Nano-Engineered Titanium Implants towards Bioactivity Enhancements

Researchers

Tianqi Guo, Sašo Ivanovski and Karan Gulati
School of Dentistry, The University of Queensland

Objectives

It is well established that cell functions are influenced by the chemistry and topography of implant surfaces; however, chemical and topographical modifications often occur concurrently on nano-engineered implant surfaces. Deciphering how topography and chemistry tailor specific cellular functions will enable the fabrication of bioactive dental implants. This study evaluates the bioactivity of nano-engineered implants with either similar topography (but different chemistry) and similar chemistry (but different topography).

Methods

Electrochemical anodization (EA) was utilized to modify Ti implants and fabricate controlled Ti/TiO2 nanotopographies with either similar topography or chemistry by tailoring EA conditions (substrate topography, EA parameters). Next, topographical and chemical characterizations were systematically performed, followed by quantifying their wettability and protein adhesion capacity. Further, human gingival fibroblasts were cultured on different surfaces to evaluate cell proliferation, adhesion and spreading.

Results

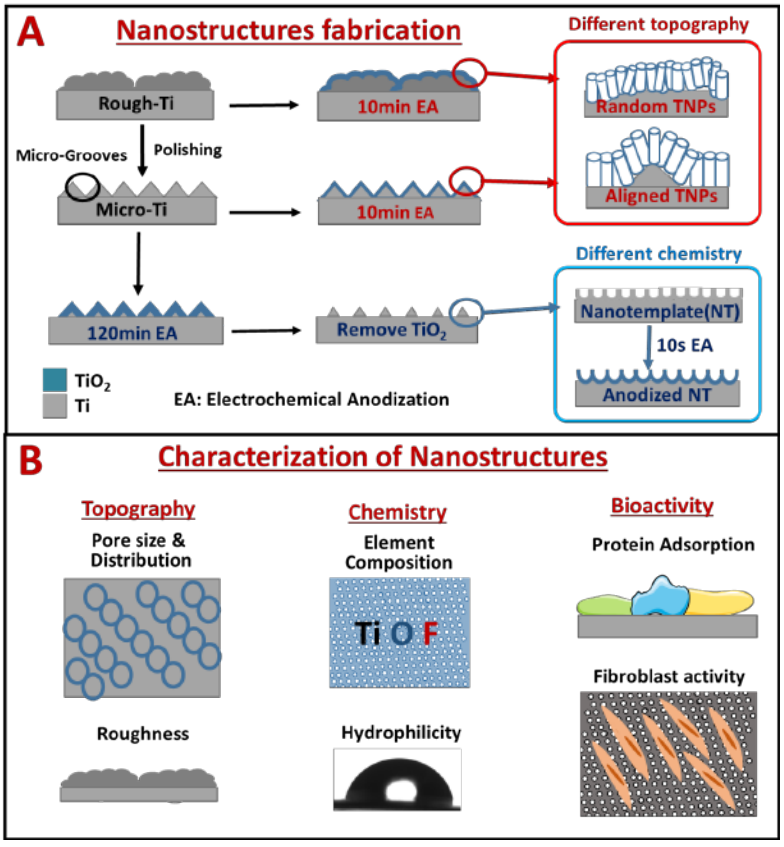
Surface characterization confirmed fabrication of stable nanostructures on different Ti substrates, among which were aligned/random nanopores (A-TNPs/R-TNPs) with similar chemistry but different topography and Ti/TiO_2 nanotemplates with similar topography but different chemistry. The hydrophilicity and protein adhesion capacity was influenced by the surface topography (pore size, density) of nanostructures, while cell metabolism/proliferation was influenced by both topography (pore size, density and alignment) and chemistry. Additionally, the distribution and alignment of nanostructures significantly influenced cell alignment and attachment.

Conclusions

This pioneering study elucidates the specific influence of various topographically and chemically modified nano-engineered surfaces on bioactivity, in order to reduce discrepancies and to define a set of parameters that control specific cell functions – towards the next generation of highly bioactive implants.

References

1. Guo, T.; Oztug, N. A. K.; Han, P.; Ivanovski, S.; Gulati, K., Old Is Gold: Electrolyte Aging Influences the Topography, Chemistry, and Bioactivity of Anodized Tio2 Nanopores. ACS *Appl Mater Interfaces* 2021, 13 (7), 7897-7912.
2. Gulati, K.; Moon, H.-J.; Li, T.; Sudheesh Kumar, P. T.; Ivanovski, S., Titania Nanopores with Dual Micro-/Nano-Topography for Selective Cellular Bioactivity. *Mater Sci Eng* C 2018, 91, 624-630.
3. Chopra, D.; Gulati, K.; Ivanovski, S., Understanding and Optimizing the Antibacterial Functions of Anodized Nano-Engineered Titanium Implants. *Acta Biomater* 2021. 127, 80-101.



Fabrication and characterisation of various nanostructures.

A) Fabrication of various nanostructures with controlled chemistry and topography on Ti implants via electrochemical anodization (EA).

(B) Systematically evaluating the characteristics of fabricated nanostructures.

Orifice barriers for the prevention of coronal microleakage: Systematic review and meta-analysis

Researchers

Pengcheng Chen, Ziyin Chen, Yu-Yao Teoh, Christine Peters, Ove A Peters

School of Dentistry, The University of Queensland

Objectives

Coronal microleakage after completion of a root canal treatment is a common cause for persistent or developing apical periodontitis. The placement of an orifice barrier material has been proposed to reduce leakage and this decrease the rate of failure. This systematic review aims to compare the effectiveness of various materials for the prevention of coronal microleakage in vitro.

Methods

After PROSPERO protocol registration, a literature search was conducted using Scopus, NCBI PubMed, NCBI PMC, NCBI Medline, Embase, Clarivate, Web of Science and Open Grey, until March 2022. Eligible criteria followed a priori PICO questions. Two independent reviewers were involved in study selection, data extraction and appraisal of included studies. A quantitative meta-analysis was considered for outcomes with homogenous studies and statistical heterogeneity was assessed.

Results

Thirteen studies were identified for this systematic review, providing data for 788 teeth. 8 studies were included in the quantitative analyses evaluating the following materials: Glass ionomer cement (GIC), resin modified GIC (RMGIC), composite resin, MTA and Cavit.

A random effect meta-analysis indicated the risk ratios of coronal microleakage for different orifice barrier materials vs. positive control with no orifice barrier demonstrating a significant effect in favour of any orifice barrier. The risk ratios for various materials were: GIC:(RR:0.38;95%CI:0.21-0.70;p=0.002;I2=26%), RMGIC:(RR:0.43;95%CI:0.26-0.71;p=0.001;I2=55%), composite resin:(RR:0.60;95%CI:0.41-0.87;p=0.007;I2=78%), MTA:(RR:0.25;95%CI:0.12-0.52;p=0.0002;I2=58%), Cavit:(RR:0.23;95%CI:0.14-0.39;p<0.00001;I2=0).

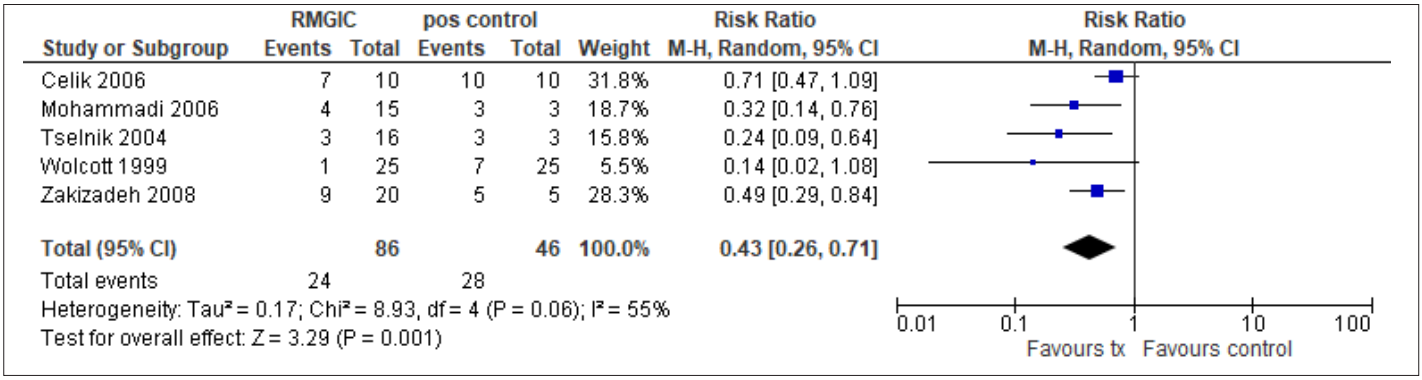
The comparison between materials demonstrates that GIC performs superior to composite resin (RR:0.47;95%CI:0.23-0.97;p=0.04;I2=0). No significant differences were detected between GIC, RMGIC and MTA.

