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Editor's Notes

Welcome

On behalf of the editorial board, I would like to extend a warm welcome and greetings to the beginning of the year. As we embark on another year, we are excited to continue our mission of disseminating high-quality research and knowledge in our field of periodontology and implant dentistry.

In this issue, we have included two research articles and a special tribute to the memory of our esteemed colleague and valued member of the Australasian Osseointegration Society, Dr Norton Duckmanton, who recently passed away. Dr Duckmanton was an exceptional scholar who made significant contributions to the field of prosthodontics and implant dentistry. We extend our deepest condolences to Norton's family and loved ones during this difficult time.

The first article of the issue by *Dr Justin Le* is a review paper titled 'Dental implant screw joint stability: Unwinding the literature.' The connection between the implant and abutment or abutment and prosthesis play a major role in the retention and stability of implant restoration. However, the presence of multiple interconnecting components predisposes them to prosthetic complications at the screw joint. This is an update on the literature pertaining to dental implant screw joint stability from 2017 to 2022.

The second article by *Dr Clarence Da Cruz* is about the adjunctive use of antimicrobial therapy in the management of peri-implantitis. Like periodontitis, peri-implantitis is a multifactorial disease characterised by inflammation and progressive loss of the peri-implant tissues. Many different treatment protocols have been suggested, but the treatment outcomes are unpredictable. This article aims to review and explore adjunctive antimicrobial therapies to either non-surgical and surgical management of peri-implantitis in the current literature.

On behalf of the editorial board, I'd like to thank all the contributors to the journal and hope to see continuous support from the societies.

Regards,

A/Prof Ryan Lee
Editor-in-chief

President's Notes

I am honoured to address you as the newly elected President of our society. As I begin my term, I would like to express my gratitude for the trust and confidence that you have placed in me to lead our organisation.

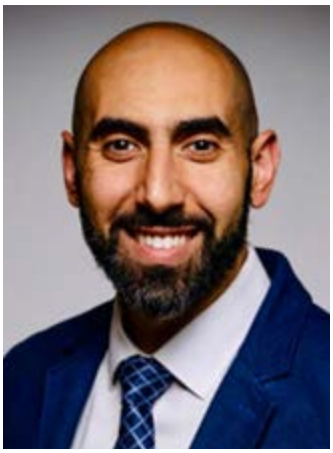
I would also like to take this opportunity to recognise the outstanding leadership of my predecessor, Dr Rajiv Verma and the hard work of our society's executive committee in the past year. The joint conference in Sydney 2022 was the first attempt to have a combined conference between the ASP and AOS. It was a great success, despite there being multiple challenges the organising committee had to experience and overcome. I'd like to congratulate both societies for the success, giving us another opportunity to organise a joint conference in the Gold Coast, 2024. In addition, the Australian Prosthodontic Society (APS) has decided to join and contribute to the 2024 conference organisation.

This collaborative event promises to be an exceptional opportunity for dental professionals to exchange knowledge, share experiences, and showcase the latest advancements in implant dentistry, periodontology and prosthodontics. With a diverse range of speakers and topics, this conference will offer a unique platform for networking, learning, and collaboration.

I would congratulate all the authors who have published in this issue of the journal and hope everyone enjoys the reading.

Regards,

A/Prof Ryan Lee
ASP Federal President



On behalf of the AOS I'd like to thank Dr Eugene Foo along with the scientific and organising committee for putting on a brilliant conference in Sydney in August, 2022. It was the first time that we have joined forces and combined our biennial conference with the ASP and I'm sure all will agree that it was a resounding success. The AOS and ASP are now in the process of organising the 2024 conference which is planned for September, 2024 in the Gold Coast. We are also pleased to announce that the Australian Prosthodontic Society (APS) will be coming on board as a partner society for this conference which will allow us to have broader reach not only to attendees but also with trade partners.

Congratulations go to all the authors that have been published in this edition of AJPID. Last but not least, I'd like to thank Kayla Ashkar and Bella Cherkasskaya for their incredible administrative efforts behind the scenes.

I look forward to being of service in my term as AOS Federal President and thank Eugene for his dedication and efforts during his tenure. If you have any comments or suggestions that could help us better serve our members please contact me on angelos@adawn.me

Dr Angelos Sourial

AOS Federal President

VOLUME 7 | Issue 1 | April 2023

The Australian Journal of Periodontology
and Implant Dentistry

Remembering Dr Norton Duckmanton OAM, RFD

It is with sadness that we advise that our dear friend and colleague Norton Duckmanton has passed away. Norton served Dentistry and the specialty of Prosthodontics as a devoted professional who was admired and respected as a teacher, clinician, and friend.

Norton was a friend and colleague to staff, and countless undergraduate and postgraduate students whilst teaching prosthodontics at the University of Sydney Dental School, and later as a specialist prosthodontist at the Sydney Dental Hospital. A period of over 55 years!

He was born 12 November 1925 and grew from humble beginnings on a dairy farm in the Clare Valley of South Australia, where he was expected to milk at least three cows before going to school! He lost his mum at age six and his father remarried. Because of an intolerable family situation, he had to leave home and school at the age of 15, working in a foundry in Adelaide, and living with his grandfather until joining the Air Force at 18. He was selected for Navigator training and graduated in early 1944 as a navigator and wireless operator and was assigned to a squadron flying Bristol Beaufighters (a ground attack and antishipping aircraft) and served with 93 Squadron serving in Borneo until the end of WWII.

Norton had always believed that someone above was looking after him. On 14 August 1945, his aircraft was to be the third on a sortie to stage a raid against a heavily fortified land- based naval gun. As the raid was scheduled for mid-morning, the defenders would know the position of the attacking aircrafts after the first plane had released its rockets and banked away. Norton knew that, as he was in the third aircraft, by which time the defenders would have the range and bearing of the attackers, he was unlikely to survive this mission. It was just when the target was reached, he received a morse message to return to base as all hostilities would cease at noon and the war in the Pacific was over. A heart thumping moment made a dramatic turn to be one of joy and relief.

He served as part of the BCOF in Japan based at Bofu (where he became a part-time black marketeer in cigarettes to US forces!). He was in Hiroshima in March 1946 and saw first-hand the effects of nuclear war. Implanted in his mind forever was the silhouettes on concrete walls of those incinerated. He was discharged in 1946 with the rank of Warrant Officer.

In RAAF Service, he was decorated with Pacific Star 1939-1945, Aust. Defence Medal 1939-1945, Victory Medal, Aust. Service Medal 45-75, Reserve Forces Decoration (and 2 bars). His service with the armed forces continued as he joined the Citizen Air Force as a Dental Officer with the rank Flight Lieutenant in 1952, was promoted to the rank of Wing Commander in 1973, and subsequently Group Captain in 1977.

Due to his war service, Norton enrolled in 1948 to obtain his matriculation (he had only completed two years of high school whilst a boy) under a special rehabilitation programme for ex-servicemen, and thereafter immediately enrolled as a first-year dental student (after rejecting Medicine as it was a

six-year course) at The University of Sydney. He believed he could contribute to dentistry with the skills and inquisitive attitude developed during his war service. His technical skills were no doubt enhanced by the skills he learnt working in a foundry casting metal objects.

Norton graduated BDS in 1952 and after a residency at Sydney Dental Hospital, opened a rural dental practice in the Hunter Valley town of Muswellbrook (with branch practices in Denman and Merriwa) for 10 years where he became very successful at the crafting of complete and partial dentures. Norton returned to his old university as a teaching fellow and enrolled for his MDS in 1963, graduating with the thesis "Rest Position in Adult Males". Here he worked with his most significant mentor Prof Cam Graham with whom he had a long-time friendship. He was appointed lecturer in the Department of Prosthodontics and promoted to Senior Lecturer in 1977. Here he continued his research on overdentures on natural teeth.

He worked with Prof Iven Klineberg, then Head of Department, to establish the Sydney Dental Hospital / Faculty of Dentistry Implant Centre, to facilitate patient care and research into long-term follow-ups of implant cases. Between 1986 and 2014, his practice at the Sydney Dental Hospital was devoted exclusively to implant rehabilitation. During this time, he also spent some time in private specialist practice in Macquarie St, Sydney.

During a period of sabbatical leave in 1974, Norton took up a position as a visiting Associate Professor at Northwestern University, Chicago, USA and was retained as a part-time visiting Professor at the same university until 2004 making two more year-long visits working with fellow Australians Prof Gilbert Brinsden and Prof Ross Taylor. It was there that Norton and Ross Taylor wrote the manual titled 'Overlay Dentures for Students; Using decoronated natural teeth restored with root caps supporting precision attachment retention anchors'. This was a major development in removable prosthodontics and foreshadowed the concept of implant overdentures for completely edentulous patients.

He served as the inaugural president of the Australian Osseointegration Society and was awarded life membership in 2015. He had been a member of the Academy of Australia and New Zealand Prosthodontists since 1963 serving in various roles and the Australian Prosthodontic Society and received life membership in 2012. He was also a member of Academy of Osseointegration, American Prosthodontic society, International Academy of Prosthodontics, Pierre Fauchard Academy and Australian Military Medicine Association. Due to Norton's significant contributions, he was honoured with the Reserve Forces Oration in 1990 and an Order of Australia Medal in 2007.

Norton was affectionately known as "Duck" or "Ducky", and considered himself fortunate and often commented that he was able to achieve largely from the privilege and opportunity of "standing on the shoulders of giants".

We extend our prayers and condolences to Norton's family and friends.

Rest in Peace our dear friend!

Iven Klineberg, Dale Howes, Kent Yuen, Peter Duckmanton
8th February 2023

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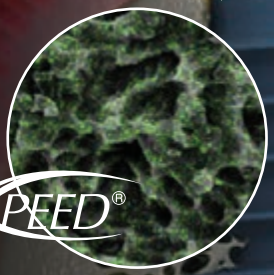

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VOLUME 7 | Issue 1 | April 2023

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Dental Implant Screw Joint Stability: Unwinding the Literature

Thanh (Justin) Le[1]
[1]The University of Queensland, School of Dentistry, Brisbane, QLD, 4006, Australia

Abstract:

Aim: This review article will provide an update on the literature on factors affecting dental implant screw joint stability.

