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The academic year 2004 marked a milestone in the history of the Faculty of Dentistry when it received dedicated research laboratory space and facilities for the conduct of dental and oral health research. The new research laboratory provides a home for staff and students where fresh ideas sprout and thrive. The direction of dental research is focused and targets five key areas that translate into improving the status of oral health and the delivery dental care. The Faculty of Dentistry has also grown its share of competitively secured funding for research. The number of graduate research students have increased, especially PhD candidates.

While research is often discussed around data, dollars, space, and impact factor, this Research Report will also provide an important and unique perspective about the research work of individuals that drive the Faculty’s mission of research, and showcases projects that ultimately impact the lives and health of our patients.

Kelvin W. C. Foong
Vice-Dean (Research)
Major Achievements: This research project aimed to determine the effect of laser in preventing enamel erosion as well as identify an optimal set of laser parameters for this purpose. Recent studies conducted in vitro and in vivo have demonstrated that low-energy erbium lasers are capable of enhancing acid resistance of enamel for potential caries inhibition. However, evidence of the preventive effect of this particular type of laser on enamel erosion is unclear due to a lack of published studies. The Er: YAG laser was the first laser system approved for hard-tissue procedures by the Food and Drug Administration in 1997 and it would be beneficial if sub-ablative low-energy Er: YAG laser can be shown to prevent enamel erosion.

A tooth was mounted on a stage and the exposed enamel lased with a pulsed Er: YAG laser (Fotona Fidelis, Ljubljana, Slovenia), 2Hz at a subablative energy density of 5.1 J/cm² with water cooling. The distance between the laser handpiece and the tooth was kept at a distance ensuring the laser spot size was 1 mm. The tooth was moved by setting the stage so that there was no overlap of the lased spots.

The results of this study showed that Er: YAG laser has the potential to reduce enamel erosion to acidic beverages but the continued exposure to erosive acid challenge may reduce this protective effect of the laser. The study was also able to identify a set of laser parameters for preventing enamel erosion without adversely affecting the enamel surface.

A representative polarized light microscopy image of an enamel section with erosive areas delineated by the original enamel surface (on top) and the eroded surface (below) within a pre-selected 100 µm wide box. On the left is the lased area and the right the unlased area.

Major Achievements: This project was the Principal Investigator’s and the Faculty of Dentistry’s first attempt to develop the important area of three-dimensional research for orthodontic and craniofacial applications. It has resulted in significant achievements in the areas of (i) core capabilities in 3D image processing and visualisation, and (ii) 3D applications developed in this research for potential clinical usage. The noteworthy applications that were developed include a software application suite for:

(i) Morphometric and space analysis of dental crowding from the 3D images of dental models
(ii) Morphometric analysis of cleft palate shape
(iii) Growth modelling of cleft palate shape
(iv) Tooth segmentation and computer-aided virtual tooth movement (Tooth movement simulator)

The ultimate aim of the research programme in 3D imaging is to develop a virtual human head that is patient-specific and acts as a virtual double of each patient that would facilitate treatment planning, as means of assessing treatment outcome, and assist the clinician in the course of treatment.
Major Achievements: This research introduces a bioengineering term to implant dentistry defined as critical bending moment (CBM). This is the bending moment at which the external non-axial load applied overcomes screw joint preload and causes loss of contact between the mating surfaces of the implant screw joint components. When the screw joint opens asymmetrically from an eccentrically applied load, the additional external load will be resisted by the screw shank. The asymmetric stress induced predisposes the screw shank to earlier failure. The methodology developed in this research allows confirmation of the gap opening of the screw joint for the test groups and determination of CBM under different experimental variables. CBM was found to differ by abutment system, implant diameter and torque level. This study was able to report actual CBM measurements in the dental literature for the first time. Dental Implant systems in clinical use exhibit significant differences in terms of system characteristics like screw preload levels, area of component interface contact, screw joint characteristics. The expected variation in CBM in these systems can now be directly measured utilising the methodology developed in this study. The level of bending moment at which this critical overload occurs for a particular abutment systems would be of great significance in designing and specifying biomechanical situations that minimize risk for prostheses in function, especially single-tooth implants.
MAJOR ACHIEVEMENTS OF RESEARCH PROJECTS
COMPLETED IN FY2004

Principal Investigator: Prof Chew Chong Lin
Title: Noise Reduction of High Speed Turbine Handpiece
Total Project Value: $17,000

**Major Achievements:** Noise generated from high speed dental handpieces have been an age old problem for both the patients and dentists. It has been made apprehensive to dental treatment and it also has adverse effects on the hearing capacity of the dentists. The sources of noise from dental handpiece during operation are: a) the air nose emitted by the drive air for the air turbine b) the mechanical noise from the rotation of the air turbine and c) the air discharge noside from the air and water coolant.

The project identified the major sources of noise from high speed handpiece and a simple method to reduce noise generated by the handpiece. The method developed has industrial value and the Principal Investigator is sourcing an industrial partner to license our noise control measure.
MAJOR ACHIEVEMENTS OF RESEARCH PROJECTS
COMPLETED IN FY2004

Major Achievements: The methodology developed and validated in this study allows better prediction of long-term clinical longevity of osseointegrated dental implant prostheses. Rotational load fatigue testing of dental structures is a niche area in dental research. This in-vitro method of determining load-fatigue performance has the potential of predicting possible mechanical complications and component failure that affect the clinical longevity of single-tooth implant systems as load fatigue performance testing is more relevant compared to the gross monotonic load to catastrophic failure of traditional dental testing. This test methodology is also in compliance with latest US Food and Drug Administration testing protocol requirements.

The study shows that for single-tooth clinical situations with significant functional loading, narrow diameter implants would be at significantly greater risk of fatigue failure. The single-tooth wide diameter CeraOne system demonstrated the best in-vitro load fatigue performance. Precautions for handling of components by technicians and clinicians were highlighted by the failures types observed in this study and failure mechanisms postulated. Inadvertent damage to abutment screws, inappropriate tightening leading to roughening of component surfaces and damaged threads, machining defects and errors during manufacture are all implicated as potential initiation points and mechanisms for the fatigue failures observed.