Conclusions

Placement of an endodontic orifice barrier is effective in prevention of coronal microleakage. The meta-analysis indicated GIC to be superior to composite resin. There is no significant difference demonstrated between GIC, RMGIC and MTA. Further testing with broth and fluid filtration methodologies comparison presents an opportunity for future research.

References

1. Wu MK, Wesselink PR. Endodontic leakage studies reconsidered. Part I. Methodology, application and relevance. International endodontic journal. 1993;26(1):37-43. doi:10.1111/j.1365-2591.1993.tb00540.x
2. Pommel L, Jacquot B, Camps J. Lack of Correlation among Three Methods for Evaluation of Apical Leakage. Journal of endodontics. 2001;27(5):347-350. doi:10.1097/00004770-200105000-00010
3. Wolcott JF, Hicks ML, Himel VT. Evaluation of pigmented intraorifice barriers in endodontically treated teeth. Journal of endodontics. 1999;25(9):589-592. doi:10.1016/S0099-2399(99)80313-6



Forest plot for coronal microleakage analysis of resin modified GIC against the positive control group using a random effect model. For root canal-treated teeth, the effect for coronal microleakage prevention favours placement of a resin-modified GIC orifice barrier. More specifically, resin modified GIC orifice barrier is associated with the lower incidence of coronal microleakage compared to the positive control without an orifice barrier (risk ratio, 0.43; 95% CI, 0.26 to 0.71) with some concerns of heterogeneity and risk of bias.

Efficiency of clear aligner therapy with and without Dental Monitoring: a randomised controlled trial

Researchers

Jonathan Lam[1], Peter Miles[2], Elissa Freer[1], Karice Hyun[3], Desmond Ong[1]

1. The University of Queensland
2. Private practice
3. University of Sydney

Objectives

The purpose of this 2-arm randomised controlled clinical trial was to assess the effect of Dental Monitoring™ (DM) on the efficiency of clear aligner therapy (CAT) as well as the patient experience, compared to the conventional monitoring (CM) procedure of regularly attended clinical appointments.

Methods

A sample of 56 subjects treated with CAT participated in this randomised clinical trial. They were recruited in a private practice and treated by 1 orthodontist. Randomisation was performed in blocks of 8 patients assigned to either a conventional monitoring group or the DM group with allocations concealed in opaque, sealed envelopes. It was not feasible to blind the subjects or investigators. The efficiency of clear aligner therapy was measured by comparing number of appointments, refinements, total number of aligners, and treatment duration. The patient experience was measured using an 8-question visual analogue scale (VAS) questionnaire.

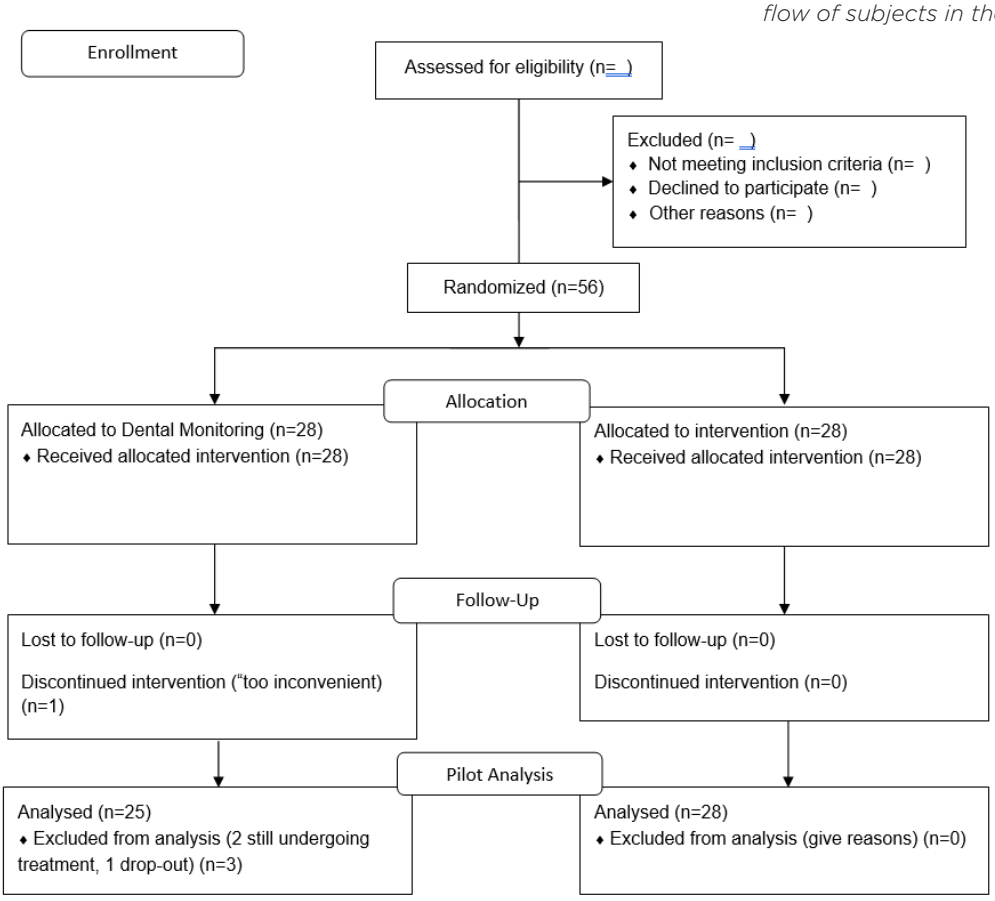
Results

There was no significant difference in the number of refinements (0.1; 95% CI, -0.2, 0.5; P=0.425), number of total aligners (5.8; 95% CI, -2.8, 14.5; P=0.181) and overall treatment duration (1.2 months; 95% CI, -0.7, 3.2; P=0.218). There was a significant difference in the number of appointments, with the DM group requiring 2 fewer visits (95% CI, -3.3, -0.7; P=0.003). There was a difference between study groups regarding the importance of face-to-face appointments, with the DM group not perceiving face-to-face appointments not as important (P=0.030).

Conclusions

DM with CAT resulted in a reduced number of clinical appointments by 2 visits. Both CM & DM groups had similarly high levels of satisfaction with CAT. However, the DM group did not regard in-person clinical appointments as important as the CM group.

CONSORT diagram showing the flow of subjects in the study.



Comparing the dental caries experience of five-year-old children whose mothers were born in Australia versus overseas

Researchers

Nicholas Jin, Erin Giec-Yorston, Sarah Whitehouse, Diep Ha, Claudia Lopez-Silva

School of Dentistry, The University of Queensland

Objectives

The aim of this study was to investigate the prevalence of dental caries and presence of decayed, missing and filled surfaces (dmfs) of five-year-old children (aged 5) whose mothers were born in Australia versus overseas.

Methods

Data on 705 participants from The Study of Mother's and Infants Life Events Affecting Oral Health (SMILE) was analyzed. The main outcomes examined were prevalence of caries and dmfs, with mother's place of birth as the primary exposure. Confounding factors investigated included socioeconomic status, dietary patterns, mother's health behaviours and oral health of the mother and child. Results were adjusted for key characteristics identified in this study, generating the amount of impact of the characteristics on the prevalence and severity of caries in children. Multivariate regression analyses were performed to identify the effect of key characteristics in the population and adjust for them.

Results

In relation to the prevalence of caries in 5-year-old children, characteristics that were statistically significant included mother's country of birth (p=0.013), mother's DMFS (p=0.006) and child's free sugar intake (p=0.039). All other characteristics were not statistically significant (p>0.05). Children of mothers born in India and other Asian countries had a higher prevalence of caries than Australia/New Zealand/UK (35.4% and 34.2% compared with 21.0%, respectfully). Regarding the severity of caries in 5-year-old children, characteristics that were statistically significant included household yearly income (p=0.004), maternal age (0.029), and maternal DMFS (0.000). All other characteristics were not statistically significant (Table 1).

Conclusions

This study suggests that maternal country of birth, maternal DMFS, and child's free sugar intake influence the prevalence of dental caries. Additionally, yearly household income, maternal age, and maternal DMFS have an impact on the severity of dental caries. The prevalence and severity of caries in 5-year-old children cannot be rationalized alone by these factors, therefore it can be assumed there are remaining confounding factors that were not accounted for in this study.