Method: A literature search was performed electronically in MEDLINE (Pubmed) and complemented by hand searches in relevant journals. Specific terms were used for the database search spanning from 2017 to 2022.

Results: 240 records were identified through the database search along with 2 additional records identified through hand searches. 173 articles were excluded after screening the titles and abstracts. 69 full-text articles were assessed for eligibility. 49 articles were included in this review.

Conclusion: In vitro studies on screw joint stability need to be interpreted with caution as they do not consider the effects of saliva, thermal changes, and oral forces on the mating surfaces. There has been a trend towards using ceramic materials for implant fixtures, abutments, and prostheses in recent years due to their aesthetic benefits and ease of fabrication. However, these have resulted in catastrophic consequences due to the inherent brittle nature of ceramics. More long-term randomised controlled clinical trials are needed to accurately determine the performance of different screw joints. In the absence of robust long-term evidence, the restorative clinician should have a sound understanding of the material properties, stress distribution and interaction of the mating surfaces to reduce the rate of prosthetic complications involving the dental implant screw joint.

Keywords: dental implant, screw joint stability, preload, clamping force, screw loosening, screw fracture, mechanical complication

Introduction

The use of dental implants for the replacement of missing teeth has seen a dramatic rise in popularity over the past few decades due to an improved understanding of dental material science, osseointegration, and biomechanics. They have the potential to predictably restore function, comfort, and self-esteem to the edentulous patient through both fixed and removable prostheses. Although they offer greater retention than conventional removable dentures in the rehabilitation of the edentulous patient, the presence of interconnecting components predisposes them to prosthetic complications at the screw joint (1).

The intimate connection between the implant and abutment or abutment and prosthesis or implant and prosthesis is facilitated through a screw or fastener. This connection should be sufficiently rigid to resist not only oral forces, but also other chemical and thermal insults in the oral cavity. Technical complications arise when persistent oral forces overwhelm the stability of this joint system, resulting in screw loosening, distortion, and fracture.

A review of the literature on screw mechanics from 1990 to 2016 was published by Kei and Klineberg (2) in 2017. This article will provide an update on the literature pertaining to dental implant screw joint stability from 2017 to 2022.

Factors affecting dental implant screw joint stability

Preload and torque application

The torque applied to the screw can be measured and delivered through a torque-limited device (TLD). Albayrak et al.(3) compared 5 different TLDs from different dental implant manufacturers. These included 2 spring-type TLDs (Straumann, Implance), 2 friction-type TLDs (Biohorizons, Dyna), and 1 electronic TLD (Megagen). Torque values were verified with a digital torque tester. The mean recorded torque values for each of the groups were significantly lower from their target values. The Megagen electronic TLD had a significantly higher percentage of absolute deviation (PERDEV) than that of the other groups. Applying insufficient

Table 1. Results of one-sample t tests and descriptors of groups (n=5) (P<.05) (3)

Manufacturer	Target Torque Value (Ncm)	Mean ±SD (Ncm)	*t*	*P*	Mean Difference
Straumann	35	30.4 ±0.3	-37.549	<.001	-4.6
Biohorizons	30	27.9 ±1.7	-2.828	.047	-2.1
Dyna	30	28.3 ±0.9	-4.174	.014	-1.7
Implance	25	22.9 ±1.2	-3.870	.018	-2.1
Megagen	35	25.1 ±3.3	-6.641	.003	-9.9

torque reduced the preload in the screw joint, thus making the joint more susceptible to failure. The table below summarises the findings of the study.

Three in vitro studies investigated the effects of different durations of torque application on maintaining screw joint stability. Khalili et al.(4) assessed different retightening protocols on maintaining the screw joint stability of internal hexagon implants. The authors reported lower mean torque loss for retightening after 10 minutes and also for the group where retightening was done after 2 weeks of cyclic loading.

Al-Otaibi et al.(5) also compared the effect of different maintenance times of torque application on reverse torque values (RTVs) of abutment screws in a full-arch fixed dental prosthesis (FDP) supported by four internal hexagon implants. A digital torque meter was used to apply 35 Ncm of instant torque application and also prolonged torque applications of 10 seconds and 30 seconds. There was no significant difference in mean reverse torque values (RTVs) between the 3 groups. Prolonged maintenance of torque for either 10 seconds or 30 seconds did not maintain a higher preload. This study was conducted on a splinted cross-arch framework and may not be reproducible for single implant-supported restorations.

Another in vitro study (6) compared different retightening protocols on preload loss of abutment screws in both internal hexagon and external hexagon implants. 40 internal hexagon dental implants (IG) and 40 external hexagon implants (EG) were divided into four subgroups depending on the retightening protocol: no retightening (IG0 and EG0), retightening after 2 minutes (IG2 and EG2), retightening after 5 minutes (IG5 and EG5), and retightening after 10 minutes (IG10 and EG10). At 30 minutes from the initial tightening, all of the dental implants were detorqued. The preload losses for the IG2 (5.8%) and EG2 (5.7%) subgroups were statistically significant compared to the IG10 (10.2%) and EG10 (10.5%) subgroups, respectively. The authors recommended retightening of the abutment screws after 2 minutes to compensate for the settling effect with the potential for reduced loosening and consequent failure of the abutment screws. A major shortfall of this study was the lack of cyclic loading on the screw joints.

Screw geometry

A study (7) investigated the effect of different screw head design and crown/implant ratios on preload maintenance. Titanium alloy (Ti-6Al-4V) conical head screws and flat head screws were used in this study. The abutments were split into two groups: crown/implant ratio > 1 and crown/implant ratio < 1. The conical head screws displayed a larger contact area of 4.16 mm^2 compared to flat head screw contact area of 1.76 mm^2. All screws were torqued to 35 Ncm and cyclic loaded for 1 million cycles. The conical head screws presented higher initial torque maintenance when compared with flat head screws. The flat head screw group experienced significant reductions in torque maintenance for the crown/implant ratio > 1 group (90.6% to 68.6%) than for the crown/implant ratio < 1 group (84.9% to 79.4%). For the crown/implant < 1 group, this effect was not as prominent as in the crown/implant ratio > 1 group (84.9% to 79.4% for the flat head screw group and 98% to 84.9% for the conical head screw group). The authors recommended using the tested conical head screws mainly in a crown/implant ratio > 1 situation.

Sun et al.(8) investigated different central (abutment) screw taper angles on screw loosening. 180 specimens were divided into 4 groups based on the matching taper angles of the central screw and the abutment: 30°, 60°, 90° and 180°. Commercially pure grade IV titanium dental implants, Ti-6Al-4V abutments and central screws were prepared with a Morse taper abutment-implant connection. The central screws were torqued to 20 Ncm and then cyclically loaded. The initial RTV of each group was lower than the tightening torque of 20 Ncm, indicating

a loss of torque after tightening. The group with the 30° taper had the highest initial RTV (mean = 18.38 Ncm) and the lowest torque loss rate (8.1%), followed by the central screws with 60° taper (mean RTV = 17.70 Ncm, torque loss rate = 11.5%) and 90° taper (mean RTV = 17.36 Ncm, torque loss rate = 13.2%) groups, and the group with 180° taper had the smallest RTV (mean = 16.34 Ncm) and torque loss rate (18.3%).

Screw material, screw coating, and lubricants

Preload and RTVs are closely linked to the friction between the mating surfaces. The joint stability of 36 zirconia abutments retained with three different screw materials in two-piece zirconia implants was evaluated by Stimmelmayr and his group(9). The screw materials used included gold, titanium, and polyether ether ketone (PEEK). In the PEEK group, one abutment screw fractured during abutment installation, whereas five screwheads fractured when torquing the abutment screw. Fracture of the screw and abutment was observed in 8 of 11 tested specimens in the PEEK group following fracture strength test. Fracture patterns for the gold and titanium groups were similar to each other with 18 out of the 24 specimens exhibiting fracture in the supra-crestal implant body without screw fracture.

Chen et al.(10) examined the effects of polyether ether ketone (PEEK) and polytetrafluoroethylene (PTFE) coatings on dental implant joint stability. 300 specimens were divided into 5 groups based on screw surface coating: group C (control; screw without coating), PEEK-1 (screw coated with 30 μm PEEK), PEEK-2 (screw coated with 60 μm PEEK), PTFE-1 (screw coated with 30 μm PTFE), and PTFE-2 (screw coated with 60 μm PTFE) groups. The PTFE-1 group had the highest clamping force, followed by the PTFE-2, PEEK-1 and PEEK-2, with group C showing the smallest value. Compared with group C, all coating groups had higher initial RTVs and reduced torque loss rate. PEEK-2 had the highest initial RTV and lowest torque loss rate, followed by the PEEK-1 and PTFE-2 groups, and the PTFE-1 group had the smallest initial RTVs and largest torque loss rate. The authors recommended the use of PEEK coating as an ideal method for improving dental implant screw joint stability.

The effect of sealing agents on preload maintenance of dental implant screw joints was evaluated by Seloto et al (11). In addition to a control group, the sealing agents tested include anaerobic sealing agent for medium torque (ASMT), anaerobic sealing agent for high torque (ASHT), and cyanoacrylate-based bonding agent (CYAB). 40 external hexagon implants were attached to engaging UCLA abutments and the sealing agent was applied to each abutment screw. A torque of 32 Ncm was applied using digital torque wrench. After 48 ± 2 hours, reverse torque values were obtained. Detorque values in the CG and ASMT group were significantly lower than the insertion torque. The opposite was true for specimens in the ASHT and CYAB group where detorque values were significantly higher than the insertion torque. ASHT and CYAB are able to maintain preload better than the CG and ASMT. A hexagonal driver fractured during the detorque of one of the specimens in CYAB group, questioning the retrievability of the components. Due to the short-term nature of this in vitro study, further studies are needed to develop methods for the long-term maintenance of preload.

A finite element analysis (FEA)(12) assessed different frictional conditions on joint stability. Three static and dynamic friction conditions were considered. The RTV was smaller than the insertion torque for all frictional conditions. Decreasing the coefficient of friction helped maintain preload, while decreasing the removal torque. Although the RTV would decrease, the resistance to screw loosening was increased due to the increased preload. The authors recommended the use of lubricants and gold-coated screws over noncoated screws.