When different implant-abutment interface systems and abutment screws (design, material and coatings) were compared, it was evident that none of the systems tested were immune from fatigue failure. External hex, cam-tube and cone-screw interface systems all experienced fatigue failures. The study has revealed several potential design weaknesses in all the systems. We were able to test some of the latest systems introduced into the market. In some cases, screw-loosening preceded the eventual fatigue failure, leading to the conclusion that the overall system design with all components considered is critical. Correlation with actual clinical complications of implant systems in service will confirm the findings. New insights obtained could lead to the development and design of superior implant-abutment systems, possibly leading to new design patents.

Principal Investigator: Assoc Prof Keson Tan Beng Choon

Title: Load Fatigue Performance of Implant Abutment Combinations

Total Project Value: $94,818

SEM of fractured implant. Fracture from cyclic fatigue failure occurred at the start of the self-tapping notch (arrows) - Regular Diameter Nobel Biocare implant fixture.

SEM at higher magnification of boxed area showing fatigue striations (arrows) indicating fatigue failure.
Major Achievements: This project has identified appropriate parameters for Er:YAG laser to enhance the fluoride uptake in enamel and root. The identified low-energy laser treatment can substantially enhance the fluoride deposition into the enamel crystalline structure, in addition to the increased fluoride deposition on the enamel surface. In root, the laser effect is more pronounced on the crystalline F-uptake, compared with that in the enamel. As to the loosely bound F-uptake on the root surface, the increase is about 37%. The crystallographic data indicated that the fluoride uptake has enhanced the crystalline stability with a significant reduction of a-axis. Micro-Raman spectroscopic evaluation suggested that the laser treatment, finished in seconds, may have a greater effect on the enamel crystallinity than that of a “72-hour” topical fluoride treatment. The reduction of type-A and type-B carbonates in the enamel treated with the laser-F combined therapy is remarkable, indicating a purification of enamel structure and the increase of its acid resistance. This research has provided unequivocal and clinically relevant evidence elucidating an important role of laser in enhancing fluoride-uptake and preventing tooth decays.
**Problems:** Recently the prevalence of enamel erosion caused by acidic beverages has increased substantially. The objective of this study is to evaluate the preventive effect of Er:YAG laser (PE-laser) on enamel demineralization and erosion caused by these beverages.

**Methods:** Six sound premolars were selected, varnished, each with 1 buccal window (4X2mm) exposed. Er: YAG laser treatment (5 J/cm², 3Hz for 3s, 1mm² spot) was done on one half of each window, leaving the other half untreated. The teeth were then sectioned and subjected to a 24-hour pH cycling regime with 6-hour demineralization (using Ribena®, Coca-Cola® and Peel Fresh®) and 6-hour remineralization for each cycle. The demineralization and erosion depth of sections were evaluated using stereomicroscopy and polarized light microscopy. One-sample t-test, ANOVA, and Kolmogorov-Smirnov tests were employed to assess the PE-laser on enamel demineralization and erosion.

**Results:** Er:YAG laser treatment has significantly reduced the amount of demineralization and erosion of enamel caused by all three acidic beverages (all p<0.002). The PE-laser on erosion was more marked in Coca-Cola® when compared with the other two beverages (both p<0.002); however, the PE-laser on demineralization caused by the three beverages was similar (p=0.786). In conclusion, Er:YAG laser treatment may be promising in preventing enamel demineralization and erosion caused by acidic beverages.

**Students:**
Low Jiun Sian, Ngauw Njuk Khim, Angela, Wong Li Beng and Lum Jing Li

**Title:**
Preventive Effects of Er:YAG Laser on Enamel Demineralization and Erosion caused by Acidic Beverages.

**Supervisor:**
Assoc Prof Stephen Hsu Ching Ying

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**Drink** | **Demin Depth (µm)** | **Erosive Depth (µm)**
--- | --- | ---
| | Lased surface | Unlased surface | Change in lesion depth | Lased surface | Unlased surface | Change in lesion depth |
--- | --- | --- | --- | --- | --- | --- |
1 | 44.84 (SD 19.27) | 88.18 (SD 20.01) | 43.34 (SD 30.56) | 56.71 (SD 18.72) | 67.63 (SD 16.60) | 10.92 (SD 8.11) |
2 | 135.50 (SD 21.84) | 170.06 (SD 31.59) | 34.56 (SD 14.91) | 106.83 (SD 41.13) | 139.26 (SD 43.99) | 32.43 (SD 17.09) |
3 | 41.33 (SD 9.777) | 67.91 (SD 8.428) | 26.59 (SD 9.709) | 23.00 (SD 11.27) | 31.72 (SD 7.084) | 8.718 (SD 7.048) |
The classic palatal surgery for closure of cleft palate defect involves undermining the palatal mucosa, swinging it medially to cover the defect of the palatine part and leaving the donor area with exposed bone for the mucoperiosteum to heal secondarily that eventually undergo wound contraction and scarring.

It has been supposed that myofibroblasts are involved in the contraction of dermal as well as palatal wounds. A marker of the myofibroblastic phenotype, which is present during wound healing is the expression of alpha - smooth muscle actin in the fibroblasts. Reducing the number of myofibroblast during palatal wound healing may decrease wound contraction and thereby reduce the impairment of maxillary and dento-alveolar growth and development.

Palatal scarring has been studied mainly in animal models. The scar tissue is characterized by an elevated amount of transversally oriented collagen type I fibers, a decreased amount of collagen type III fibers, increased alpha smooth muscle actin and by a lack of elastin. These characteristics indicate that the tissue is more rigid than normal mucoperiosteum. A modulation of the mentioned characteristics towards a more normal situation might reduce the unfavourable effects of scarring on maxillary growth and dento-alveolar development.

Corticosteroids are known to reduce collagen synthesis in vitro. Corticosteroids are the standard treatment for fibrotic and scar conditions in skin. However, reports are mainly confined to application in skin. The effects of intralesional steroids on palatal mucoperiosteum is still unknown as there is no study that looked into that.

The goal of this study is to analyse the effects of intralesional corticosteroid on mucoperiosteal wound healing process in 24 five-weeks old rats. The rats were divided into steroid injected treated groups, normal saline injected treated groups and non injected groups. They were then sacrificed at 8 and 42 days and stained for alpha-smooth muscle actin, type I and III collagen and measurement of the wound margin were done under light microscope.

The steroid injected treated groups have lower alpha-smooth muscle actin, type I and III collagen compared with the other 2 groups, of which the differences for alpha-smooth muscle actin and type III collagen were statistically significant despite the small sample size. The steroid treated group also had lesser wound contraction. This may imply that intralesional steroid can reduces the amount of wound contraction and scarring in cleft palate repair.