3D bioprinted extracellular vesicles for in vitro cell attachment

Researchers

Kexin Jiao, Nimal Thattaruparambil Raveendran, Pingping Han, Sašo Ivanovski

School of Dentistry, The University of Queensland

Objectives

Bioprinting is a novel method in tissue reaeration and refers to extended three-dimensional (3D) printing or additive manufacturing (AM). Extracellular vesicles (EVs) have outstanding value in a variety of research fields, due to their well-established capacity to promote intercellular communication (Figure a,b) [1]. Existing research recognises that EVs have been incredibly attention as treatments to be utilised for a variety of diseases as well as periodontal disease. Our recently published review evaluated 33 articles that used EVs from periodontal and dental-pulp cells for in vitro and in vivo periodontal regeneration that was in [2]. However, no study used bioprinted EVs for periodontal regeneration. The purpose of the current research was to determine the capability of incorporating bioprinted EVs into tissue engineering.

Methods

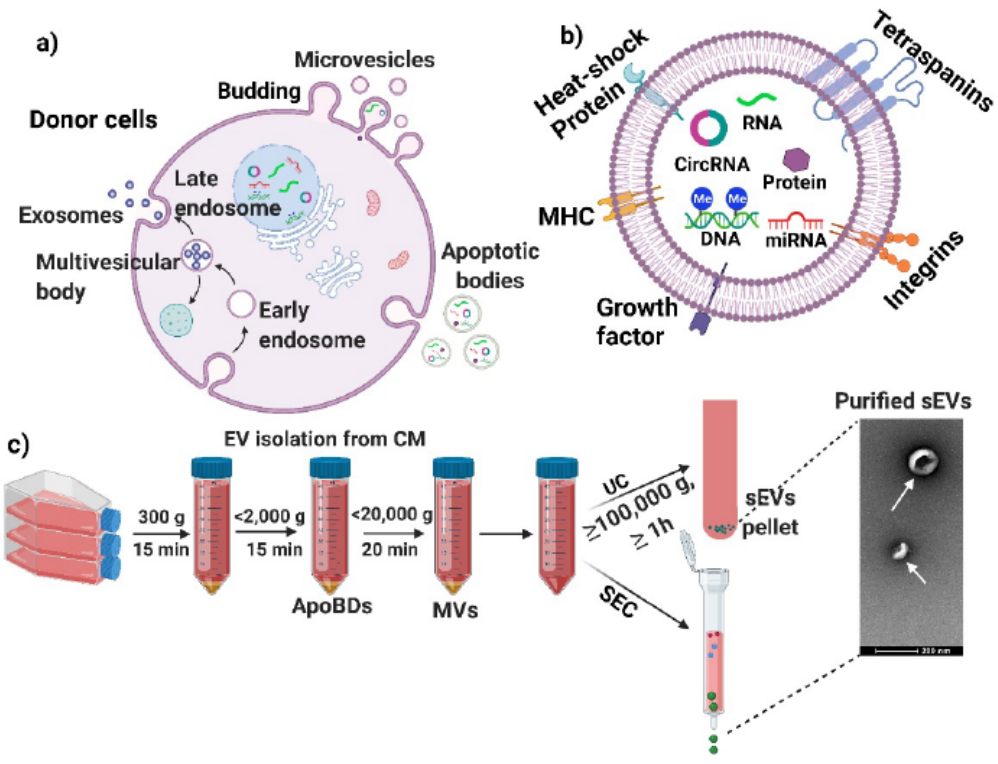
Isolated EVs from three types of periodontal cells (osteoblast, gingival fibroblast, periodontal ligament-PDL) using the method shown in Figure c, then utilized in the creation of bioinks as bio-additives bioprinted scaffold with gelatin methacrylate (GelMA). EVs were characterized through BCA Protein Assay Kit, Nanoparticle Tracking Analysis (NTA), western blot (WB), transmission electron (TEM), and multiplex EVs analysis (MACSPlex Exosome Kit) [1]. PBS was used as a control with GelMA printed and optimized the printability of bioprinted EVs.

Results

EVs have been successfully isolated from three types of periodontal cells, in which NTA identified the particle size of EVs, WB indicated specific protein markers and TEM results illustrated the cup shape or features of the EVs. 37 EVs surface markers were also identified. Confocal images captured the localization of EVs in the bioprinted scaffold, and cell-attached on the scaffold.

Conclusions

Recently investigators have examined that EVs were essential in tissue engineering and regeneration [3]. We successful achieved bioprinted EVs for in vitro cell attachment. Furthermore, it also provides a new approach for the first time by 3D bioprinting technology of EVs obtained from human dental ligaments cells in regenerative medicine. Future reconstruction of the periodontal tissues will be used asa treatment of periodontal diseases in vivo in pre-clincial animal models.



EVs Biogenesis, components, and Isolation method.
a) Biogenesis of Extracellular vehicles (EVs); b) components of EVs; c) Common EVs isolation method using a serial centrifuge and sEVs isolation by either UC or SEC method prior to TEM analysis of sEVs morphology. MHC: Major histocompatibility complex; CM: condition media; ApoBDs: Apoptotic bodies; MVs: Multivesicular body; SEC: Size Exclusion Chromatography; UC: ultracentrifugation.

References

1. Han, P., P.M. Bartold, and S. Ivanovski, *The emerging role of small extracellular vesicles in saliva and gingival crevicular fluid as diagnostics for periodontitis.* J Periodontal Res, 2022. 57(1): p. 219-231.
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3. Romano, M., et al., 2 - *Extracellular vesicles in regenerative medicine*, in *Nanomaterials for Theranostics and Tissue Engineering*, F. Rossi and A. Rainer, Editors. 2020, Elsevier. p. 29-58.

Dentinal tubule penetration and bond strength of 2 novel calcium silicate-based root canal sealers

Researchers

Karissa Shieh, Jack Yang, Elsa Zhu, Ove A. Peters, Sepanta Hosseinpour

School of Dentistry, The University of Queensland

Objectives

This study aimed to assess the penetration of 2 novel calcium silicate-based sealers (CSS) into dentinal tubules in comparison to contemporary epoxy resin-based sealers, as well as correlating that penetration to bond strength to dentinal tubules.

Methods

39 single-rooted premolars were prepared according to the crown-down technique using rotary system TruNatomy™ (Dentsply Sirona) and randomly allocated to be obturated via single cone technique using gutta percha and one of the following sealers (n=3): epoxy resin-based AH Plus (Dentsply Sirona), CSS EndoSequence BC Sealer (Brasseler), and CSS AH Plus Bioceramic (Dentsply Sirona). Each sample was obturated using single-cone technique, then transversely sectioned into 0.14 mm slices. Samples were then separated into 3 groups according to the sealer used. To assess penetration, 3 samples from each group were randomly selected to be obturated with sealer mixed with 0.1% Rhodamine B dye, with each slide individually viewed under CLSM. Sealer penetration area into dentinal tubule was measured by Nikon NIS-Elements Analysis software. The values between groups were statistically compared with Two-way ANOVA (α=0.05).

Results

Penetrability results were similar for both AH Plus Bioceramic and EndoSequence BC sealers regardless of the area of evaluation ($p>0.05$), however, they were significantly greater than control ($p<0.05$). CLSM analysis verified tags formation in all groups. Failure pattern distribution showed the highest adhesive failure in the apical third and cohesive failure in coronal third for all experimental groups.

Conclusions

The penetration of AH Plus Bioceramic and EndoSequence BC sealer resulted in greater penetration and bond strength to the root dentine. There was no significant correlation between the bond strength of the sealers and dentinal tube penetration of them.

Clinical expression of programmed mandibular canine rotation using various attachment protocols and 1- vs 2-week wear protocols with Invisalign® SmartTrack® aligners

Researchers

Caitlin Stephens, Tony Weir, Stacey Llewellyn, Elissa Freer and Brett Kerr

School of Dentistry, The University of Queensland

Objectives

Rotation of rounded teeth, particularly canines, is reported as one of the most difficult and inaccurate tooth movements with aligners.[1-3] This retrospective study aimed to assess the accuracy and reliability of prescribed mandibular canine rotation with Invisalign® aligners, as well as the influence of attachment type and wear schedule on accuracy.