An in vitro study (13) investigated the effects of saliva, blood, chlorhexidine gel, and special sealing silicone on the preload force of abutment screws. The agents tested in this study had no lubricating action on the screw joint complex. The presence of blood and saliva into the implant lumen appeared to have no negative effect on the preload force.

Two articles by Sun et al. (14, 15) assessed plasma nitriding to reduce the coefficient of friction of abutment screws and increase preload. In one study(14), plasma nitriding was found to reduce the coefficient of friction (from 0.45 to 0.33), increase preload (from 260.68 N to 361.74 N), increase reverse torque values (from 15.80 N to 17.57 N), and increase pullout force (from 81.92 N to 101.49 N). These were all significant differences. This study showed plasma nitriding to improve the mechanical performance of abutment screws.

In a second study by the same authors (15), nitriding treatment was found to change surface morphology and reduce surface friction. Preload force was greater in the nitriding group than the control group. A higher torque loss rate was found in the nitriding group compared to the control group without loading. After loading, the nitriding group had higher detorque values under different cyclic loads.

Basílio et al. (16) investigated the coating of abutment screws with Vaseline on maintaining preload and found there was no significant differences between coated and uncoated screws of zirconia abutments on external hexagon implants after loading.

Wu et al. (17) also investigated the effects of lubricants on the dental implant-abutment joint stability. 59 dental implant assemblies were divided into 3 groups based on various lubricating conditions: graphite (n = 18, group G), vaseline (n = 18, group V); and blank control (group C). The highest clamping force of 244N was achieved with group G, followed by group V, and group C. The average RTVs at initial and at post-loading was highest for group C. The low coefficient of friction contributed to screw loosening for groups B and V.

The conclusions of this study were:

1. Lubricants reduce the coefficient of friction of the abutment screw, resulting in high clamping force.
2. Lubricants significantly decrease the fatigue life expectancy of the screw at high functional load but have no effect on fatigue resistance at a load lower than the fatigue limit.
3. Better lubrication leads to higher stress concentration on the thread of the screw.
4. Screws treated with lubricant provide lower initial and final loosening torque and are released earlier than non-lubricated screws.

Implant-abutment connection design

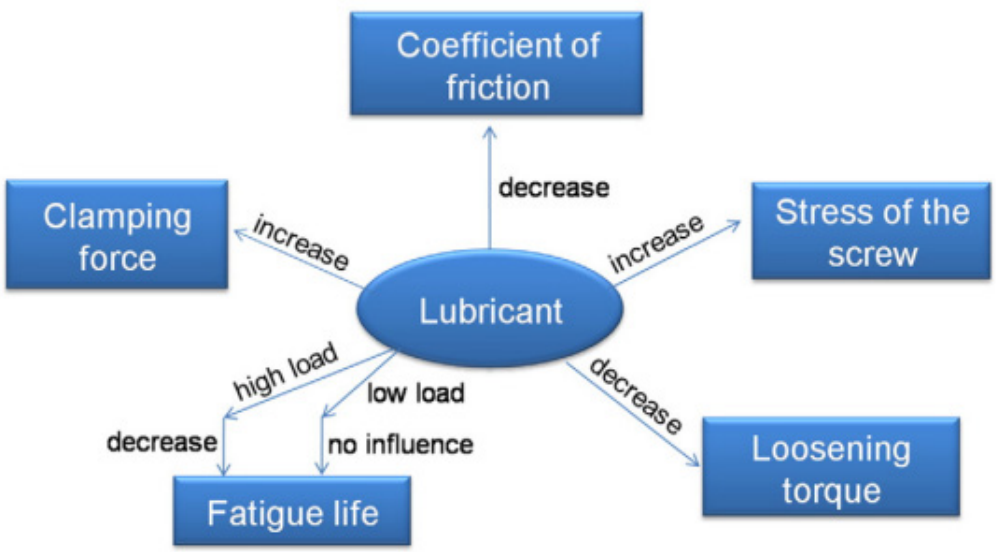
Three studies (18, 19, 20) investigated different internal connection designs. A randomised controlled clinical study (20) involving 158 patients assessed the effect of different implant systems on preload maintenance. The implant systems included were:

- Ankylos system – bone-level, Morse-tapered, internal connection, platform-switching
- Straumann BL – bone-level, 15-degree tapered, internal connection, platform-switching
- Zimmer Tapered Screw Vent – bone-level, 1-degree tapered, 1.5-mm-height internal connection, platform-switching

Preload loss was confirmed if the set torque was still not reached after rotating the screwdriver wrench by 90-degree rotation. The results from this study showed that the type of internal connection implant system did not significantly affect the rate of preload loss one month after initial torque.

An in vitro study (19) compared the effects of two different implant-abutment connections and two different implant diameters on screw joint stability. This study tested internal conical-hexagon and internal hexagon connections in both 3.3 mm and 4.2 mm diameter implants. The internal conical-hexagon group experienced a decrease in removal torque loss from 14.45% initially to 11.47% following cyclic loading. On the other hand, the internal hexagon connection

Figure 1. Relationship between lubricant and reliability of the joint assembly (17)



experienced a significant increase in removal torque loss from 20.47% initially to 35.35% post loading. The 4.2mm diameter implants were better at reducing torque loss than the smaller 3.3mm diameter implants. The presence of the conical component at the abutment-implant connection appeared to improve joint stability.

The superiority of the internal conical-hexagon connections was confirmed by Jacobs et al.(18) who found the abutment screws of the internal hybrid connection implants maintained their preload more efficiently than those of the internal conical connection implants following cyclic loading. The RTV for the internal conical connection group was significantly less than that for the internal hybrid connection group.

Numerous studies (21, 22, 23) investigated the effects of indexed abutments on screw joint stability. Yao et al. (23) found indexed abutments showed higher axial displacement into the implants when compared with non-indexed abutments. Moreover, the lack of index design resulted in a serious compromise in the stability of the conical connection after cyclic loading.

An in vitro study (22) compared non-engaging and partially engaging abutments in implant-supported fixed dental prostheses (FDPs). Partially engaging abutments were fabricated by selectively removing the interferences on the outer walls of the engaging abutments through CAD software. The mean number of cycles to failure for a prosthesis supported by non-engaging abutments was significantly less than for partially engaging abutments. 9 out of 10 abutment screws fractured inside the implant housing in the non-engaging abutment group. 7 out of 10 abutment screws fractured in the partially engaging abutments group but at a significantly higher number of cycles. The use of partially engaging abutments appeared to have less evidence of stress concentration due to the larger area of contact between the abutment extension and implant housing. The extension and partial engagement of the abutment could provide protection for the abutment screw and increase joint stability.

Calderon et al. (21) investigated engaging and non-engaging connections on both cylindrical and conical Ti base abutments supporting monolithic zirconia FDPs. 90% of the non-engaging conical Ti base abutments experienced screw deformation, compared with 82.1% for the non-engaging cylindrical Ti base abutments and 61.9% for the engaging cylindrical Ti base abutments. The lower screw deformation rate for the engaging cylindrical Ti base abutments was a statistically significant difference.

Three studies (24, 25, 26) investigated different implant-abutment connection tapers. Yao et al. (26) used finite element analysis to optimise the conical angle to obtain the highest connection stability in an Ankylos-based conical connection system. The optimal conical half angle obtained was found to be 10.1°, which was greater than the original design angle of 5.7°. This optimal design would have a decreased microgap at the implant-abutment interface and a more uniform stress distribution in the connection, resulting in a more stable screw joint.

This is in contrast to studies by Gehrke et al. (24) and Ozdiler et al. (25) who found the use of smaller taper angles to decrease torque loss following cyclic loading. No recent clinical studies investigated the effects of different taper angles on screw joint stability.

The effect of serrating the abutment-implant mating surfaces on joint stability was investigated in an in vitro study (27). Torque loss occurred in all abutments before and after cyclic loading, indicating the absence of cold welding in this study. Serration of implant-abutment mating surfaces was shown to have a significant effect on the reduction of torque loss in both one-piece and two-piece abutments before and after cyclic loading.

Lee et al. (28) evaluated the effects of different implant diameters with internal conical connections. Larger diameter implants demonstrated lower RTV value loss after cyclic loading in overload conditions.

Abutment material

Yilmaz et al. (29) compared Zr and Ti machined abutments on two different internal conical connection implants. The two connections used were an internal conical connection with dodecagram indices (CC, OsseoSpeed TX) and a modified internal conical connection with five evenly spaced slots with an additional sixth slot limiting abutment placement to just one position (MCC, OsseoSpeed EV). Both implants had the same taper angle of 11 degrees. Abutment screws were torqued to 20 Ncm for CC and 25 Ncm for MCC to the manufacturer recommendations. Abutments were subjected to cyclic loading through a chewing simulator. The screws used in MCC implant with Ti abutments exhibited significantly higher mean RTVs (36.27 Ncm) than those used in CC implants with Ti abutments (27.4 Ncm). The mean RTV for Ti abutments (36.27 Ncm) was greater than that for Zr abutments on MCC implants (31.18 Ncm) although this was not found to be statistically significant.

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Prosthetic and implant-abutment misfit

A systematic review (30) was conducted as part of the 2016 Foundation of Oral Rehabilitation Consensus Conference to assess the impact of marginal misfit at the implant-prosthesis interface on clinical outcomes. The authors concluded there was insufficient clinical evidence in the literature to support the increased risk of screw joint instability as a consequence of misfitting screw-retained implant-based prostheses.

An ovine model by Abduo and Judge (31), compared the effect of implant framework misfit on loosening torque values. Loosening torque values of the retaining screws were measured at the first and second reviews. At the first review, the RTVs for the immediate fitting frameworks were significantly greater than the immediate misfitting frameworks. At the second review, RTVs were comparable to the immediate fitting and misfitting frameworks. Retightening the retaining screws during bone maturation appeared to maintain torque values. Abduo and Judge reported a vertical misfit of 0.5 mm seemed to be associated with lower RTVs of the retaining screw.