**ENTREPRENEURIAL THRUST**

A Tripartite Collaboration between Government, NUS and Industry

A joint industrial collaboration between Rapid-Tech Pte Ltd and Faculty of Dentistry, entitled ‘In-vitro and In-vivo testing of Bio-scaffold for Bone Reconstruction and Implants’ received $700,000 in April 2005 from The Enterprise Challenge, Prime Minister’s Office. The Faculty of Dentistry is the co-proposer of the project, represented by Dr Victor Tan and Dr Cao Dong, with the Industry & Technology Relations Office, NUS as the piloting agency. Benefits arising from the success of the project would be multi-fold, contributing towards more indepth knowledge of bone augmentation in dental implantology and making a landmark in reconstructive surgery of the jaw. Subsequent commercialization of the bio-scaffold products could arise and NUS would share the resulting intellectual property rights.
RESEARCH HIGHLIGHTS

BIOMERS: AN AWARD-WINNING START-UP COMPANY

The company BioMers, was initiated by Ms Karen Teo, a research assistant of Restorative Dentistry, Faculty of Dentistry and Ms Renuga Gopal, a PhD student of Mechanical Engineering together with 3 members from the Centre for Scientific Enterprise, UK, to develop and market aesthetic orthodontic archwires and brackets. The team plans to produce some 200 wires for clinical use as a pilot project prior to carrying out a clinical trial.

Beating 300 other international entries, BioMers won the top prize of $30,000 and the Best Executive Summary at the prestigious Start-Up @ Singapore Competition 2005. The team also received Honorable Mention with a US$500 cash prize at the Pacific Specialty Insurance International Business Plan Competition held in the University of San Francisco. The team will also represent NUS in the World Championship of Business Plan competitions at “Global Startup @ Standford” in January 2006 at Standford University, USA.

A full US patent application under “Fiber–Reinforced Composite Product with Flexible Longitudinal Geometry” has been submitted for the archwire and bracket. They have been published on the United States Patent and Trademark Office website. The team will also be registering its patents in Japan, China, India and Europe.

These achievements are spin-offs of the research project, “Development of a Fiber Reinforced Polymer Orthodontic Bracket and Arch Wire” whose Principal Investigators is Professor Chew Chong Lin, Faculty of Dentistry with Co-principal Investigator Professor Seeram Ramkrshina, Faculty of Engineering. Both professors were appointed Directors of BioMers.

NEW RESEARCH INITIATIVE

The research programme on “Graded Porous Bioscaffolds for Tissue Repair”, received the in principle approval of the Biomedical Sciences Proof-of-Concept Scheme, Economic Development Board. This is a joint collaboration amongst SIMTech, A*STAR and Faculty of Dentistry, NUS. Dr Cao Tong and Dr Victor Fan represent the Faculty as the co-principal investigators of the Programme.

The biocompatible and biodegradable scaffold is made up of the Food & Drug Administration (US) approved clinical Poly-Lactic Co-Glycolic Acid bio-copolymer, fabricated through the rapid prototyping 3D printing based on CT/MRI data.
Dr Cao Tong and his stem cell group have successfully differentiated pluripotent human embryonic stem cells into specialised osteogenic and chondrogenic cells capable of growing into mature bone and cartilage tissue. These human embryonic stem cells derived bone and cartilage cells are unlimited, stable and ideal sources of genetically young and healthy bone and cartilage forming cells.

The major potential applications of these cells are: (1) Toxicity screening tests of biomaterials and drugs for bone and cartilage; (2) Cell transplantation based bone and cartilage regeneration and reconstruction; (3) Cell injection therapy for bone and cartilage repair; (4) Gene/protein delivery therapy to cure bone and cartilage lesions; (5) Study of genetic and developmental mechanisms relating to bone and cartilage biology and physiology; (6) Study of genetic and developmental disorders of bone and cartilage disease; and (7) Drug discovery and development of bone and cartilage disease.

**Principal Investigator:** Dr Cao Tong

**Group Members:**
Dr Heng Boon Chin, Mr Ye Chaopeng, Dr Liu Hua, Mr Toh Wei Seong

**Collaborators:**
Dr Lawrence W. Stanton, Dr Paul Robson, Prof Hong Yunhan

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**A:** Sphere aggregation of human embryonic stem cells in suspension culture.

**B:** Attachment and migration of human embryonic stem cells during early stage of differentiation.

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**A:** Bone-specific Alkaline Phosphatase fluorescent (red) stained human embryonic stem cell derived bone cells and STRO-1 fluorescent (yellow-green) stained human embryonic stem cell derived mesenchymal precursor cells.

**B:** Osteogenic nodule structure with human embryonic stem cell derived bone cells with FDA (green) and PI (red) stained under confocal laser microscope.

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**A:** Osteopontin fluorescent (green) stained human embryonic stem cell derived cartilage cells.

**B:** Collagen-II fluorescent (red) and DAPI (purple) stained human embryonic stem cell derived cartilage cells.

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**A:** Osteopontin fluorescent (green) stained human embryonic stem cell derived cartilage cells.

**B:** Collagen-II fluorescent (red) and DAPI (purple) stained human embryonic stem cell derived cartilage cells.
## International Awards