Methods

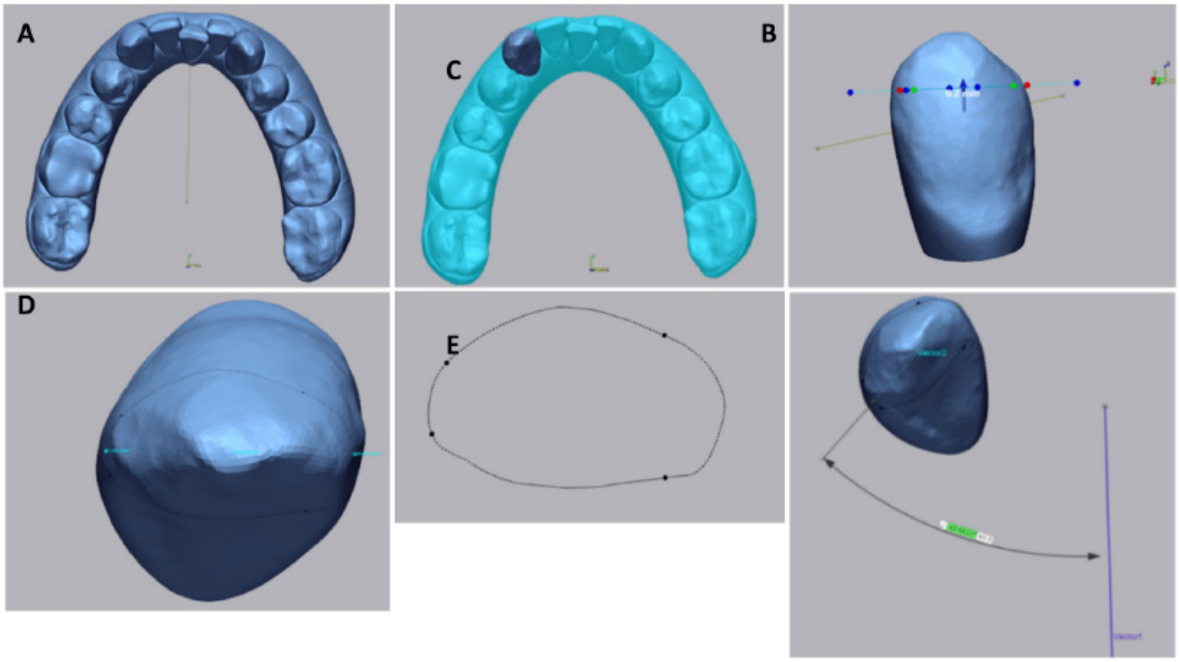
A sample of 75 subjects with lower canines requiring rotation was collected from an existing database. The initial (T1), predicted finish (T2), and achieved finish (T3), were measured using metrology software, and the differences between predicted and achieved mandibular canine rotations were calculated. The sample was divided into 3 groups: optimised rotation attachments using 1-week wear (OR1), optimised rotation attachments using 2-week wear (OR2), and conventional rectangular attachments using 2-week wear (V2).

Results

Rotation was an under-expressed movement, with an overall median sample efficiency of 75.4%. For all groups predicted rotation was not equivalent to achieved rotation at a ±5° equivalence margin. This indicates that none of the Invisalign® SmartTrack® aligner attachment configurations display clinical accuracy in their predicted rotation. By attachment type, median efficiencies of 81.5%, 76.5% and 63.1% were found for groups OR1, OR2, and V2, respectively. By wear schedule, there was no significant difference in efficiency for optimised rotation attachments.

Conclusions

The clinical expression of canine rotation with SmartTrack® aligners is less than the prescribed rotation for all attachment configurations. Vertical rectangular attachments were associated with the least accurate expression of prescribed movement. There was no difference in rotation efficiency between one- or two-week aligner wear.



Method performed on Geomagic Control X® metrology software. A) Constructed midline reference vector. B) Removal of all scan data except canine of interest. C) Measurement of standardised theoretical contact point. D) 2D slice from axial view through the theoretical contact point. E) Canine rotation angular measurement, from canine vector to midline reference vector

References

1. Kravitz ND, Kusnoto B, Begole E, Obrez A, Agran B. How well does Invisalign work? A prospective clinical study evaluating the efficacy of tooth movement with Invisalign. Am J Orthod Dentofacial Orthop 2009;135:27-35. **Online**.
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3. Weir T. Clear aligners in orthodontic treatment. Aust Dent J 2017;62:58-62. **Online**.

Bioinspired mesoporous silica nanoparticles for local plasmid delivery for bone regeneration

Researchers

Huan Dai, Chun Xu

School of Dentistry, The University of Queensland

Objectives

Promoting osteogenic differentiation of mesenchymal stem cells is important for bone regeneration. This study aims to develop a non-virus gene delivery system to deliver bone morphogenetic protein (BMP-2) plasmid for bone repair and test the osteogenic effects in vitro.

Methods

Bioinspired mesoporous silica nanoparticles (MSNs) with virus mimicking morphology were synthesized to achieve high cellular uptake efficacy. The biocompatibility and cellular uptake efficacy are evaluated on preosteoblasts (MC3T3-E1 cells). The effects of BMP-2 plasmid-loaded MSNs on in vitro osteogenesis were tested using RT-qPCR, Alkaline phosphatase (ALP) activity assay and Alizarin red staining.

Results

Bioinspired MSNs exhibited good biocompatibility in cell viability assay and further showed the highest cellular uptake efficiency (74.94%) compared to commercial transfection liposomes (Lipofectamine 3000) and control groups. BMP-2 plasmids can be efficiently delivered into MC3T3-E1 cells by bioinspired MSNs as evidenced by more than 7000 folds increase in BMP-2 mRNA expression level compared to the control group after 28 days. The osteogenic related genes (OCN, RUNX2, ALPL and COLA1), ALP activity and Alizarin red staining also showed high osteogenesis in the plasmid-loaded MSNs group compared to control.

Conclusions

Bioinspired MSNs successfully deliver BMP-2 plasmid into MC3T3-E1 cells and promote osteogenesis in vitro. Our study provides a new strategy using nanoparticles for bone regeneration.

Automatic Metric Comparison of Access Cavities in a Preclinical Setting: Novel Teaching and Feedback Tool

Researchers

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School of Dentistry, The University of Queensland

Objectives

A 3D guided software program was developed provide to visual, guided feedback to students on their molar access cavity preparation in preclinical learning. The specific aim of the study was to investigate students' overall experiences with the new learning method and compared their experiences with traditional teaching.

Methods

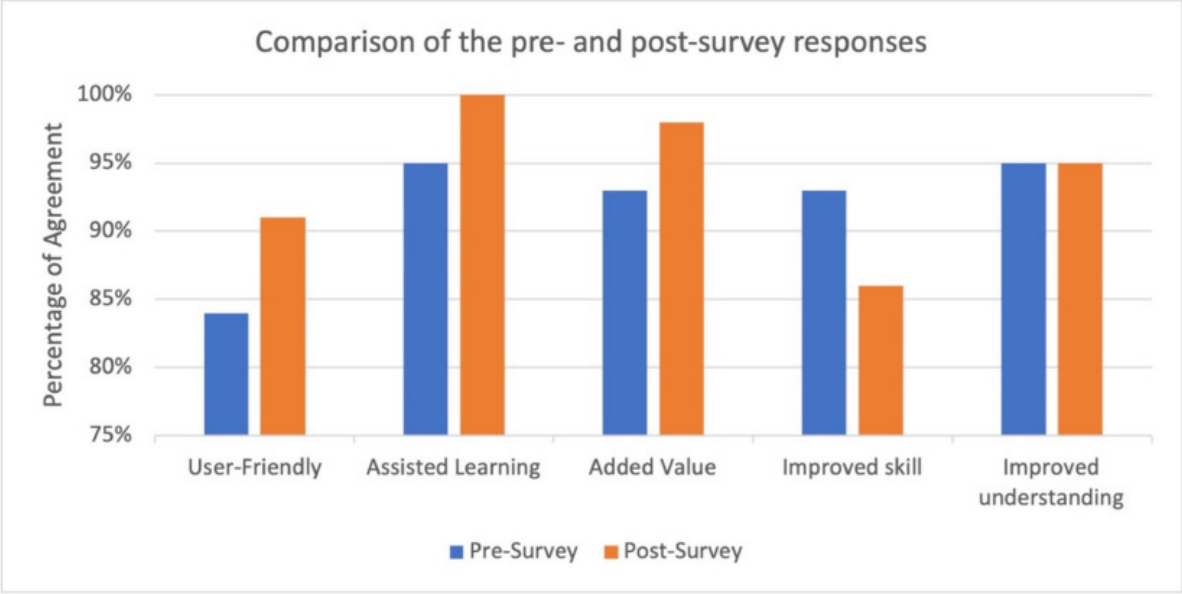
Third-year students enrolled at the dental school practicing molar endodontics access cavity preparation in preclinical labs were invited to participate in the study. A total of 44/79 students completed self-administered questionnaires prior and after the use of the 3D guided software program to gauge their overall learning experience.