An in vitro study (32) investigated the extent of fit between the implant and abutment on joint stability after loading. Joint stability was measured by the extent of tight contact surface between the implant and abutment with microgap of 3 microns or less between the abutment, abutment screw, and implant surfaces. Three different titanium abutments (Straumann Variobase, Ebi Best Duo, and Implant Direct) were torqued on original Straumann 4.1 RN 10 mm implants. Tightness of contact at various contact areas were measured through scanning electron microscopy (SEM) following implant-abutment splicing. After two million cycles of in vitro loading, the joint stability in all three groups did not appear to be affected.

Attachment system

A randomised controlled clinical trial (33) over 5 years investigated the prosthetic complications and maintenance of different attachments used in mandibular 2-implant overdentures. 90 edentulous patients were randomly allocated into 3 groups depending on the attachment system: bar overdentures (Dolder bar), telescopic overdentures, and stud overdentures (Locators). Amongst other outcome variables, the researchers assessed abutment screw loosening and abutment screw fractures. The incidence of abutment screw loosening was statistically significant, affecting 12.2% of patients in the telescopic group, 7.6% of patients in the stud group, and 3.2% of patients in the bar group. Abutment screw fracture occurred in 5.1% of patients in the telescopic group, 2.5% of patients in the stud group, and 1.3% of patients in the bar group. However, this was not statistically significant. The authors attributed the increased screw complication rate with telescopic overdentures to the increased vertical height of the attachment, thus creating a vertical cantilever and increasing stresses to the screw joint.

A prospective clinical study (34) assessed the 5-year clinical and technical outcome of mandibular 2-implant overdentures on stud (Locator) abutments. 56 patients were enrolled in the study. Screw loosening was categorised as a minor complication with 8 minor complications (out of a total of 375 complications) reported over the 5-year period. On average, each patient required 6.7 interventions for complications over the 5-year study.

Abutment and prosthetic design

Three studies (35, 36, 37) investigated the effects of different crown retention systems. A randomised controlled clinical trial (35) compared the outcomes for cemented versus

Table 2. Proposed fit and misfit classification according to reported assessment techniques (30)

Fit/misfit	Before screw tightening: Gap size at the interface (vertical and horizontal)	During screw tightening or loosening: Rotation (°) to final load (+ screw torque monitoring)	After screw tightening: Strains in the pontic	Fabrication feasibility and clinical acceptance
Perfect	0 µm	Small final rotation (Screw torque initial: low; final: steep increase)	0 µm/m	Theoretical
Very good	< 25 µm		< 25 µm/m	3-unit IFD
Good	< 50 µm	< 45° final rotation	< 50 µm/m	4-9 unit IFD
Fair	50 -100 µm		100 - 150 µm/m	Complete IFD
Moderate	100 - 150 µm		100 - 150 µm/m	Not acceptable
Poor	> 150 µm	> 90° final rotation	> 150 µm/m	Not acceptable
Very poor	> 200 µm	Great final rotation ° (Screw torque initial to final: constantly high and increasing)	> 200 µm/m	Not acceptable

Table 3. Clinical in situ assessment methods on the fit of prosthesis requiring only basic chairside equipment. One-ST: one screw test, All-ST: all screw test (30)

Assessment method	Screw retention	Criteria	Limitations
Visual (Eye, binoculars)	None (One-ST) (All-ST)	Macroscopic gap visible	- Subgingival interface/mucosa interposition - Conical connection - Age > 40 years - Experience - Light, angle, background - Quantitative discrimination
Tactile (Alternate finger pressure)	None (One-ST)	Lifting, Rocking, Motion Saliva movement	- Subgingival interface/mucosa interposition - Close implant position - Linear implant position - Conical connection - Experience - Inconsistent - Quantitative discrimination
Tactile (Explorer)	One-ST All-ST	Tactile discrimination	- Subgingival interface/mucosa interposition - Conical connection - Clinician's discriminatory ability - Explorer worn tip > 100 µm - Experience - Inconsistent - Quantitative discrimination
Radiographical (Periapical)	One-ST All-ST	Macroscopic gap visible	- Non-perpendicular alignment/angulation - Overlapping components - Radiolucent components - Knowledge on system - Experience - Analogue: size and contrast - Digital: filter effects
Screw retention	Serial screwing	Resistance while screwing up to final torque: none/steep vs consistent/flat	- Subgingival interface/mucosa interposition or pressure - Conical connection - Clinician's discriminatory ability - Ranking of serial screwing - Experience - Inconsistent - Quantitative discrimination

screw-retained zirconia-based single implant crowns. There were no abutment screw loosenings nor fractures during the 5 years for twenty-six patients with 26 implants.

A prospective cohort study (36) evaluated the outcomes of using angulated screw-retained and cement-retained implant crowns in the aesthetic region with 1-year follow-up. Angulated screw-retained crowns or cemented crowns were chosen according to patients' requirements. The angulated screw-retained group consisted of 23 patients and the cemented-retained group consisted of 20 patients. Two cases of screw loosening occurred during the observation period in the angulated screw-retained group whereas no screw loosening nor fractures occurred in the cement-retained group.

An in vitro study (37) compared abutment screw torque changes with five different abutments. The authors reported angulated access channel crowns performed similarly with straight-line screw access screw-retained crowns with regards to percentage torque loss following cyclic loading. However, they failed to mention the angulated access screw channel crowns only outperformed the straight screw-retained crown with a high noble metal implant connection. The comparison was unfair and the conclusion did not accurately reflect the findings of the study. The high noble metal Gold-Adapt crowns demonstrated the greatest percentage of torque loss when compared to the zirconia crown-Ti base group.

Two studies (38, 39) examined the effects of different abutment-crown combinations. Pitta et al. (39) attempted to evaluate the joint stability of different abutment-crown combinations, including PFM using gold abutment (GAbut-PFM), lithium disilicate crown bonded to customized titanium abutment (TAbut+LDS), lithium disilicate abutment-crown bonded to titanium base (TiBase+LDS), zirconia abutment-crown bonded to titanium base (TiBase+ZR), polymer-infiltrated ceramic-network (PICN) abutment-crown bonded to titanium base (TiBase+PICN). The restorations were subjected to simultaneous thermal cycling and mechanical loading. Screw loosening only occurred in the GA-PFM group (18.2%). However, the TiBase+LDS, TiBase+ZR and TiBase+PICN groups experienced significantly higher debonding events of 58.3%, 87.5%, and 85.7% respectively.

Cantarella et al. (38) investigated the effect of five types of reconstructions on mechanical stability. The different constructions included:

- Control group (C): two-piece Ti implants restored with screw-retained monolithic all-ceramic crowns using Ti base abutments
- Test group 1 (T1): two-piece Zr implants restored with screw-retained monolithic all-ceramic crowns using customised zirconia abutments
- Test group 2 (T2): two-piece Zr implants restored with screw-retained monolithic all-ceramic crowns using Ti base abutments
- Test group 3 (T3): two-piece Zr implants restored with cemented monolithic all-ceramic crowns on PEKK abutments
- Test group 4 (T4): one-piece Zr implants restored with cemented monolithic all-ceramic crowns

The restored specimens were subjected to simultaneous thermal and mechanic loading over 1.2 million cycles. Screw loosening occurred in 58.3% specimens in the control group, 10% of specimens in T1, and 50% of specimens in T3. Although no screw loosening events occurred in T2, two implants and one abutment fractured. The results of this study need to be interpreted with caution due to the large variation in abutment dimensions, abutment/implant connection geometry, screw material, and torque. Material thickness and the design of the implant-abutment connection play an important role in fatigue resistance of the material.

Hein et al. (40) measured the effect of abutment angulation on prosthetic abutment screw loosening. Straight, 17-degree, and 30-degree angulation prosthetic abutments (both indexed and non-indexed) were installed on internal conical connection implants and cyclically loaded. The specimens with indexed abutments had a mean RTV less than that of the nonindexed abutment group. Only 59.9% of the initial torque of 15 Ncm was maintained in the nonindexed group and 44.8% in the indexed group. 30-degree angulation prosthetic abutments exhibited the lowest RTVs followed by the 17-degree angulation abutments. However, this decrease did not occur for non-indexed abutments.

An in vitro study (41) investigated different 25-degree angled screw hexalobular systems on applying the target torque to the abutment screws. 28 implants were divided into 4 groups (n = 7): DY (Dynamic Tibase; Dynamic Abutment Solutions), DE (AngleBase; Dess Dental Smart Solutions), ASC (Angulated Screw Channel Solutions; Nobel Biocare AG), and UB (Universal Base; Nobel Biocare AG), with UB serving as the control group. The recommended torque values were 25 Ncm for DY and 35 Ncm for ASC, UB, and DE. The initial torque value in the DY group did not significantly deviate

Figure 2. Different hexalobular systems: ASC, Nobel Biocare angulated screw channel; DE, Dess Dental Smart Solutions anglebase; DY, Dynamic Abutment Solutions dynamic tibase; UB, Nobel Biocare universal base. A, Screw drivers. B, Abutment screws (41)

from the manufacturer's recommended value. This is in contrast to the ASC and DE groups that deviated significantly in their initial torque values. The 25-degree angled screw channel solutions with recommended torque values of 35 Ncm had RTVs similar with those of conventional straight access crowns following cyclic loading.

Five studies (42, 43, 44, 45, 46) have reported on the incidences and extent of screw joint instability in long span implant-supported FDPs. These studies have adopted the popular "All-on-4" treatment protocol (Nobel Biocare) involving the placement of 4 implants in a completely edentulous jaw to support a full arch implant-supported FDP. The two most anterior implants are placed axially, whereas the two most posterior implants are distally tilted. Multiunit abutments are attached to the implants and the implants are immediately loaded. A prospective clinical study with 7-year follow-up by Ayub et al. (42) evaluated the prosthetic complications of full arch fixed implant-supported prostheses following the All-on-4 treatment concept. The All-on-4 protocol involved the placement of two axial implants in the lateral incisor region and two tilted implants in the second premolar/molar region. 16 patients were initially enrolled in the study (12 women and 4 men). After the 7-year follow-up period, only 12 patients were included in the analysis because of non-attendance or were deceased. Prosthetic screw and abutment loosening was observed in 25% of patients (n = 3), which was erroneously underreported as 18.75% by the authors. It is important to note that 50% of arches restored by the All-on-Four protocol in this study were opposing conventional complete dentures.