<table>
<thead>
<tr>
<th>Department: Dean’s Office</th>
<th>Award</th>
<th>Awarding Agency</th>
<th>Details</th>
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<tbody>
<tr>
<td>Prof Teoh Swee Hin, A/P D.W. Hutmacher, Dr Cao Tong and A/P Ho Kee Hai.</td>
<td>Cash prize: $100 at Graduate Programme in Bioengineering Academic Conference, Singapore, 6 August 2004.</td>
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<tr>
<th>Department: Preventive Dentistry</th>
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<th>Awarding Agency</th>
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<tbody>
<tr>
<td>Dr Zou Xiao Hui</td>
<td>Travel Award on 6 August 2004</td>
<td>Society for Glycobiology</td>
<td>Paper entitled: “Analysis of the Effects of Heparin Sulphation Patterns on Palatal Fibroblast Activities.”</td>
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<tr>
<td>A/P Kelvin Foong, Dr Cao Tong, A/P Bay Boon Huat, Prof Zhou Yi Fa and Dr George Yip</td>
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<tr>
<th>Department: Restorative Dentistry</th>
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<tr>
<td>Ms Teo Chieh Yin, Karen</td>
<td>Top prize and Best Executive Summary at Start-Up@Singapore. S$30,000 prize.</td>
<td>National University of Singapore</td>
<td>Business plan to develop and market a set of almost invisible braces that work just as well as the conventional ones.</td>
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<tr>
<td>Team-Members:</td>
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<tr>
<td>Ms Renuga Gopal, Dr. Fathianathan Mervyn and Mr. George Aliphtiras</td>
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<tr>
<td>Ms Teo Chieh Yin, Karen</td>
<td>Best Elevator Pitch at the University of Oxford Business Plan Competition</td>
<td>University of Oxford</td>
<td>Business plan to develop and market a set of almost invisible braces that work just as well as the conventional ones.</td>
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<td>Ms Teo Chieh Yin, Karen</td>
<td>Honorable Mention with a US$500 cash prize at the Pacific Specialty Insurance International Business Plan Competition</td>
<td>University of California, San Francisco</td>
<td>Business plan to develop and market a set of almost invisible braces that work just as well as the conventional ones.</td>
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## Regional Awards

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<tr>
<td><strong>Department: Oral And Maxillofacial Surgery</strong></td>
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<td><strong>Department: Preventive Dentistry</strong></td>
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<tr>
<td>A/P Stephen Hsu, <strong>Co-Authors:</strong> Dr V Girija</td>
<td>Best Paper Award.</td>
<td>International Association for Dental Research (South East Asia Division)</td>
<td>Paper entitled: “Preventing Root Caries with combined Er: YAG Laser and Fluoride treatment.”</td>
</tr>
<tr>
<td>Dr Ng Yuk Ching, Dr Selvajothi d/o Veerasamy, Dr Sng Hong Cheong, Dr Wee Chun Kheng, Dr Zheng Hongyan,</td>
<td>1st Place at Dentsply Asia Student Clinicians Competition</td>
<td>International Association for Dental Research (South East Asia Division)</td>
<td>Project entitled: “In Situ Evaluation of Laser Effect on the prevention of Enamel Demineralisation Using an Intra-Oral Model.” The winning team represents South-East Asia at the International Dentsply Student Clinician Programme at American Dental Association in annual meeting in Sept 2004. This is a significant honour for NUS, indicative of the high level of quality in research achieved in undergraduate UROP projects.</td>
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<tr>
<td><strong>Supervisors:</strong> A/P Stephen Hsu, A/P Keng Siong Beng</td>
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<tr>
<td>Dr Woo Mei Yee, <strong>Co-Authors:</strong> A/P Kelvin Foong, Dr Chan Yiong Huak</td>
<td>Best Paper Award.</td>
<td>International Association for Dental Research (South East Asia Division)</td>
<td>Paper entitled: “Light Based Visualisation System - A 3 D Validation Study.”</td>
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<tr>
<td>Dr Wang Xiao Yan, <strong>Co-Authors:</strong> A/P Adrian Yap, Dr KY Zeng</td>
<td>Best Paper Award.</td>
<td>International Association for Dental Research (South East Asia Division)</td>
<td>Paper entitled: “Effect of Environmental Calcium Phosphate on Acid Resistance of Glass Ionomers.”</td>
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<tr>
<td>Ms Wu Xiaowa, <strong>Co-Authors:</strong> A/P Adrian Yap, Dr KY Zeng</td>
<td>Division Travel Award in the Senior Researcher Category.</td>
<td>International Association for Dental Research (South East Asia Division)</td>
<td>Paper entitled: “Environmental Index of Resin-based Restorative Materials.” She represents South-East Asia to compete in the Hatton Award Competition held at the International Association for Dental Research General Session in March 2005, Baltimore, USA.</td>
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## Local Awards

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<tr>
<td>Dr Liu Hua</td>
<td>Best Oral Science Poster Award</td>
<td>National University of Singapore and National University Hospital Annual Scientific Meeting</td>
<td>Poster entitled: “Early Separation of MSC Differentiated Cells for Osteogenesis in Local Implantation.”</td>
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<tr>
<td>Co-Authors: Dr Heng Boon Chin, Ms Saw Tzue Yih, Dr Ouyang Hongwei, Dr Cao Tong</td>
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<td>Co-Authors: Prof Teoh Swee Heng, A/P D.W Huttmacher, Dr Cao Tong, Dr F Chen, Dr K Yacob, A/P Ho Kee Hai</td>
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<tr>
<td>Dr Anil Kishen, Dr S George, Dr Song Keang Peng</td>
<td>Best Scientific Poster Award</td>
<td>Singapore Endodontic Society &amp; Malaysian Endodontic Society</td>
<td>Poster entitled: “A Mono-Species Biofilm Model for Persistent Endodontic Infection”</td>
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## Patents

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<tr>
<th>Patent / Subject</th>
<th>Team</th>
<th>Status</th>
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<tr>
<td>“Advanced Non Invasive Light Activated Therapy to Eliminate Microbes in Teeth”</td>
<td>Dr Anil Kishen, Mr Saji George, Dr Song Keang Peng, A/V Prof Jennifer Neo</td>
<td>U.S. provisional patent filed on 13 June 2005</td>
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NEW RESEARCH PROJECTS APPROVED IN FINANCIAL YEAR 2004 - 2005

New Research Projects Funded by the Academic Research Fund

The Effects of Low Level Laser Therapy on the Rat's Sciatic Nerve following Lysolecithin – Induced Focal Demyelination

Principal Investigator: A/P Yeo Jin Fei
Amount: $45,150

Aim:
This research study investigates the effects of Low-level laser therapy (LLLT) on the rate and completion of remyelination process as well as the rate and completion of re-clustering of remyelination of the sodium and potassium channels as compared to controls.

In this study, chemical demyelination would be achieved by lysolecithin application on the exposed sciatic nerves of the rats used as the experimental animals. In the controls, demyelination is allowed to take its course and the start and completion of remyelination are to be assessed. In the experimental group, LLLT applications would be given to the experimental animals to note its effects on the rate and completion of remyelination, together with the return of normal features of sodium and potassium channels. A comparison with the results of the controls would provide evidence-based information on the efficacy of LLLT on remyelination.