Results

The results of the post-training questionnaire illustrated that all surveyed students agreed/strongly agreed that the 3-dimensional Tooth comparison software assisted their learning in access cavity preparation. In addition, 89% of students felt more confident about their access cavity preparation skills after using the 3D Tooth comparison software. The results also demonstrated that 86% of participating students agreed/strongly agreed that the use of 3D tooth comparison software improved their skills of access cavity preparation in a plastic tooth, and 89% of students agreed/strongly agreed that the 3D Tooth comparison software should be an optional part of the dental curriculum for BDSc (Hons) students.

Conclusions

This initial study suggests that the use of intelligent 3D technology software to assist dental students' access cavity preparation learning appears to be a promising, adjunctive method of providing feedback to students.



Paediatric Crowns - Biocompatibility and Acid Resistance Studies

Researchers

Thomas Hogerheyde, Laurence Walsh, Sobia Zafar

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Objectives

Preformed paediatric crowns (PPCs) are indispensable restorations to preserve and protect the primary dentition from dental caries. However, the *in vitro* biocompatibility of established paediatric crown materials remains largely underreported, despite their widespread use. The study aimed to determine the effects of ions released from PPCs in oral cavity, in terms of cell viability, cytotoxicity, and apoptosis. It also determined the effects of three acids commonly found in the diet on PPCs.

Methods

This *in vitro* study compared the viability, cytotoxicity, and apoptosis of PPCs on human gingival fibroblasts (HGFs). The HGFs were grown on the preformed metal crown (PMC) discs, CR (composite resin)-coated wells, and monolithic ZR fragments (zirconia) at 24, 48, and 72 h. Additionally, PPCs were immersed in 0.1% lactic acid, 0.2% phosphoric acid, or 10% citric acid for 7 days at 37oC to reproduce conditions such as diet or gastric reflux. Samples were then subject to inductively coupled plasma optical emission spectrometry (ICP-OES) to quantitate the release of ions.

Results

The viability of HGFs on stainless steel and CR significantly declined at 48 and 72 h, representing potential cytotoxicity ($p < 0.05$). Additional testing found stainless steel and ZR cytotoxicity to be above those of cells cultured on tissue culture plastic (TCP; $p < 0.05$). Both PMCs and ZR crowns gave minimal ion release. Meanwhile, significant quantities of metallic ions, including Cu, Fe, Ni, and Zn, were present in eluates from V-PMCs.

Conclusions

The study showed that PPCs are mildly cytotoxic to HGFs. Whether cytotoxicity is limited to the early phases of growth or continues long-term remains to be determined. The leaching of ions from V-PMCs into acidic solutions raises potential health concerns. In particular, the release of the metallic ions Cu, Fe, Ni, and Zn warrants further investigation.

Gallium-doped Therapeutic Dental Implants

Researchers

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Objectives

Appropriate soft-tissue integration and osseo-integration are crucial to the long-term success of dental implants to prevent the ingress of oral pathogens (1). Nanoscale surface modification of titanium dental implants has shown promising outcomes in achieving enhanced bioactivity and antibacterial efficacy (2). We hereby propose the fabrication of dual micro-nano titania nanopores (TNPs) via electrochemical anodization of Ti, followed by the incorporation of gallium (Ga) towards enhanced antibacterial efficacy, while maintaining the functions of gingival fibroblasts.

Methods

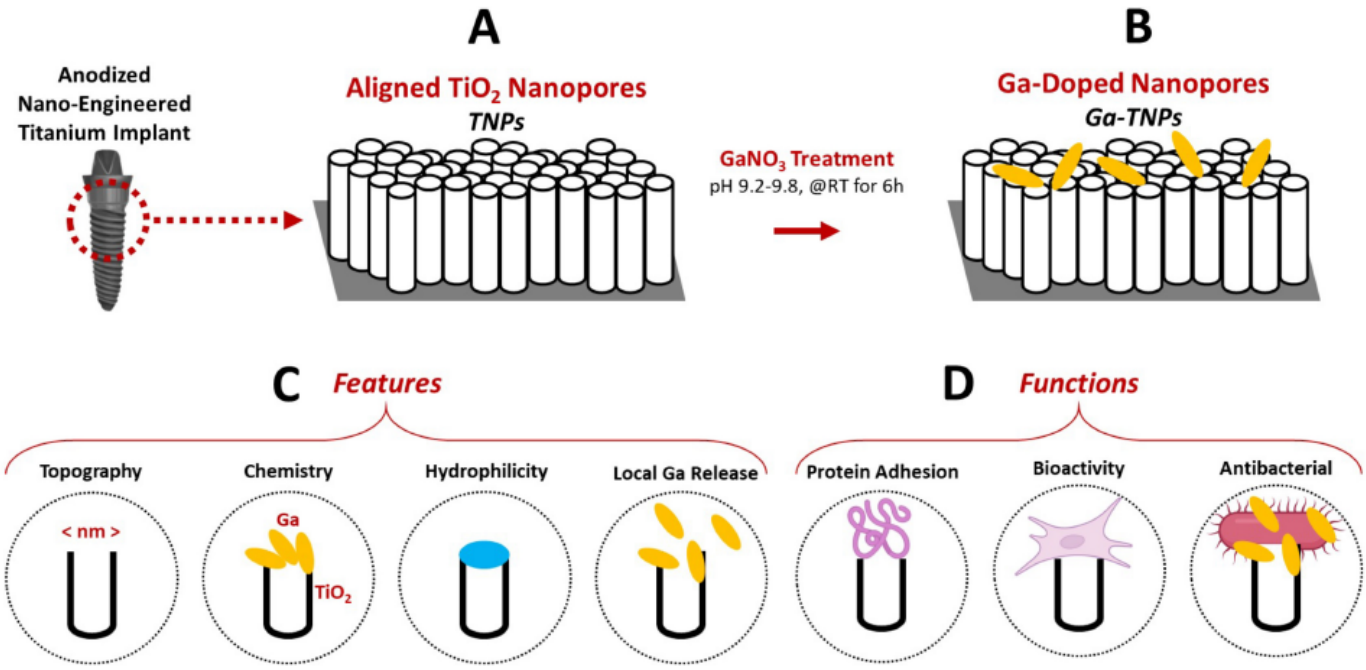
Optimization of chemical functionalization of Ga on TNPs was followed by in-depth surface topographical/chemical characterizations and *in vitro* Ga release. Finally, their bioactivity towards human gingival fibroblasts and oral salivary biofilm was evaluated *in vitro*.

Results

The study revealed that the surface chemistry, hydrophilicity and topography of the TNPs were altered upon Ga-doping, resulting in the formation of Ga-containing nanoscale particulates firmly bound to TNPs. Further, the local release of Ga from TNPs did not cause any toxicity to the fibroblasts, as their favourable bioactivity on TNPs was maintained. Finally, the antibacterial efficacy of Ga-TNPs was evaluated using a human oral salivary biofilm model that confirmed significant antibacterial efficacy against the biofilm.

Conclusions

Ga-doped dual micro-nano Ti dental implants are suitable as the next generation of bioactive and bactericidal dental implants.



***Ga-doped therapeutic dental implants**. Schematic representation of (A) Anodization of Ti implants to fabricate nanopores; (B) Doping of Ga on nanoengineered Ti implants; (C) characteristics of the modified implant; and (D) bioactivity and antibacterial functions.*

Identifying factors that affect dental students' attitudes towards participation in rural and remote clinical outplacements in Australia

Researchers

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School of Dentistry, The University of Queensland

Objectives

To identify factors of dental students' attitudes towards participating in Rural Clinical Outplacement (RCOP) and assess the associations between socio-demographics such as age, gender and background (i.e. growing up in rural or metropolitan setting) on attitudes towards RCOP.

Methods

An online cross-sectional survey was conducted amongst dental students across 7 of the 9 dental schools in Australia. The survey was a combination of close- and open-ended questions on socio-demographic information of the participants and a Likert scale assessing influencing factors grouped into common themes of education, personal/health, social and financial.

Results

Of the 287 responses, 202 (70%) were sufficiently complete for analysis. Growing up in a rural area was the only demographic factor significantly affecting students' desire to attend an RCOP ($p = 0.042$). 88% of students were motivated by a desire to give back to an underserved community; 91% believed that RCOP would provide opportunities to enhance their clinical skills. The majority of students (88%) expressed a desire for more information on RCOP from their university and believed they would require additional financial support for an RCOP (79%).