A prospective clinical study (43) compared the prosthetic outcomes of metal-ceramic and PEEK-composite implant-supported prostheses using the All-on-4 treatment concept (Nobel Biocare). 30 participants with edentulous maxillary and distal extension mandibular ridges were enrolled in the study. Group 1 (metal group) comprised 15 patients who received fixed porcelain-fused-to metal restoration. Group 2 (PEEK group) consisted of 15 patients and rehabilitated by fixed PEEK framework veneered with composite resin. Prosthetic complications were measured after 3 years. Abutment screw loosening occurred in 8.3% implants in the metal group and 3.3% of implants in the PEEK group. Abutment screw fracture did not occur for any implants. The most frequent complication for the metal group was prosthetic screw loosening (11.6%), which was significantly higher than the PEEK group (1.6%). Prosthetic screw fracture occurred in 3.3% of implants in the metal group and 0% of implants in the PEEK group. Prosthetic complications from the provisional restorations were not evaluated in this short-term study.

An in vitro study by Tiossi et al.(46) investigated the effect of long span implant-supported FDP on screw torque loss. Two groups were tested in this study (n = 5 per group):

- "All-on-4" (AO4) zirconia framework with porcelain crowns, 12-unit cantilevered FDPs supported by four implants; Implants #1 and #2 were placed axially to the occlusal plane; implants #3 and #4 were tilted 30° to distal
- "All-on-6" (AO6) zirconia framework with porcelain crowns, 14-unit FDPs supported by six implants; Implants #1 and #2 were placed axially to the occlusal plane; implants #3 and #4 were tilted 30° to distal; and implants #5 and #6 were tilted 17° to mesial

Prosthetic screws were torqued to 10 Ncm. The AO6 group showed significantly higher screw torque loss after mechanical loading. The AO4 group presented significantly higher screw torque loss before mechanical loading compared to the AO6 group. A significantly higher percentage of torque loss was found for group AO4 compared to AO6 when the most distal implants were compared.

A retrospective longitudinal study by Maló et al.(44) evaluated the long-term outcomes of the All-on-4 treatment concept for the rehabilitation of the edentulous mandible. 1884 implants were placed in 471 patients (286 women, 185 men; average age = 57.7 years) and followed up for 10 to 18 years. 27 patients deceased (5.7%) and 149 patients (31.6%) were lost to follow-up. Mechanical complications occurred in 173 patients in the definitive prostheses (36.7%) and 139 patients in the provisional prostheses (29.5%), with 28 patients accumulating mechanical complications in both the definitive and provisional prostheses. For the provisional prostheses, there were 75 incidences (15.9%) of abutment screw loosening, 3 incidences (0.6%) of prosthetic screw loosening, and 1 incident (0.2%) of prosthetic screw fracture. For the definitive prostheses, there were 70 incidences (14.9%) of abutment screw loosening, 23 incidences (4.9%) of prosthetic screw loosening, and 9 incidences (1.9%) of prosthetic screw fracture.

A similarly conducted retrospective study was conducted by the same author(45) for the edentulous maxilla. 4288 implants were placed in 1072 patients (men: 442 patients; women: 630 patients; average age 55.8 years) through

the All-on-4 treatment concept and followed up for 5 to 13 years. 18 patients deceased unrelated to the implant treatment (1.7%) and 219 patients (20.4%) were lost to follow-up. Mechanical complications occurred in 630 patients (58.8%) in the provisional prostheses and 78 patients (7.3%) in the definitive prostheses with one patient accumulating mechanical complications in both prostheses. For the provisional prostheses, there were 399 incidences (37.2%) of abutment screw loosening, 3 incidences (0.3%) of prosthetic screw loosening and 12 incidences (1.1%) of prosthetic screw loosening. For the definitive prostheses, there were 21 incidences (2.0%) of abutment screw loosening and 2 incidences (0.1%) of prosthetic screw loosening. The retrospective nature of these studies(44, 45) and the large number of patients lost to follow-up would reduce the study's validity.

One study(47) investigated the effects of different additive manufacturing (AM) technologies on the marginal fit and screw-loosening torque of full-arch metal frameworks supported by dental implants. Velôso et al.(47) compared frameworks manufactured by electron beam melting (EBM) and selective laser melting (SLM) with milled frameworks. Fifteen Ti-6Al-4V frameworks were made from the same STL file. Marginal fit and screw-loosening torque evaluations were completed at baseline, following veneer layer application, and following spark erosion. At baseline, the SLM group showed a worse marginal fit compared with the other two groups. The milling frameworks showed higher screw-loosening torque than the other two groups. Following veneer layering, the EBM group showed the worst marginal fit values. Higher detorque values were found for the milling group, followed by the EBM and SLM groups. Following spark erosion, the SLM group showed the worst marginal fit values compared with the other groups. EBM showed an improvement in marginal fit values. Framework manufacturing method influenced the marginal fit and preload maintenance. The milling group showed superior marginal fit and higher reverse torque values.

Oral forces and occlusal overload

Two in vitro studies(48, 49) investigated the effect of crown height on joint stability. Yilmaz et al.(49) assessed the effects of crown height on the screw joint stability of zirconia screw-retained implant crowns on Ti base abutments. Three different heights of zirconia crowns (6mm, 10mm, 14mm) were milled and cyclic loaded. Crown height did not have a significant effect on detorque values of screws but it did have a significant effect on survival of the crown-implant complex with screws fracturing.

In another study(48), Yilmaz et al. fabricated seven titanium crowns of 3 different heights (6 mm, 10 mm, and 14 mm) and then cyclic loaded them at 120 N, 275 N and 475 N, replacing screws in between cycles. Despite detorque values in the 14mm group being lower than the other groups, the authors concluded that crown heights of screw-retained titanium implant crowns with UCLA abutment connections did not significantly affect RTVs. Screw fracture was greater for crowns 14 mm in length than those of shorter crowns.

An animal study(50) utilising a beagle dog model was used to evaluate the outcomes of excessively loaded implants. The treatment groups included: a single implant crown with stable occlusal contacts, a single implant crown with a cantilever unit with excessive occlusal overload, and a non-loaded implant. Prosthetic screw loosening occurred in 13.3% of cantilevered implant crowns compared to 3.3% for the single implant crown group.

Dental implant material

An in vitro study(51) compared the stability of two-piece zirconia implants with two-piece titanium implants. All implants were restored with monolithic zirconia crowns in the form of either an incisor-shape or a molar-shape. Eccentric two-point alternating loading protocol was carried out to promote abutment and screw loosening. Screw fractures (n = 3) were most common with zirconia implants in the incisor region whereas screw loosening (n = 3) was most common in with titanium implants in the molar region. Despite the authors' conclusion that the tested zirconia implants had a comparable connection to standard titanium implants, the low sample size would undermine the validity of the study.

Conclusion

In vitro studies on screw joint stability need to be interpreted with caution as they do not consider the effects of saliva, thermal changes, and oral forces on the mating surfaces. There has been a trend towards using ceramic materials for implant fixtures, abutments, and prostheses in recent years due to their aesthetic benefits and ease of fabrication. However, these have resulted in catastrophic consequences due to the inherent brittle nature of ceramics. More long-term randomised controlled clinical trials are needed to accurately determine the performance of different screw joints. In the absence of robust long-term evidence, the

restorative clinician should have a sound understanding of the material properties, stress distribution and interaction of the mating surfaces to reduce the rate of prosthetic complications involving the dental implant screw joint.

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Qualityover quantity

How less fluoride can actually be more

Moira Crawford speaks to Prof Hill and asks how less fluoride can actually be more

Fluoride has long been seen as the 'magic bullet' in dental protection. There's no doubt that the introduction of fluoride has had a beneficial effect on the rates of decay, especially among children from deprived backgrounds, but it may be time to reassess the levels of fluoride that are given.

Too much fluoride, caused either by fluoride treatment or children ingesting toothpaste, can cause fluorosis and has led to strong anti-fluoride lobby.

In the **UK scientists are now arguing that high concentrations of fluoride alone are actually not the best strategy.**

Professor Robert Hill, research director at the Dental Institute and head of dental physical sciences at Queen Mary University of London, has been researching this area for some years, and is convinced that applying ever higher concentrations of fluoride to the teeth does not have the benefit that has previously been believed. 'Simply increasing the amount of fluoride within the toothpaste is frankly a crude solution,' he argues. 'Much of the additional soluble fluoride just goes to waste.'

The problem with fluoride toothpaste

Professor Hill's experiments have demonstrated that when conventional fluoride toothpaste containing a soluble fluoride such as sodium fluoride or sodium monofluorophosphate is used, there is an immediate 'high' of fluoride in the mouth, but that this drops rapidly as the toothpaste is washed away by salivary flow, so that after around only 100 minutes the amount of fluoride that remains is below therapeutic levels (Figure 1). **Even at high concentrations, the fluoride is rapidly washed away, so the effect is only short term.**

A further drawback is that high concentrations of fluoride form calcium fluoride (also known as fluorite) instead of fluorapatite, which is what is required for effective remineralisation. In large quantities fluorite can form a whitish crust on the tooth surface, which was previously thought to act as a reservoir of fluoride, but Professor Hill's completely insoluble, and does not release fluoride at all,' he explains.

BioMin F

Professor Hill and his team have developed a toothpaste that contains a bioactive glass that delivers a combination of calcium, phosphate and fluoride-ions to promote effective remineralisation of tooth enamel through the production of fluorapatite. Because the fluoride in BioMin F is incorporated within the structure of the glass, it is delivered gradually as the glass dissolves, and therefore a lower concentration (approx 530 ppm is required yet is more effective.

The fluoride contained within the glass structure of BioMin F is released slowly over around 12 hours and is therefore used more effectively. Prof. Hill says: 'As it dissolves, the glass structure in BioMin F provides a slow release vehicle for the fluoride, calcium and phosphate together, enabling it to form fluorapatite, which is more stable and resistant to acid conditions.'

BioMin F continues to remineralise tooth enamel for approximately 12 hours but some effects are still continuing at 24 hours after brushing.