Abstract:
The relation between demyelination and pain has been well-known. Demyelination involves changes in the ultra-structures of myelin and effects on the sodium and potassium channels at the Nodes of Ranvier. In the case of trigeminal neuralgia which is commonly seen by dentists, the evidence linking demyelination to this painful condition is still lacking. Low-level laser therapy is reported to promote myelination.

Clinical Relevance:
Presently, demyelinating conditions like trigeminal neuralgia are treated by medication (Carbamazepine). Sometimes, it is ineffective due to adverse side effects and increasing dose dependency. Current surgical options are either by intracranial procedures or peripheral nerve avulsion, which have its morbidity and numbness respectively, both of which are not preferred by patients. This study would provide evidence-based treatment parameters of LLLT for remyelination in conditions involving demyelination (e.g. trigeminal neuralgia) and hence LLLT could provide an alternative treatment modality to enhance remyelination of this condition.

Tissue Reaction to Implanted Viscosity Enhanced Root Repair Material

Principal Investigator: Dr Chng Hui Kheng
Amount: $45,382

Aim:
1. To evaluate the tissue reaction to Viscosity Enhanced Root Repair Material in the tibias and mandibles of guinea pigs using histomorphological studies.
2. To compare the tissue reactions to implanted Viscosity Enhanced Root Repair Material, ProRoot MTA and ProRoot MTA (Tooth colored formula).

Abstract:
The emergence of Mineral Trioxide Aggregate (MTA) as a root-end filling material has generated a lot of interest due to its superior sealing ability and biocompatibility. Although MTA possesses superior sealing ability and is less cytotoxic compared to traditional root-end filling materials such as Super-EBA and IRM, it has poor handling characteristics. A novel root-end filling material with similar chemical composition but improved handling characteristics was recently developed through a joint collaboration between Department of Restorative Dentistry and Department of Chemical Engineering at the National University of Singapore. A U.S.A. provisional patent was filed for this material, Viscosity Enhanced Root Repair Material, in October 2003. This material has been tested and was found to fulfill the physical properties requirements for use as root-end filling material. Our earlier studies also found the root-end sealing ability of this material to be comparable to MTA. The material is nontoxic when tested using Direct Contact Test, in accordance with ISO 10993-5:1999. However, there is a lack of in vivo studies to ascertain its biocompatibility. (The aim of this project is to examine the tissue reactions to implanted Viscosity Enhanced Root Repair Material in the tibia and mandible of guinea pigs and compare the reactions with those induced by MTA.)

Clinical Relevance:
A thorough understanding of the biocompatibility of Viscosity Enhanced Root Repair Material will lead to appropriate recommendations for its clinical application. It is hoped that understanding the limitations of Viscosity Enhanced Root Repair Material will lead to further research to improve the material, with potential applications such as a bone filler or bone cement material used in oral surgery and orthopedics.
Tooth avulsion represents one of the more severe forms of dental injuries known to inflict extensive damages not only to the pulp but also to the tooth-supporting periodontium (PDL). While pulp injuries could be optimally managed, the undesirable periodontal complications usually result in tooth loss if replantation of avulsed teeth is not carried out immediately.

In order to achieve an understanding of the underlying molecular mechanisms during the periodontal healing, extraction and replantation are undertaken to simulate avulsion and replantation in a canine model.

The immediate and delayed replantation groups observed at 0-hr serve as control and the observation time points at 1, 3, 7 days serve as experimental groups. The periodontal structures, namely the periodontal ligament, cementum and alveolar bone, from the samples of each group are isolated and total RNA is thereafter extracted. The RNA sample is then processed for hybridization in separate affymetrix genechip canine genome array containing 21,500 transcripts. The gene expression data is analyzed using computational methods for identifying both upregulated and downregulated genes involved in this canine tooth replantation model. This gives a snapshot of the genes expressed in each condition of interest. Further validation of the biologically relevant genes is to be done by kinetic PCR. Attempts are made to classify the gene products according to their molecular function and biological process to which they contribute. The gene of interest can be mapped to the metabolic and signaling pathway databases in order to better understand their role.

Clinical Relevance:
Avulsion injuries are the most commonly occurring dental injuries which incur severe damage to the attachment apparatus of tooth. As a treatment, the tooth can be replanted back to the socket. Immediate replantation of the avulsed tooth is rarely possible in clinical scenario for obvious reasons like unavailability of immediate dental care and/or other primary injuries which make dental treatment rather elective. In such clinical situations, delayed replantation is inevitable. As a consequence, the health of supporting periodontal tissue is largely compromised thereby critically affecting the prognosis of replanted teeth. A better understanding of the molecular phenomena occurring in the periodontal tissues of delayed replanted teeth may elucidate the underlying mechanisms for complicated healing and will also aid in establishing a promising replantation treatment strategy.

Molecular Profiles of Periodontal Tissues after Tooth Replantation - A Canine Model

Principal Investigator: A/P Varawan Sae-Lim
Amount: $179,756

Aim:
To obtain an overview of the molecular factors which may be specifically expressed in periodontal tissues after tooth replantation.

Abstract:
Substantial investigations have attempted to regenerate functional periodontium after tooth replantation by inhibiting dentoalveolar ankylosis / replacement resorption, the sequelae of the severely damaged periodontium following prolonged extra-oral duration and/or undesirable extra-oral condition, which could potentially lead to tooth loss. However, these therapeutic strategies have not resulted in breakthrough success. While healing potential of the periodontal tissue on the replanted root surface and the role of the alveolar socket have been speculated upon, the mechanism underlying functional healing following replantation of avulsed teeth with severely damaged periodontium had not been fully elucidated.