Conclusions

Overall, despite students' negative opinions on certain social and financial factors, they still held generally positive expectations about the clinical experiences and fulfilling work they would experience whilst on placement. Attitudes were generalized throughout the student population independent of socio-demographics except for rural background during childhood. Universities should aim to promote these educational aspects of RCOP more to further improve students' attitudes prior to attending RCOP, and enable students' desire for more information and involvement in the placement allocation process. This research also supports that universities accepting a proportion of applicants from rural settings may help boost the rural graduate workforce. More research is required into students' concerns regarding financial and social aspects of RCOP.

Participant attitudes towards information and communication regarding RCOP within their university

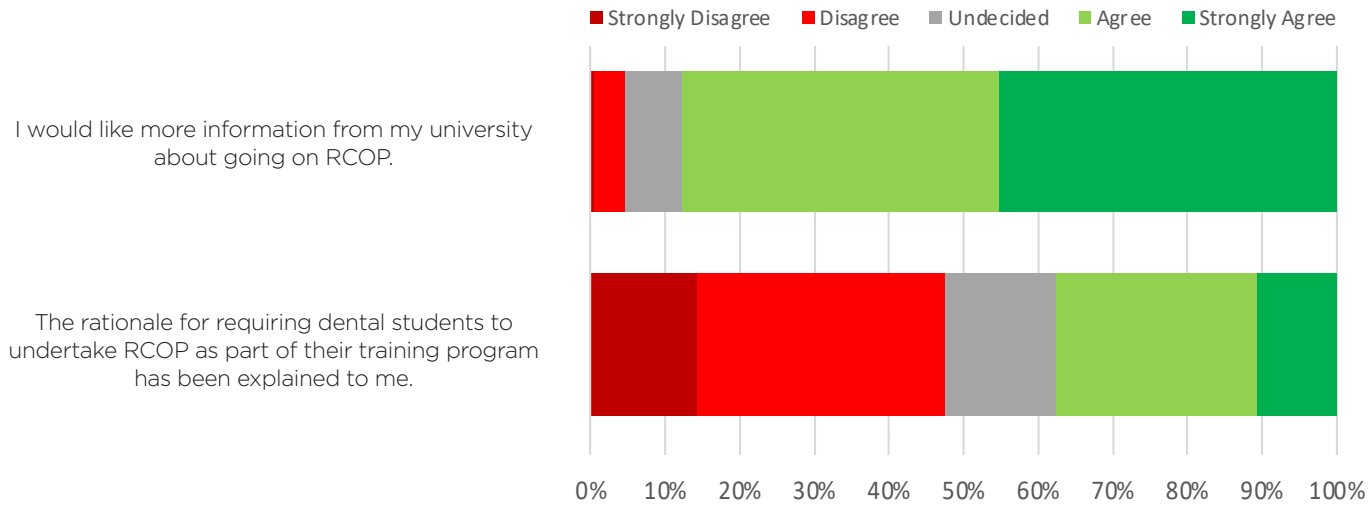

Figure 1 represents participant responses to matrix questions on the Likert-scale regarding information and communication participants received from their universities. Less than 40% of students' felt they had received an explanation of the rationale for RCOP; and 88% wanted more information from their university. This figure demonstrates students' need for more transparent and clear communication regarding RCOP from administrative bodies such as university coordinators and the Australian government.

Using 3D scaffolds to detect salivary immune response after mRNA vaccine

Researchers

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School of Dentistry, The University of Queensland

Objectives

Sensitive detection of immunoglobulin antibodies against SARS-CoV-2 during the COVID-19 pandemic is critical to monitor the adaptive immune response after BNT162b2 mRNA vaccination. Currently employed binding antibody detection tests using 2D microplate-based enzyme-linked immunosorbent assays (ELISA) are limited by the degree of sensitivity.

Methods

In this study, a 3D antibody test was developed by immobilizing the receptor-binding domain on Spike subunit 1 (S1-RBD) of SARS-CoV-2 onto engineered melt electrowritten (MEW) poly(ε-caprolactone) (PCL) scaffolds (pore: 500 µm, fiber diameter: 17 µm) using carbodiimide crosslinker chemistry. Protein immobilization was confirmed using x-ray photoelectron spectroscopy (XPS) by the presence of peaks corresponding with nitrogen. Self-developed indirect ELISA was performed to assess the functionality of the 3D platform in comparison with a standard 2D tissue culture plate (TCP) system, using whole unstimulated saliva samples from 14 non-vaccinated and 20 vaccinated participants (1- and 3- weeks post-dose 1; 3 days, 1 week and 3 weeks post-dose 2) without prior SARS-CoV-2 infection.

Results

The three-dimensional S1-RBD PCL scaffolds, while demonstrating a kinetic trend comparable to 2D TCP, exhibited significantly higher sensitivity and detection levels for all three immunoglobulins assayed (IgG, IgM, and IgA).

Conclusions

These novel findings highlight the potential of MEW PCL constructs in the development of improved low-cost, point-of-care, and self-assessing diagnostic platforms for the detection and monitoring of SARS-CoV-2 antibodies.

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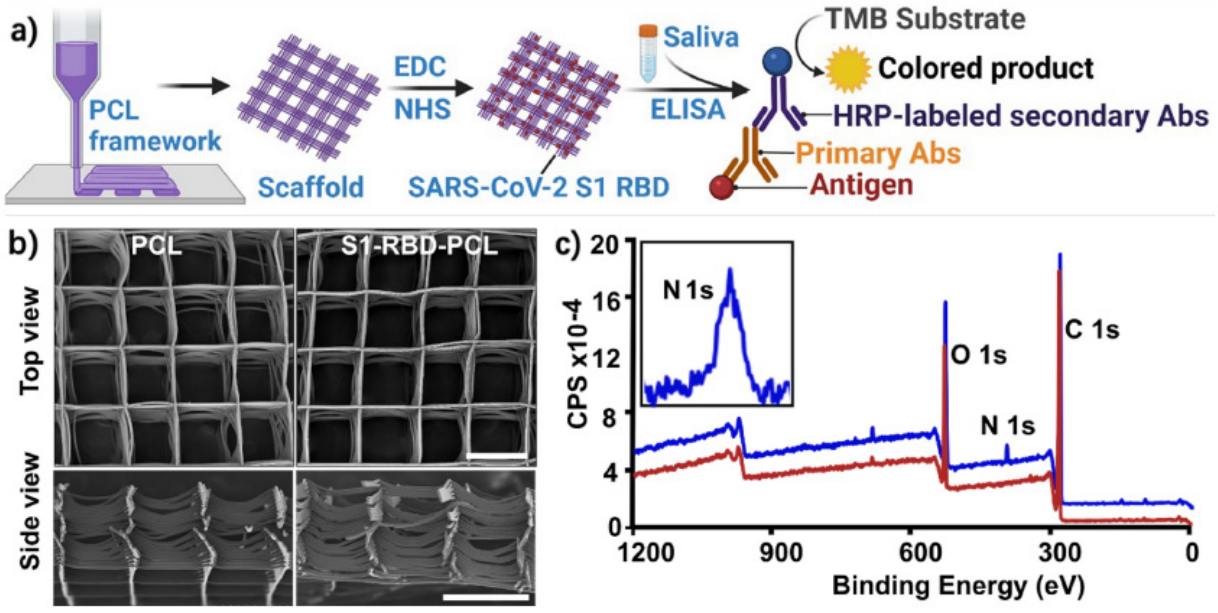

MEW PCL scaffolds as a 3D platform for salivary immunoglobulin antibody detection against SARS-CoV-2 S1-RBD. a) Experimental design of using MEW PCL scaffolds as a substrate to immobilise SARS-CoV-2 S1-RBD protein for salivary antibody detection using indirect ELISA; b) Representative SEM images of PCL scaffolds with and without S1-RBD protein immobilisation; Scale bar: 500µm. c) XPS spectra before and after immobilisation to characterise functionalised PCL scaffolds, with the presence of nitrogen signal.

Effects of the COVID-19 pandemic on the final year dental clinics

Researchers

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School of Dentistry, The University of Queensland

Objectives

This study investigated the impact of COVID-19 on final year dental clinics at The University of Queensland, School of Dentistry. The aims were two folds (1) evaluate the influence of the suspension of student dental clinics, restrictions to dental practice, and reduced patient flow on number of treatments provided by dental students, and (2) assess if the type of treatment rendered to patients by dental students changed during the COVID-19 pandemic.