How fluoride works in Biomin F

BioMin F has been developed to address three key problems in dental health: hypersensitivity, caries and dental erosion, caused by loss of tooth enamel or demineralisation. Under normal conditions, the hydroxyapatite mineral in tooth enamel is in dynamic equilibrium with the calcium, phosphate and hydroxyl ions in saliva, but under acidic conditions, such as following an acidic drink, this equilibrium is shifted, the pH in the mouth falls and demineralisation can occur.

As the bioactive glass in BioMin F gradually dissolves it releases phosphate, calcium and fluoride ions, these work in concert with the saliva to raise pH and restore equilibrium. Even more clever, at a lower pH the glass dissolves faster, so that the effect kicks in more rapidly.

Professor Hill summarises: 'This smart response means that if the user consumes an acidic drink, BioMin F dissolves faster to protect the teeth against acid dissolution.'

Sensitivity

In order for the glass to dissolve slowly where it's needed, the toothpaste has to stay on the teeth. The polymer used in Biomin F increases the viscosity of the toothpaste, but also chemically bonds to both the calcium in the tooth enamel and the calcium in the Biomin F, so that it sticks to the tooth surface and remains in place to release the fluoride, calcium and phosphate ions for several hours . **As the glass particle size is very small, these particles are able to enter the dentinal tubules and work to occlude these** . Fluorapatite forms preferentially on the apatite rich walls of the peritubular dentine within the tubules gradually occluding them, an effect still visible after acid challenge . Professor Hill and his research team believe that fluorapatite crystals probably favour growing on the existing apatite-rich walls of the dentinal tubules, which have a higher mineral content.

As the fluorapatite occludes the dentinal tubules, it reduces the flow of fluid, known as hydraulic conductance, which is the cause of sensitivity. Studies at Queen Mary have shown that the fluorapatite formed by the dissolution of the glass in BioMin F is more resistant to acid challenge than hydroxy-carbonated apatite formed from soluble fluoride in conventional toothpastes, and so the tubules remain occluded more completely.

The hydraulic conductance shows a greater percentage reduction as well as faster remineralisation rates than other toothpastes tested, says Professor Hill.

Professor Hill and his research team's have shown that it is not quantity of fluoride that improves its efficacy, but quality – the way that it is delivered.

Incorporating fluoride within the structure of the bioactive glass, combining it with phosphate and calcium ions to enable quicker production of stable, acid-resistant fluorapatite, and adhering the product to the teeth so that it can dissolve slowly where it can deposit fluorapatite most effectively, is the key to its effectiveness. Biomin F is a smart toothpaste, using new technology to deliver efficient remineralisation at levels of fluoride far lower than conventional toothpastes. It seems that in this case, less fluoride really can be more!

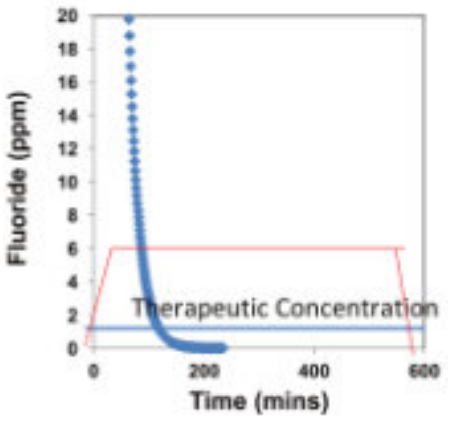

Figure 1: Soluble fluoride drops rapidly below therapeutic levels

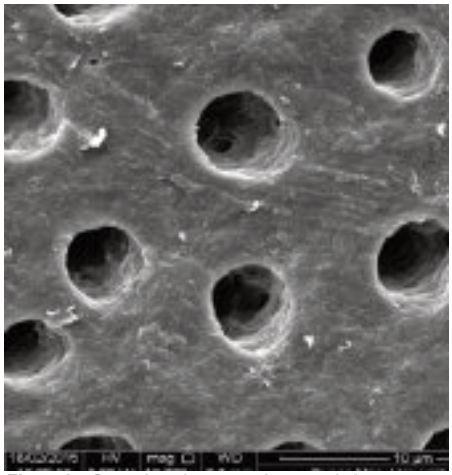

Figure 2a: Scanning electron micrograph image showing tubule occlusion before brushing with Biomin F

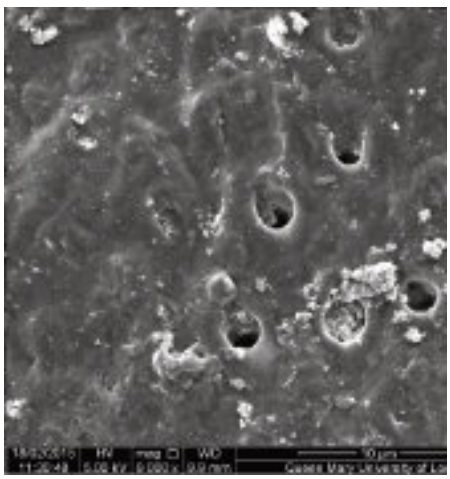

Figure 2b: Scanning electron micrograph image showing tubule occlusion after acid challenge

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The Adjunctive Use of Antimicrobials in the Management of Peri-Implantitis

Dr Clarence Da Cruz[1]
[1]Melbourne Dental School, The University of Melbourne, Carlton, Victoria, Australia

Introduction

Dental implants and advancing implant technology over the past 40 years have revolutionised modern dentistry (1). However, dental implants are prosthetic devices that can present with biological complications of which a great concern is peri-implantitis. A systematic review has reported the prevalence of peri-implantitis to be wide ranging from 1-85% and an incidence appearing low within the first 0-3yrs at 0.4% but rapidly increasing within 5yrs to ~40% (1). A Swedish epidemiological study has reported the prevalence of peri-implantitis to be 45% (2). "Peri-implantitis is a pathological condition occurring in tissues around dental implants, characterized by inflammation in the peri-implant mucosa and progressive loss of supporting bone" (3). Whilst aetiology of peri-implantitis is multifactorial, it is predominately associated with bacterial plaque biofilm composed of a heterogenous mix of periodontal pathogenic bacteria including asaccharolytic anaerobic gram +ve rods and gram -ve rods (4). Effective control of plaque is one of clinical rationales for the use of adjunctive antimicrobial agents in the management of peri-implantitis. Antimicrobials include varying classes of drugs including antibiotics, antivirals, antifungals and antiparasitics used to prevent and treat infections in humans, animals and plants (5). For the purpose of this review, the scope of antimicrobials will pertain to antibiotics/antibacterials, antiseptics, laser therapy, photodynamic therapy (PDT) and ozone therapy. This review will discuss the clinical outcomes of adjunctive systemic, local and combination antimicrobial therapies in two parts. Part A will discuss non-surgical therapy with adjunctive antimicrobials, while part B will discuss surgical treatment of peri-implantitis with adjunctive antimicrobials. Furthermore, surgical intervention will be subcategorized into four sections: B1) Open flap debridement (non-resective), B2) open flap debridement with resective therapy, B3) Reconstructive, B4) combination resective and reconstructive.

Abstract:

There is currently no consensus on the adjunctive use of antimicrobials in the management of peri-implantitis. The current literature shows a heterogeneous mix of nuanced interventional protocols with varying results. The following review approaches the literature on antimicrobial therapy (antibiotics, antiseptics, laser therapy and photodynamic therapy) from a non-surgical and surgical approach and explores the use of local, systemic and combination (local & systemic) antimicrobial therapies for the management of peri-implantitis. Additionally, surgical therapy is assessed based on treatment approach via open flap debridement non-resective, resective, reconstructive or combination resective and reconstructive therapies. Non-surgical management of peri-implantitis with adjunctive local, systemic and combination antimicrobial therapies all had limited efficacy. More favourable results were achieved with a surgical approach using a combination resective and reconstructive approach combined with both local and systemic antimicrobials. However, more long term parallel-arm randomised control trials are needed to provide more clear guidelines on peri-implantitis management.

The Australian Journal of Periodontology and Implant Dentistry

PART A: Non-surgical peri-implantitis management with adjunctive antimicrobials

Non-surgical management: local antimicrobials

Minocycline spheres v chlorhexidine Gel

The rough surface topography of modern dental implants presents a challenge to surface decontamination efficacy, which has led to adjunctive therapies in the form of slow releasing local antibiotics. Renvert et al. (2006) conducted a 12 month RCT to investigate the adjunctive effects of Local Drug Delivery (LDD) minocycline microspheres (Arestin®, OraPharma) against 1% Chlorhexidine (CHX) gel in the non-surgical management of peri-implantitis. 32 patients with peri-implantitis received supra-subgingival non-surgical treatment and were subsequently randomly allocated to two groups to receive either 1% CHX gel (n = 16) or minocycline spheres (n = 16). Minocycline treatment involved drying the implant surface and applying a single dose sub gingivally using a dispenser provided with the product (Arestin®, OraPharma). The 1% CHX group received 1ml of 1% CHX gel inserted submucosally 4 sites around each implant via a syringe. Patients were instructed not to brush for 12hr and avoid interproximal brushing for 10 days. The results showed for the deepest sites in the minocycline group a probing depth (PD) change of 0.6mm and 0.3mm in the 1% CHX group. These results were statically but not clinically significant. Furthermore, the mean values showed no significant difference between baseline and follow-up observations for both groups (6). This study showed neither minocycline nor 1% CHX gel to be of clinical benefit in non-surgical management of peri-implantitis. A follow up study by Renvert et al. (2008), conducted a similar study on 17 subjects. However, instead of single application, multiple applications of minocycline and CHX were made at baseline, 30 and 90 days. Over 12 months the results showed again for the deepest sites that minocycline treatment with PD reduction of 0.6mm and the CHX with a PD reduction 0.4mm reduction (7). These studies showed there was no clinically significant benefit from single or repeated applications of minocycline spheres or 1% CHX gel as part of non-surgical management of peri-implantitis

Chlorhexidine biodegradable matrix v Placebo biodegradable matrix

Biodegradable matrix of CHX had been previously been used in the management of periodontitis and interest had grown for the application in peri-implantitis treatment. A multicentred RCT by Machtei et al. (2012) investigated the use of adjunctive CHX chips (PerioChip®, Dexcel Pharma) as part of non-surgical treatment of peri-implantitis. 60 patients contributing 77 implants were randomly allocated to two groups receiving either CHX impregnated matrix chips or placebo cross link gelatin chips. The results at 6 months showed a trend favouring the use of CHX 2.5mg impregnated matrix chips with a PD change of 2.19 + 0.24mm compared to placebo chips 1.59 + 0.23mm. However, the difference between the two treatment groups was not statistically nor clinically significant (8). A larger RCT study of 290 patients conducted by the same group Macheti et al. (2021) investigated repeated applications of CHX chips compared to repeated implant surface debridement alone. Following interventional sessions every 2 weeks for 12 weeks results were recorded at 6 months. These results showed a mean implant PD reduction for the CHX chip group was 1.76 +/- 1.13mm compared to 1.54 +/- 1.13mm for the control group (9). These results again showed no clinically significant benefit from the use of a local biodegradable application of CHX chip.