The recent advances in proteomics and genomics as well as the integrated bioinformatics implicate promising feasibility in the molecular diagnostics of dentoalveolar ankylosis / replacement resorption which to date have not been demonstrated. It is recognized that with these emerging technologies, multiple gene and protein expressions during the periodontal healing and regenerative processes could be extensively studied. The aim of this proposal is to investigate the differential spatial and temporal molecular profiles of periodontal tissue in replanted teeth susceptible to ankylosis / replacement resorption, in comparison to that of the replanted teeth having optimal healing with the non-experimental teeth serving as baselines. In this study, tooth extraction would be undertaken to simulate avulsion injury in a canine model. It is envisaged that novel genes / evidences discovered from the molecular expression profiles of this proposed replantation study would allow a more comprehensive understanding of the healing of replanted teeth under adverse conditions and that the data obtained would be used to establish definitive hypotheses for subsequent verification and functional studies. This basis is deemed imperative in the formulation of a therapeutic strategy and modulation of ankylosis / replacement resorption.
Caries Risk Assessment for Children in Singapore

**Principal Investigator:** A/P Stephen Hsu Chin-Ying  
**Amount:** $144,925

**Aim:**
To establish a sensitive and specific caries risk assessment/prediction (CRA) model for early identification of and treatment for the high caries risk children in Singapore

**Abstract:**
Tooth decay (caries) is a chronic infectious disease with a multifactorial etiology. Despite the decrease of caries rate in developed countries in the last few decades, caries remains as the single most common chronic childhood disease with the majority of lesions found in the minority of the children (15-25%). Recently, a resurgence of caries in children has been revealed in several industrialized countries, including Singapore. Therefore, to establish a CRA model for early identification of and treatment for the high risk patients is of paramount importance. However, there is no CRA model available in Singapore with satisfactory sensitivity and specificity.

In the past few years, our research team has carried out several preliminary studies to identify the disease/caries profile and potential caries risk factors among children in Singapore. This longitudinal study aims to profile the caries prevalence/incidence/risk for establishing a biopsychosocial CRA model relevant to children population aged 4-7 years in Singapore. Baseline data collection and a 1-year follow-up evaluation will be done using an interviewer-administered questionnaire, an oral examination, and salivary tests. The traditional statistical methods coupled with various artificial intelligence will be employed for model construction and validation.

**Clinical Relevance:**
The production model will enhance evidence-based diagnosis and planning of treatment in managing caries in children.

Rapid Optical Method to Monitor Caries Activity in Children

**Principal Investigator:** Dr Mohamed Azharashid Mohamed Tahir  
**Amount:** $37,965

**Aim:**
1. To evaluate the ability of an optical biochemical sensor as a chair-side tool to identify caries activity in children.
2. To compare the effectiveness of the optical biochemical sensor with established salivary test markers of caries activity.

**Abstract:**
Dental caries is one of the most prevalent infectious diseases in children. Mutans streptococci (MS) and Lactobacillus species are believed to be the main indicator organisms. They are aciduric, acidogenic and involved in high caries activity. Sugary diet forms the substrate for these bacteria to produce acids that demineralise tooth enamel that initiates the carious process. Therefore, it is important to be able to identify children at risk of dental caries so that they benefit from aggressive preventive measures thus avoiding dental surgical intervention. An optical chemical sensor is a device that is used to measure the concentration or activity of a chemical species in a sample of interest. The potential of using the sensor enables us to conduct rapid, selective and quantitative in-situ measurements of specific biochemical changes. Recently an optical chemical sensor that can monitor chemical variables associated with MS activity in saliva has been reported. In the proposed study, an extrinsic optical chemical sensor will be used to determine the acidogenic profile of saliva and plaque of known caries-free and caries-active children. The proposed sensor will enable us to attain a chair-side system that may indicate caries activity in children.

**Clinical relevance:**
The sensor would be able to provide real-time, quantitative information of caries activity in children at the chair-side compared to established bacterial screening tools.
Roles of Chondroitin Sulphate Proteoglycans in Palatal Wound Healing

Principal Investigator: A/P Kelvin Foong Weng Chong

Amount: $69,500

Aim:
The main purpose of the study is to analyse the roles played by chondroitin sulphate proteoglycans in palatal wound healing. The specific objectives are to:

1. Determine and compare the expression of chondroitin sulphate proteoglycans in palatal fibroblast during wound healing in vitro;
2. Examine the biological effects of perturbation of chondroitin sulphate proteoglycan biosynthesis on palatal fibroblast behaviour; and
3. Evaluate the biological effects of different chondroitin sulphate proteoglycans on palatal wound healing in vitro.

Abstract:
Critical events for wound healing after surgical repair of the cleft palate include proliferation, adhesion and migration of both fibroblasts in the connective tissues and cells in the overlying epithelium. Since the roles played by chondroitin sulphate proteoglycans in regulating palatal fibroblast biological behaviour during wound healing are currently not well understood, this project aims to extend our previous work on palatal wound healing in rabbits by analysing the functions of chondroitin sulphate proteoglycans in human palatal fibroblasts by means of an in vitro wound healing model. Transcript and protein levels of various chondroitin sulphate proteoglycan species will be measured and compared at different time points during wound healing in this model. The biological effects of perturbation of chondroitin sulphate proteoglycan biosynthesis on palatal fibroblast will be examined, and the potential of using chondroitin sulphate proteoglycans to promote palatal wound healing in vitro will be evaluated. Together, these experiments will help to extend our understanding of the biology in palatal wound healing, and may lead to new therapeutic approaches to promote post-surgical palatal wound healing.

Clinical relevance:
Results from this project may be used in the development of membranes enriched with specific chondroitin sulphate proteoglycans which could be used in the surgical repair of the cleft palate to reduce and minimize scarring during post-surgical wound healing.
RESEARCH INDICATORS

Number of New Research Grants and On-going Projects for FY2000 - FY2004 Supported by the Academic Research Fund

Research Funds Allocated to Dentistry from the Academic Research Fund for FY2001 - FY2005
Number of Refereed Publications for AY2001 - AY2004

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<th>Others</th>
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Number of Conference Papers for AY2000 - AY2004

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POSTGRADUATE RESEARCH
STUDENTS PROFILE
FROM AY2001 TO AY2005

Intake by Nationality

Cumulative Enrolment in MSc and PhD Programmes

Academic Year

Number

Academic Year

Number

2000/01 2001/02 2002/03 2003/04 2004/05

MSc  PhD

Singapore/Singapore PR  International
## Collaborations with other Universities

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<thead>
<tr>
<th>S/N</th>
<th>International / Local</th>
<th>Name of University</th>
<th>Principal Investigator</th>
<th>Collaborating Department in Faculty</th>
<th>No. of Collaborations</th>
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<tr>
<td>1</td>
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<td>Saratov State University</td>
<td>Dr Anil Kishen</td>
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<td>Nanyang Technological University</td>
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<td>Restorative Dentistry</td>
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<td>Karolinska Institute, Sweden</td>
<td>Dr Cao Tong</td>
<td>Dean's Office</td>
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<td>University of Wisconsin Madison</td>
<td>Dr Cao Tong</td>
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**Total 11**