Methods

Data was collected from clinical logbooks from the cohorts of 2018, 2019 and 2020 regarding the number of each item code performed by each student per month, separated into urban and rural placement locations. Data were analysed using Jamovi and graphed using GraphPad Prism.

Results

On average, the cohort of 2020 performed a reduced number of treatments across all disciplines compared to the cohorts of 2018 and 2019, for students. This difference was greatest in the early stages of the pandemic, from March to May 2020. There were no significant changes in the proportion of treatment for each discipline for the cohort of 2020 compared to the cohorts of 2018 and 2019.

Conclusions

The number of clinical treatments provided by the final year dental students was decreased during COVID-19 pandemic. However, the changes in the proportion of treatment for each discipline was not significantly different compared to pre-COVID years.

Investigation into metal composition of oral piercings and rate of metal dissolution under acidic challenge

Researchers

Manal Masood, Laurence Walsh and Sobia Zafar

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Objectives

Complications with oral piercings can be related to metal ions leaching from oral piercings into surrounding tissues, that cause hypersensitivity reactions and mucosal changes [1,2]. This laboratory study measured ion release from metallic piercings when exposed to organic acids (lactic and citric acids) and inorganic acids (phosphoric and hydrochloric acid).

Methods

Various metallic oral piercings (e.g. barbells and rings), composed of stainless steel, titanium alloys or gold-plated titanium (PVD) were submerged in 2 mL volumes of 0.1% lactic acid, 10% citric acid, 0.2% phosphoric acid (H3PO4) and 0.1% hydrochloric acid (HCl) for 7 and 34 days. De-ionised (DI) water was the negative control. Ion release into the liquid was measured using inductively coupled plasma optical emission spectroscopy, and expressed in relationship to surface area. Surface changes from baseline were assessed using light microscopy and backscatter scanning electron microscopy (SEM).

Results

HCl and phosphoric acid caused the greatest release of ions per surface area. More ions were released at the longer time point of 34 days than at 7 days. Released ions (from highest to lowest) included: Aluminum, Barium, Calcium, Cobalt, Chromium, Copper, Iron, Potassium, Magnesium, Manganese, Sodium, Nickel, Phosphorus, Sulfur, Silica, Titanium and Vanadium. SEM imaging identified qualitative surface changes consistent with corrosion, for the majority of piercing types examined.

Conclusions

Under the exposure conditions used, inorganic acids (such as HCl and phosphoric acid cause greater metal dissolution than organic acids (citric and lactic acids). Inorganic acids from gastric reflux and black cola drinks could therefore pose a risk of corrosion and leaching of ions from metallic oral piercings.

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Understanding the building blocks of UQ School of Dentistry Undergraduate curriculum

Researchers

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School of Dentistry, The University of Queensland

Objectives

To identify and understand issues that the Year 3 to 5 undergraduate dental students encounter in UQ School of Dentistry's curriculum.

Methods

An online survey was distributed to Year 3 to 5 dental students to gather feedback regarding their perception of the curriculum. The questionnaire consisted of three sections, primarily related to: lectures, preclinics, and clinics. The data was analysed using GraphPad Prism.

Results

The response rate of the survey was 22.9%. The issues that were raised by the majority (≥80%) of the students are given below:

a) Lectures: relevance of lecture material (88%), prompt updating of the lecture schedule when required (80%) and support for block teaching (63%).

b) Preclinics: preference for self-directed practice outside of scheduled preclinic hours (97%), preference for more time available to practice before preclinical assessments (76%), and the relative inefficiency of Year 1 preclinics (42%).

c) Clinics: insufficient supervisors (88%), discrepancy in quality of supervision (91%), clinical supervisors should be trained to provide effective supervision as well as teaching (94%), and supervision provided by the postgraduate students was preferred (84%). There was a strong consensus to introduce clinical supervisor evaluation surveys (94%).

Conclusions

The study showed that the current UQ undergraduate dental curriculum has significant room for improvement in all aspects of its delivery – from lectures to preclinics and clinics. Effecting positive change would only be possible with a collaborative effort; both student feedback and staff recognition of these issues are required to identify ongoing problems or areas that are lacking in the current curriculum.

Experimental and finite element analysis of nickel-titanium endodontic instruments

Researchers

Philip Chien, Ove Peters, Laurence Walsh

School of Dentistry, The University of Queensland

Objectives

The present study aimed to examine the mechanical behaviour and cyclic fatigue resistance of nickel-titanium (NiTi) endodontic instrument using both experimental and finite element analysis (FEA) techniques. The study also aimed to critically review the existing literature to improve on previous methodology and suggest future directions and standardised frameworks for the testing of nickel-titanium instruments.

Methods

A literature search was conducted to identify studies that had both finite element analysis of nickel-titanium instrument models. Experimentally, nickel-titanium wire specimens of different metallurgy (Untreated, Gold, Blue, Superflex) were subjected to uniaxial tensile tests in temperature-controlled water baths to determine a stress-strain curves. Differential scanning calorimetry analyses were performed to determine austenitic and martensitic phase transitions. Endodontic instruments with the corresponding metallurgical compositions were subjected to cyclic fatigue testing using a test rig proposed for the ISO 3630-1 standard. 3D models of the instruments and test rig were generated via micro computed tomography (micro-CT) and numerical methods, and an in silico simulation of the cyclic fatigue tests were conducted using finite element analysis, using mechanical constants derived from the uniaxial tensile tests.

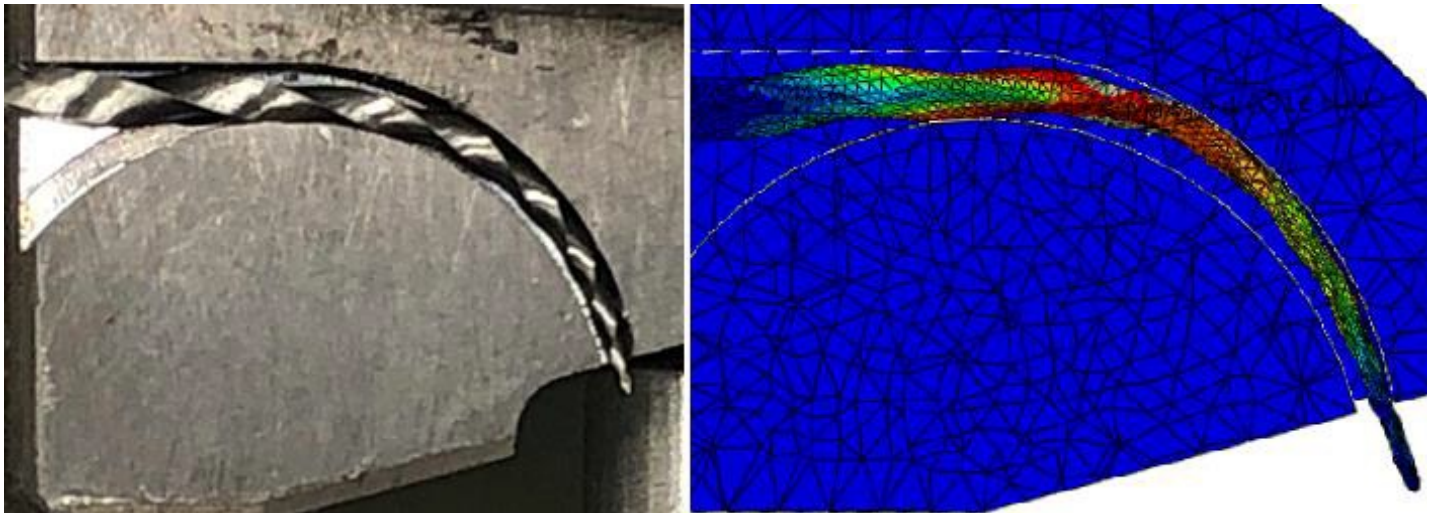
Results

Most previous studies used outdated instrument models or examined unrealistic load conditions. Uniaxial tensile tests revealed different stress-strain curves that were affected by temperature. Data from the cyclic fatigue tests validated the test rig as suitable for the ISO 3630-1 standard. FEA testing replicated some aspects of the experimental fatigue tests but was not able to determine the failure life.

Conclusions

The four NiTi groups examined have different mechanical properties. Extracted data from mechanical testing is suitable as input data for FEA platforms for exploring these instruments in silico, but with limitations. Further research into fatigue criterions will provide a better model for the prediction of the failure life of endodontic instruments.

Comparison of a Profile Vortex *™ instrument under light microscopy (left) vs a finite element model (right).*



Evaluating parental source of information for their child's oral health

Researchers

Gurek Nahal, Rafia Tasneem, Gwen Vo, Christine Peters, Sobia Zafar

School of Dentistry, The University of Queensland

Objectives

To assess child oral health awareness and attitudes of parents towards oral health-related content in a Parent-Held Child Health Record (PHCHR) book in Queensland, Australia.