Laser therapy: Er:YAG

In the late 90's and early 2000's research was being conducted into lasers and their adjunctive management of peri-implantitis. Schwarz et al. (2005) in a pilot study investigated the efficacy of Er:Yag laser (ERL) in the treatment of peri-implantitis. 20 patients contributing 32 implants were randomly allocated to a test group 10 patients (16 implants) treated with ERL and a control group 10 patients (16 implants) treated with mechanical debridement using plastic curettes and CHX 0.2% pocket irrigation and subgingival 0.2% CHX gel application. At 6 months both groups showed statistically significant improvements in clinical parameters from baseline. However, between test and control groups there was no significant difference in PD and CAL gain (10). A follow up study by the same group examined 40 implants from 20 patients over 12 months with a similar methodology comparing Er:Yag to plastic curettes supplemented with CHX solution and gel intra-operatively. Their results at 12 months again showed no significant difference between both groups. Furthermore, no significant difference was

seen from baseline to 12 months. Therefore, the efficacy of both Er:YAG and plastic curette with CHX pocket irrigation and CHX gel application was not sustained at 12 months (11).

Laser therapy: Diode

Arisan et al. (2015) performed a split mouth clinical trial exploring the efficacy of diode laser treatment compared to conventional scaling of peri-implantitis. 10 patients contributing two bilateral rough surface implants (n= 48) with peri-implantitis were randomly allocated to either treatment by conventional debridement or diode laser. The results showed similar PD at both baseline and 6 months follow up and no significant difference between groups. Microbiology was also examined by DNA hybridisation 1 month after treatment and showed a reduction in total bacterial load but no significant difference between groups (12). This study showed that diode laser treatment does not provide any additional clinical benefit to the outcome of non-surgical peri-implant therapy.

Photodynamic therapy

Photo dynamic therapy (PDT) involves the use of a photosensitive dye activated by laser treatment to generate oxygen radicals that kill periodontopathogens. Schär et al. (2013) investigated clinical outcomes of PDT as part of non-surgical therapy. 40 patients contributing at least 1 implant with peri-implantitis received mechanical debridement with titanium curettes and air abrasive device (AAD) with glycine powder (Air-Flow Maser®, EMS). Patients were then randomly allocated to the test group for adjunctive PDT with a wavelength of 660nm and a photosensitiser dye phenothiazine chloride for 3 mins. Pockets were then irrigated with 3% hydrogen peroxide. Each pocket received laser treatment for 10seconds. PDT was then repeated 1 week later. The control group received peroxide 3% irrigation followed by adjunctive LDD minocycline hydrochloride microspheres (arestin, HANSAmed) equivalent to 1mg of minocycline. post operative the control group was advised not to floss to avoid dislodgment of the LDD, while the test group was instructed to keep flossing. The results showed mean PD had in both groups but not statistically significant difference between groups. The control group (minocycline) showed a mean PD change of 0.49mm and the test (PDT) group showed 0.36mm. These results showed no clinically significant difference between both groups nor between baseline and 6 months review (13). Overall photodynamic therapy does not appear to show significant clinical benefit in a non-surgical approach to peri-implantitis treatment. A limitation of this study was the lack of control group without any antimicrobial therapy. A more recent study has conducted a similar investigation of PDT with use of a saline control group. Wang et al. (2019) Investigated the use photodynamic therapy in the management of peri-implantitis amongst 132 patients. Patients were randomly allocated to two groups, 66 patients received photodynamic therapy and 66 received a saline wash. Both groups underwent full mouth debridement and AAD (Airflow, EMS). Following AAD treatment the PDT group received PDT with toluidine blue photosensitiser and the control group a saline wash. The results at 6 months showed a PD change of 1.87 mm in the test group (PDT) and 0.45 mm in the control group (saline). These results suggest PDT is more effective than saline alone in non-surgical management of peri-implantitis (14). The difference between Schär et al. (2013) may be attributed to different controls used.

Non-surgical management: Systemic antimicrobials

Systemic azithromycin

Azithromycin has an affinity for inflamed tissues preferentially taken up by phagocytes and has been used as an adjunct for management of periodontitis with clinical benefits (15). The inflammatory profile of peri-implantitis is also associated with plaque biofilm and this led Gomi et al. (2015) to investigate the use of Azithromycin as an adjunct to non-surgical peri-implantitis management. 20 patients with peri-implantitis classified as C or D based on the cumulative interceptive supportive therapy (CIST) protocol were allocated into control and test groups. Both groups received supragingival debridement. The test group was then given Azithromycin 3 days before non-surgical subgingival treatment. Therapy was performed in a single visit and plastic curettes and plastic ultrasonic scalers were used; the average treatment time was 100mins. The control group received non-surgical debridement over multiple visits within 5 weeks and no antibiotic therapy. Patients were followed up at 1 week and 1, 3, 6, 9 and 12 months following debridement. The mean values favoured the test group over the control group at 1 to 12 months post treatment. At 12 month the mean change for PD reduction was 0.94mm for test group and 0.13mm for the control group (16). Whilst the results showed a statistically significant difference, this was clinically less applicable.

Systemic amoxicillin and metronidazole

Shibli et al. (2019) identified no previous RCTs on combination amoxicillin and metronidazole in non-surgical management of peri-implantitis. This led Shibli and co-workers to run such an RCT comparing outcomes against placebo pills. 40 subjects with at least 1 implant with peri-implantitis received non-surgical therapy in the form of treatment with Teflon curettes and in two groups given either a course of metronidazole 400mg and amoxicillin 500mg prescribed for 3 times a day for 14 days (test group) or placebo pills (control group). Following treatment both groups were placed on a maintenance program of 3 monthly reviews for 1 year. Their results at 12 months showed treatment success of <5mm PD with absence of BOP and no further bone loss was achieved in 65% (13/20) of the test antibiotic group and 55% (11/20) in the control placebo group (17). Overall, there was not a significant difference between both groups, concluding there is insufficient evidence to support routine use of adjunctive systemic amoxicillin and metronidazole over non-surgical therapy alone.

Non-surgical management: Combination systemic and local antimicrobials

Systemic ornidazole with local chlorhexidine

Mombelli and co-workers in 1987 had identified high numbers of anaerobic gram -ve rods shaped bacteria from failing implants. This led Mombelli & Lang. (1992) to investigate the clinical and microbiological effects of adjunctive systemic antimicrobials effective against gram -ve anaerobic bacteria as part of non-surgical peri-implantitis treatment. Ornidazole was selected based on longer half-life properties than metronidazole. 9 patients with hollow designed ITI implants were included. Patients with PD >5mm 6 months from placement along with microbial samples showing >10^6 CFU/ml were included. Treatment involved mechanical instrumentation, pumice polishing with rubber cup, irrigation with 0.5% CHX and 1 times daily, 10 day course of ornidazole 1000mg. Home care instructions included twice daily personal home care subgingival irrigation with 0.2% CHX via a luer syringe with blunt canula for 10 days. The clinical and microbial culture analysis results at 12 months showed a significant mean PD reduction and significant drop in anaerobic gram -ve rods from 40% at baseline to 15% at 12 months and also a drop in gram + anerobic cocci from 17% at baseline to <1% at 12 months. Overall, this study showed a reduction in anaerobic bacterial load may of which may have contributed to a resolution of inflammation (18).

Systemic amoxicillin/metronidazole and local chlorhexidine

Whilst Shibli et al. (2019) had previously conducted a study with combination antibiotic therapy showing no significant difference between antibiotics and non-surgical treatment alone. They did not combined treatment with local adjunctive antimicrobials. De Waal et al. (2021) conducted an RCT investigating the use of combined systemic amoxicillin with metronidazole and local application of CHX as part of non-surgical peri-implantitis management. 57 patients contributing 122 implants underwent non-surgical therapy with dental hygienists. Treatment included AAD/erythritol powder, ultrasonic scaling, CHX gel, and CHX/CPC mouth rinse. Patients were then randomly allocated to test and control groups. The test group received a 3 times daily 7 day course of amoxicillin 500mg and metronidazole 500mg. The results showed both groups with improved over baseline however no significant difference was seen between groups (19). These results supported Shibli and co-workers, discouraging the routine use of combination amoxicillin and metronidazole for the non-surgical management of peri-implantitis.

Systemic metronidazole and local chlorhexidine

A RCT conducted by Blanco et al. (2022) investigated the efficacy of adjunctive systemic metronidazole with non-surgical management of peri-implantitis. 32 patients contributing 62 implants underwent a non-surgical therapy debridement with stainless steel curettes, ultrasonic scaling, irrigation with CHX. Subsequently, patients were allocated a course of either Metronidazole 250mg (test group) or a placebo pill (control group). Both groups were advised to take two tablets 3 times a day for 7 days. The success criteria was <5mm with or without BOP or 5mm without BOP. The results at 12 months showed more of the patients in the test group, 56% met the success criteria compared to 25% in the control group. Additionally, statistically significant improvements were seen in the CAL and bone gain for the test group. The study demonstrated non-surgical debridement therapy combined with metronidazole was more effective than conventional non-surgical debridement therapy in achieving pocket reduction, CAL gain and bone gain in the management of peri-implantitis, albeit with a low success rate of 56% (20). The results of Blanco and co-workers were in agreement with the previous study by Mombelli & Lang. (1992), supporting the adjunctive use of antibiotics targeting anaerobic bacteria.