## Collaborations with Industries

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<td>Assoc Prof Jennifer Neo</td>
<td>Restorative Dentistry</td>
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<td>Local</td>
<td>Rapid Tech Pte Ltd Dr Victor Fan</td>
<td>Dr Cao Tong &amp; Maxillofacial Surgery</td>
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**Total 2**

## Collaborations with Research Institutions

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<th>Name of Research Institutions</th>
<th>Principal Investigator</th>
<th>Collaborating Department in Faculty</th>
<th>No. of Collaborations</th>
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<td>1</td>
<td>Local</td>
<td>Genomic Institute of Singapore, A*STAR</td>
<td>Dr Cao Tong</td>
<td>Dean's Office</td>
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<td>2</td>
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<td>SIMTech Pte Ltd, A*STAR Dr Victor Fan</td>
<td>Dr Cao Tong &amp; Maxillofacial Surgery</td>
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**Total 2**

## EDITORIAL MEMBERSHIPS

Number of Staff Holding Editorial Memberships for AY2000-AY2004

![Diagram showing number of staff holding editorial memberships for different academic years]
RESEARCH PROJECTS IN THE MASTER OF DENTAL SURGERY PROGRAMMES
ACADEMIC YEAR 2004-2005

Endodontics

Year 3
1) Dr Ang Ee Choon, Richard
Analysis of VEGF Expression in Immediate and Delayed Replanted teeth.
Supervised by Assoc Prof Varawan Sae-Lim

2) Dr Kuah Hong Guan
The Effects of Chelating Agents on Smear Layer Removal With and Without Ultrasonics on the Apical 1/3 of the Root Canal: A SEM Study
Supervised by Dr Patrick Tseng

3) Dr Lee Chee Wee
PDLP/Tooth Co-culture
Supervised by Assoc Prof Varawan Sae-Lim

Year 1
1) Dr Lim Toh Seong, Andy
Microarray Evaluation - Periodontal Ligament
Supervised by Assoc Prof Varawan Sae-Lim

Prosthodontics

Year 3
1) Dr Leong Woei Jian, Elvin
The Effect of Tooth Preparation Height and Taper on Resistance Form
Supervised by Assoc Prof Keson Tan Beng Choon Dr Chua Ee Kiam Dr Wong Keng Mun

2) Dr Mirza Rustum Baig
Evaluation of Marginal Fit of Cerec 3 or Other Contemporary CAD/CAM All Ceramic Full Coverage Crowns
Supervised by Assoc Prof Keson Tan Beng Choon

Year 1
1) Dr Nguyen Thi Ouyinh Huong
Load Fatigue Performance of Implant - Ceramic Abutment Combinations
Supervised by Assoc Prof Keson Tan Beng Choon

Orthodontics

Year 3
1) Dr Mok Tong Bee
A Cephalometric Study of Cranial Bases in Chinese Adults
Supervised by Dr Mimi Yow Dr Chew Ming Tak

2) Dr Poon Kee Hoon
The Effectiveness of Mandibular Advancement Device on Chinese Patients with Obstructive Sleep Apnoea
Supervised by Dr Chay Siew Han Assoc Prof Kelvin Foong Weng Chiong

Oral and Maxillofacial Surgery

Year 3
1) Dr Lai Juen Bin
The Effects of Locally Injected Steroid on Palatal Wound Healing
Supervised by Dr Goh Bee Tin

2) Dr Ng Chee Hon
A Local study anticonvulsant on prescription by oral healthcare professionals.

Supervised by Assoc Prof Kelvin Foong Weng Chiong

2) Dr Poon Kee Hwong
Cephalometric Dimensions of the Width of the Anterior Alveolus in Chinese
Supervised by Assoc Prof Kelvin Foong Weng Chiong

3) Dr Tang Sin Yee Anna
3D Analysis of Orthodontic Tooth Movement with First and Second Premolar Extractions in the maxillary arch
Supervised by Assoc Prof Kelvin Foong Weng Chiong

Year 1
1) Dr Chng Chai Kiat
SEM and Frictional Evaluation of Esthetic Resin Braided Wires
Supervised by Assoc Prof Kelvin Foong Weng Chiong Assoc Prof Ashraf Kassim

2) Dr Mah Kuan Seet Michael
A 3-Dimensional Frontal Evaluation of Occlusal Plane changes
Supervised by Assoc Prof Kelvin Foong Weng Chiong Assoc Prof Kelvin Foong Weng Chiong

3) Dr Koh Wei Ching Robyn
Frictional Evaluation of conventional & self-ligating Aesthetic Brackets of various aesthetic arch wire configurations
Supervised by Assoc Prof Kelvin Foong Weng Chiong

4) Dr Wee Teng Yau
3D analysis of orthodontic Tooth Movement in the Mandibular Dental Arch with 1st & 2nd Premolar Extractions
Supervised by Assoc Prof Kelvin Foong Weng Chiong

Periodontics

Year 3
1) Dr Khurram Attaullah
Non-Surgical Periodontal treatment and High Sensitive C-reactive proteen level in Diabetics
Supervised by Assoc Prof Lim Lum Peng

2) Dr Tan Wah Ching
Effects of Simple Periodontal Therapy on Periodontal Disease and Glycaemic Control in Patients with Diabetics
Supervised by Assoc Prof Lim Lum Peng

Year 2
1) Dr Chee Hoe Kit
Longitudinal Evaluation of Periodontal Healing Response in Patients with Diabetes
Supervised by Assoc Prof Lim Lum Peng

2) Dr Tan Ching Ching
Periodontal Research in Patients with Diabetes
Supervised by Assoc Prof Lim Lum Peng
PHD AND MSC RESEARCH PROJECTS
ACADEMIC YEAR 2004-2005

Doctor of Philosophy

Ms Bina Rai
Effect of Growth Factors on Bone Regeneration on 3D PCL-TCP Scaffolds
Supervised by
Assoc Prof Ho Kee Hai
Prof Teoh Swee Hin

Dr Hla Myint Htoon
Oral Health Promotion Programme for Diabetics in Singapore
Supervised by
Assoc Prof Lim Lum Peng

Dr Khoo Suan Phaik
Biopsychosocial Characteristics as Predictors of Treatment Outcome of Temporomandibular Disorder (TMD) Patients with Symptoms of Pain.
Supervised by
Assoc Prof Adrian Yap
Dr Chan Yiong Huak