Methods

Parents and caregivers from a range of childcare locations were invited to complete a questionnaire. Child oral hygiene practices, dietary habits, parental oral hygiene knowledge, and the use of the PHCHR (Red Book) in Queensland was assessed. Microsoft Excel, Jamovi and GraphPad Prism were used for data analysis and graph creation.

Results

A total of 131 participants were recruited to complete a questionnaire. Half of the participants stated that their children brush less than twice a day and have access to sweets most days. Most participants (65%) took their child for a dental visit, however 57% of these children attended their first dental appointment after three years of age. More than half (55%) of the participants do not feel that their child needs to have a dental check-up before their first birthday. When asked at what age they think their child's first dental check-up should be completed, 71% of participants were either not sure or selected after two years. 83% of the participants use the Red Book, however the majority of participants stated that they do not use the book for any oral health-related information. Most of the participants (73%) believe that it is important to participate in an oral health education program for their child's oral health, and more than half of them would like this information provided to them by a dentist.

Conclusions

PHCHR books are received and utilised by many parents throughout Brisbane, however they appear to lack emphasis about the importance of early dental check-ups. Parental oral health knowledge is not satisfactory. Providing a standardised framework for early dental check-ups would help in preventing, identifying and treating caries.

Students' perception of undergraduate education and training in Special needs dentistry at an Australian dental school

Researchers

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Objectives

To obtain an understanding of final year undergraduate dental students' level of confidence and perception of Special needs dentistry (SND) education and training at The University of Queensland (UQ), and their willingness to treat individuals with special needs.

Methods

Fifth year undergraduate dental students at UQ were invited to complete a 56-item questionnaire. Self-reported confidence in theoretical knowledge, pre-clinical training, clinical observational experience and clinical training in SND were assessed, as well as participants' level of willingness to treat individuals with special needs. This information was recorded using a five-point Likert scale. Microsoft Excel, Jamovi and GraphPad Prism were used for data analysis and graphs.

Results

A total of 65 students from the 2021 and 2022 cohort in UQ BDSc(Hons) completed the questionnaire. The response rate was 41.4%. Most participants (83.1%) reported that they have not received training in SND in a simulated environment. A high percentage of participants (69%) felt they have not received sufficient clinical experience in SND. Students reported to be the least confident in performing dental extractions (56.9%) and dental trauma management (67.7%) in patients with special needs. Nevertheless, 46.2% of participants indicated they were willing to provide dental treatment to individuals with special needs after graduation. Lack of confidence and case complexity concerns were frequently mentioned as reasons for students' unwillingness to treat individuals with special needs.

Conclusions

Overall, students reported a low level of confidence in providing treatment to patients with special needs. Many students expressed the need for more observational experience with specialists or post-graduate students in SND, as well as more exposure to patients with special needs through case study and clinical training.

Surface Modification of Biodegradable Zinc by Acid Etching: Enhanced Corrosion Rates, Biocompatibility, and Antibacterial Characteristics

Researchers

Enmao Xiang

School of Dentistry, The University of Queensland

Objectives

Zinc (Zn) has recently been identified as an auspicious biodegradable metal for dental implants and devices due to its tunable mechanical properties and good biocompatibility[1]. However, the slow corrosion rate of Zn in a physiological environment does not meet the requirements for biodegradable implants, hindering its clinical translation[2]. The present study aimed to accelerate the corrosion rate of pure Zn by utilizing acid etching to roughen the surface and increase the substrate surface area.

Methods

The effects of acid etching on surface morphology, surface roughness, tensile properties, hardness, electrochemical corrosion, and degradation behaviour, cytocompatibility, direct cell attachment, and biofilm formation were investigated.

Results

Interestingly, acid-treated Zn showed an exceptionally high rate of corrosion (~226-125 µm/year) compared to untreated Zn (~62 µm/year), attributed to the increased surface roughness (R_a ~ 1.12 µm) of acid-etched samples. Immersion tests in Hank's solution revealed that acid etching accelerated the degradation rate of Zn samples. *In vitro*, MC3T3-E1 cell lines in 50 and 25% conditioned media extracts of treated samples showed good cytocompatibility. Reduced bacterial adhesion, biofilm formation, and dispersion were observed for *Staphylococci aureus* biofilms cultured on acid-etched pure Zn substrates.

Conclusions

These results suggest that the surface modification of biodegradable pure Zn metals by acid etching markedly increases the translation potential of zinc for various dental and biomedical applications.

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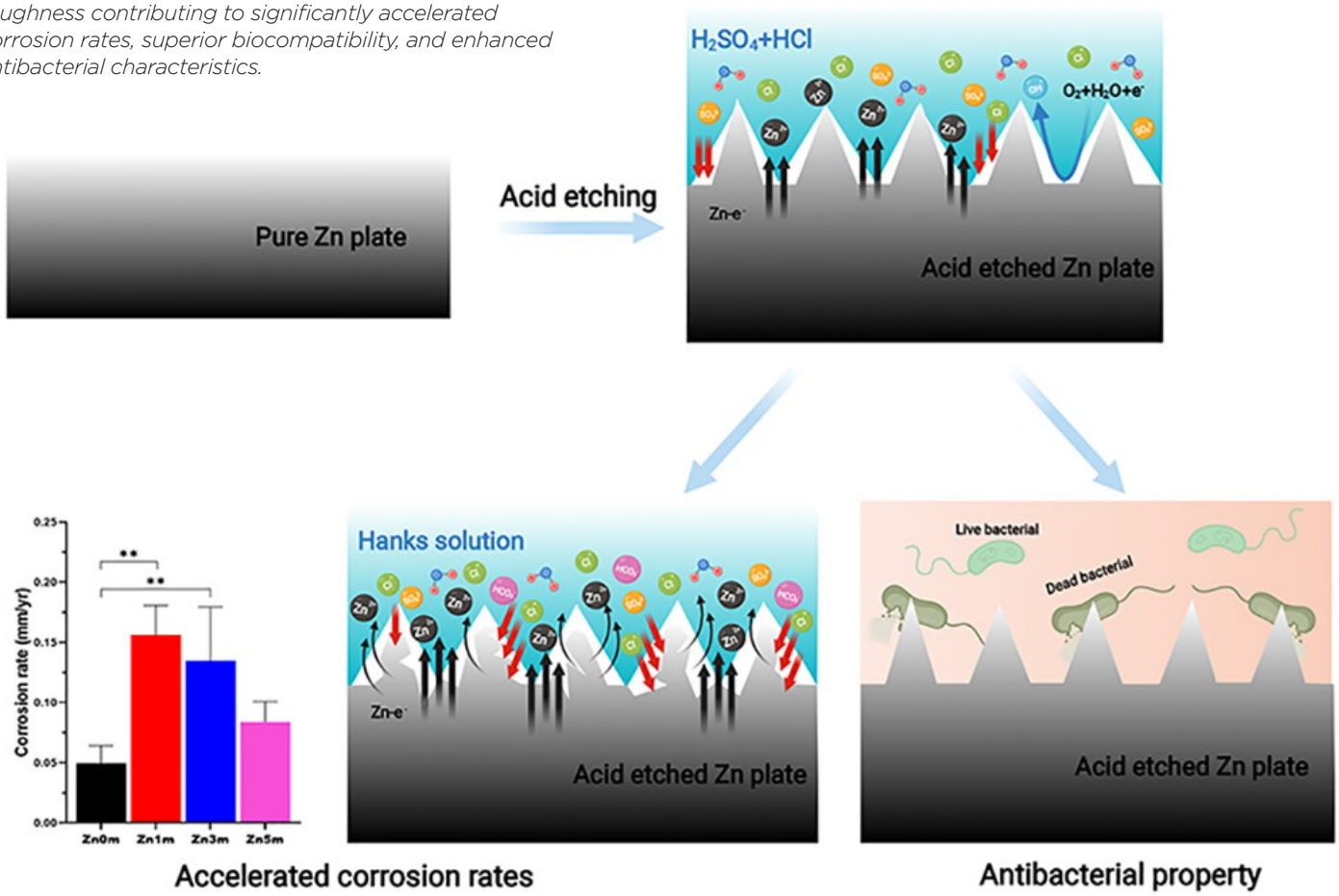
The acid-etched Zn substrates exhibited higher surface roughness contributing to significantly accelerated corrosion rates, superior biocompatibility, and enhanced antibacterial characteristics.



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