Dr Wang Xiaoyan
Interaction between Environmental Calcium/Phosphate and Glass Ionomer Restoratives
Supervised by
Assoc Prof Adrian Yap
Assoc Prof Hien Ngo
Dr Zeng Kaiyang

Dr Zou XiaoHui
Proteoglycans & Palatal Wound Healing
Supervised by
Assoc Prof Kelvin Foong Weng Chiong
Dr Cao Tong
Dr George Yip

Mr Chung Sew Meng
Development of Micro-mechanics Strategies for Characterization of Dental Composites
Supervised by
Assoc Prof Adrian Yap
Assoc Prof Tsai Kuo Tsing
Assoc Prof Lim Chwee Teck

Dr Gao Xiaoli
Caries Risk Assessment for Children in Singapore.
Supervised by
Assoc Prof Stephen Hsu Chin-Ying

Mr Saji George
Advanced Non-invasive Light Therapy to Eradicate Bacterial Flora in Dentine
Supervised by
Dr Anil Kishen

Ms Soh Mui Siang
Synthesis and Characterisation of “Non-shrinking” Nanocomposites for Dental Application
Supervised by
Assoc Prof Adrian Yap
Dr Alan Sellinger

Dr Sum Chee Peng
Structural and Functional Characterisation of Dentine for Endodontic Retreatment
Supervised by
Dr Anil Kishen

Dr Deng Bin
Inverse Analysis of Dental Implant Systems Using Finite Element Method
Supervised by
Assoc Prof Kesan Tan Beng Choon
Assoc Prof Liu Gui Rong

Dr Nyi Lay Maung
Characterization of Enamel Diffusion Modulated by Er:YAG Laser.
Supervised by
Assoc Prof Stephen Hsu Chin-Ying

Master of Science

Dr Abhiram Maddi
Effect of Therapeutic Ultrasound on Bone Regeneration via Release of Growth Factors and Cytokines
Supervised by
Assoc Prof Ho Kee Hai

Dr Joseph Antoniraj Jude Aarthi
Genetic Profile of Periodontal Tissues in Replanted Teeth - a Baseline Study
Supervised by
Assoc Prof Varawan Sae-Lim
Dr George Yip
Dr Yang He, Henry

Dr Meenaskhi
The myelination effects of Low Level Laser Therapy on the rat’s sciatic nerve following Lysolecithin - Induced Demyelination
Supervised by
Prof Loh Hong Sai

Dr Toh Wei Seong
Stimulations and Modulations of Chondrogenic Differentiation from Human Embryonic Stem Cells
Supervised by
Dr Cao Tong

Dr Wu Xiaowa
Chemo-Mechanical Degradation of Resin-Based Hybrid Restoratives.
Supervised by
Assoc Prof Adrian Yap
Dr Zeng Kaiyang

Dr Ye Chaopeng
Characterisation of Osteogenic Cells Differentiated from Human Embryonic Stem Cells
Supervised by
Dr Cao Tong

Dr Tian Xianfeng
Molecular Events in Nerve and Bone Healing in Jaw Defects
Supervised by
Assoc Prof Yeo Jin Fei
Dr Victor Fan

Ms Huang Li
Laser – Induced Caries Prevention
Supervised by
Assoc Prof Stephen Hsu Chin-Ying

Dr Adeela Rafique
Investigations on Effect of Hydration on the Mechanical Characteristics of Dentine
Supervised by
Dr Anil Kishen

Dr Vinoth Kumar Jayaseelan
Hepatic Differentiation of Human Embryonic Stem Cells for Toxicity Screening of Dental Materials
Supervised by
Dr Cao Tong
Dr Pallavi Uppangala
Tissue Reaction to Implanted Viscosity Enhanced Root Repair Material
Supervised by
Dr Chng Hui Kheng

Dr Tarun Kumar Maheshwari
Molecular Profile of Periodontal Tissues following Tooth Replantation
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Dr Wu Xiaowa
Chemo-Mechanical Degradation of Resin-Based Hybrid Restoratives.
Supervised by
Assoc Prof Adrian Yap
Dr Zeng Kaiyang

Dr Ye Chaopeng
Characterisation of Osteogenic Cells Differentiated from Human Embryonic Stem Cells
Supervised by
Dr Cao Tong

Osteogenic differentiation of Mesenchymal Stem Cell.
Teo Kuo-Yih, Terry Seow Yan San (Miss) Yang Shi Lin, Sherine (Miss) Tang Panmei (Miss)
Supervised by Dr Cao Tong

Cytotoxicity of Composite resin with Neutral Red and MTT.
Quek Yeow Hsien Seah Soon Kwang Lee Kwan Kai, Kenneth Khoo Tuo Sheng, Joel Kwan Wei Yen
Supervised by Dr Cao Tong

Low Jiun Sian Ngauw Njuk Khim, Angela (Miss) Lum Jing Li Wong Li Beng
Supervised by Assoc Prof Stephen Hsu Chin-Ying

Does Controlled Light Polymerization really Work?
Chye Chuan Hee, Kelvin Neo Bijuan (Miss) Teo Juin Wei Lai Ye Choung
Supervised by Assoc Prof Adrian Yap Ms Soh Mui Siang

Co Hao Ming, Kevin Sham Pui Yin, Enrica (Miss) Low Yi Han Wong Ren Jie, Patricia (Miss)
Supervised by Assoc Prof Yeo Jin Fei Assoc Prof Adrian Yap

Accuracy of Computer-Aided Methods of Measuring Intermaxillary Tooth-Size Discrepancy.
Ng Kok Wai, Edwin Ng Dih Hann, Simon Hong Pooi Mun (Miss) Tan Kian Meng
Supervised by Dr Soh Jen

A Comparison of the Efficacy of a Power-driven Sonic Toothbrush and a Manual Toothbrush in Care-Dependent Residents of a Nursing Home.
Syed Fadzleigh Bin Shafari Lim Tse Chiuin (Miss) Loo Sun Din Sim Qixia, Chelsia (Miss)
Supervised by Assoc Prof Lim Lum Peng Dr Benjamin Tan

Soong Poh Luon Gan Tsering, Sapphire (Miss) Chong Tse Feng, Gabriel Yap Hejia, Louise (Miss)
Supervised by Dr Lim Kian Chong