Part A conclusions: Non-surgical management of peri-implantitis with adjunctive antimicrobials

Currently local application of antimicrobials (antibiotics, antiseptics, laser and PDT) do not appear to show a clinically significant benefit over non-surgical therapy without adjunctive antimicrobials in the management of peri-implantitis (7, 9, 11-13). Systemic antibiotic therapy only appears to show at just over 50% efficacy when using antibiotics targeting anaerobic bacteria combined with local antimicrobials (17-20).

PART B: Surgical management of peri-implantitis with adjunctive antimicrobials

Open flap debridement: Systemic antimicrobials

Systemic amoxicillin

Heitz-Mayfield and co-workers noted the similar bacterial aetiology of peri-implantitis to periodontitis, this provided the rationale for systemic antimicrobials as part of surgical management of peri-implantitis. Heitz-Mayfield et al. (2012) in a prospective cohort study investigated the efficacy of systemic amoxicillin with surgical management of peri-implantitis. 24 patients contributing 36 implants with peri-implantitis underwent surgery involving raised flaps, removal of granulation tissue, use of titanium coated curettes, or carbon fibre curettes and saline soaked gauze used with a rubbing action. Flaps were repositioned, sutured and patients were prescribed amoxicillin 500mg and metronidazole 400mg 3 times daily for 7 days. patients were also given mouth rinse 0.2% CHX twice daily for 4 weeks. At 12 months the results showed a mean PD changing from 5.3 + 1.8mm at baseline to 2.9 + 0.8mm at 12 month. The PD improved from 3 months and was sustained over 12 months. Furthermore, implant survival over 12 months was 100%. The authors stressed the importance of strict post operative protocols to assist in beneficial outcomes (21). A follow up study by Heitz-Mayfield et al. (2018) investigated 5-year clinical outcomes of the same cohort in a maintenance program. Treatment success was defined as absence of peri-implant PD >5mm with BOP and or SOP and absence of progressive bone loss. The results showed on a patient level success was achieved in 63% and on an implant level 53%. One of the limitations of this study was the lack of control group, hence a robust conclusions about the efficacy of adjunctive amoxicillin cannot be made.

Systemic azithromycin

Due to Azithromycin's long half-life and predilection for inflamed tissues, Hallström and co-workers chose Azithromycin for further investigation. Hallström et al. (2017) conducted a 12-month RCT investigating clinical, radiographic, and microbiological outcomes of OFD with or without systemic antibiotics in the management of peri-implantitis. 39 patients with peri-implantitis received open flap debridement, removal of granulation tissue, decontamination with curettes and saline soaked gauze. 20 patients were prescribed an adjunctive 5 day course of azithromycin starting on the day of surgery (test group) and 19 were not (control group). The results showed at 12 months both groups with a reduction in PD. The test group showed a mean reduction in PD of 1.7mm and the control group 1.6mm. These results show no significant difference between groups. Overall, this study showed adjunctive systemic azithromycin did not show clear a clinical benefit over conventional peri-implant OFD (22).

Open flap debridement: Local antimicrobials

Diode laser

Diode lasers are capable of decontaminating implants without causing damage to the implant surfaces. A RCT by Papadopoulos et al. (2015) investigated the efficacy of diode laser combined with OFD treatment of peri-implantitis. Out of 19 patients with peri-implantitis, 10 were randomly allocated to the control group and 9 to the test group. Patients in both groups received non-surgical therapy 4 weeks prior to surgery. Surgical intervention for both groups involved raised flaps, mechanical instrumentation of the implant surface with plastic curettes, followed by rubbing with sterile cotton swabs soaked in saline. The control group treatment stopped, and the test group received additional treatment with a diode laser (low power 980nm). Post operatively patients were given 0.12% CHX for twice daily rinsing for 2 weeks. The results at 6 months showed both treatments showed statistically significant differences from baseline. However, no significant difference in clinical efficacy between both groups (23). Therefore, surgical decontamination with diode laser does not provide addition clinical benefits over saline-soaked sterile cotton swabs.

Open flap debridement: Combination systemic and local antimicrobials

Systemic amoxicillin and local minocycline

Despite the limited results of local minocycline with non-surgical therapy, Cha and co-workers identified a lack of evidence on repeated local application of minocycline with a surgical approach to peri-implantitis management. Cha et al. (2019) in a 6-month RCT investigated the efficacy of locally applied minocycline ointment combined with surgical management of peri-implantitis. 50 patients contributing at least 1 implant were randomly allocated to a test group (n = 25) with minocycline ointment or control group (n = 25) with placebo ointment. Both groups received OFD and decontamination with titanium curettes, ultrasonic scaling, titanium brush and AAD. Random allocation was then applied for the test group (minocycline Periocline® 1mg) and control group (vehicle ointment without minocycline). Post operatively patients were given amoxicillin 500mg and ibuprofen 600mg for 3 times daily for 3 days. Follow up 1 week, 1, 3, 6 months with repeated test and placebo ointment applied. The results showed both groups with significant improvement in clinical parameters from baseline. However, greater reduction in PD was seen in the test group (2.68 ± 1.73mm) over the control group (1.55 ± 1.86 mm). Furthermore, a significant drop in PCR detection of red complex bacteria for both groups occurred at 3 and 6 months. Treatment success was defined as PD <5 mm, nil BOP nor SOP, and no additional bone loss. Overall this study showed at 6 months following surgical treatment with local and systemic antibiotics and repeated delivery of local minocycline, treatment success of 67% was reached in the test group compared to 36% in the control placebo group (24). This study shows a clinical benefit for the use combined systemic and local antibiotics however considerations also need to be made for decontamination protocol using titanium brush and AADs. A study by Toma et al. (2019) demonstrated surgical intervention with titanium brush was more effective than plastic curettes an AAD.

Open flap debridement with resective approach: Systemic antimicrobials

Systemic amoxicillin

Berglundh and co-workers had identified many studies examined the outcomes of reconstructive approaches to peri-implantitis management but little on resective approaches. Berglundh, Wennström & Lindhe in 2018 reported retrospective data from long term clinical outcomes of a resective approach to peri-implantitis management on 95 implants (composed of non-modified and modified surfaces) from 50 patients. 36 patients received antibiotics as part of treatment while 14 did not. Antibiotic therapy was prescribed 3 days prior to surgery as a 10-day course of amoxicillin 750mg, 2 times daily. Surgery involved raised flaps, granulation tissue removal, mechanical decontamination with saline soaked gauze, calculus removal with titanium curettes and osseous recontouring. Post operatively patients were given 0.2% CHX twice daily for 14 days. 4 monthly reviews were conducted and clinical recordings annually. The results showed mean time in function before treatment was 7.5yrs, follow up reviews after treatment were made at a mean 4.5yrs (range 2-11yrs). Mean PD reduction for patients who received systemic antibiotics was 2.6 + 2.4mm of which was no different to patients who received surgery without antibiotics showing a mean PD reduction of 2.5 + 1.7mm. Interestingly, when comparing success criteria PD <5mm without BOP and no bone loss >0.5mm, the results showed on an implant level 45% success for non-modified surfaces and 22.5% success for modified surfaces. Therefore, on an implant level, the surface topography plays an important factor in peri-implantitis management with non-modified surfaces achieving greater success outcomes (25).

Resective approach: Local antimicrobials without implantoplasty

Local chlorhexidine + Cetylpyridinium chloride (CPC)

Previous In vivo studies have shown reduced bacterial load on titanium surfaces exposed to antiseptics like CHX and CPC (Gosau et al. 2010) this led De Waal et al. (2013) to investigate the microbiological and clinical effects of CHX and CPC in the management of peri-implantitis over a 12 month RCT. 79 implants from 37 patients received treatment. Both the test and control groups received surgical intervention involving raised mucoperiosteal flaps, granulation tissue removal, vertical relieving incisions and apical repositioning of flaps, bone recontouring to remove angular defects, gauze soaked saline was used to clean the implant surfaces. Random allocation was made for the test and control groups with the test group receiving 0.12% CHX + 0.05% CPC (alcohol free) for 1 min and the control group receiving a placebo vehicle solution without active ingredients CHX or CPC. Solutions were delivered via a 22 gauge needle followed by rinsing with saline for 1 min. The test group was instructed to perform mouth rinsing with 0.12% CHX and 0.05% CPC (alcohol free), 30sec, 2 times daily for 2 weeks.

Follow up reviews were made at 3, 6 and 12 months. The microbiological results showed both groups with a reduction microbial load however a greater reduction was seen in the test group (log 4.21+ 1.89 v Log 2.77 + 2.12) p = 0.006. However, this did not translate to improved clinical outcomes of the test group over control group. While clinical outcomes improved in both groups from baseline to follow up, there was no significant difference between groups. Therefore, this study showed combined local antimicrobial 0.12% CHX and 0.05% CPC do not improve the clinical outcomes of peri-implantitis surgical management. Possible confounding factors in this study was the implants surface roughness was not controlled with a greater number of modified surfaces present in the control group (26). A similar study by De Waal et al. (2015) used the same protocol (De Waal et al., 2013) to investigate the efficacy of a higher concentration of CHX 2%. However, the results again showed no significance between the 2% CHX test group and control group (0.12% CHX + 0.05% CPC) (27). Therefore, higher concentrations of local antimicrobial solutions of CHX do not improve clinical outcomes.

Local chlorhexidine

Following the 8th European workshop on periodontology was a recommendation for more parallel-arm randomised control trials examining adjunctive antimicrobial therapy in the management of peri-implantitis (28). This formed part of the basis for Carcuac et al. (2016) to conduct a 12month prospective parallel-arm RCT to investigate the efficacy of adjunctive systemic amoxicillin and local CHX in surgical peri-implantitis management. 100 patients (179 implants) were stratified into 4 groups. 1) systemic amoxicillin + CHX (n = 27), 2) systemic amoxicillin + saline, 3) local CHX without systemic antibiotics, 4) local saline without systemic antibiotics. Prior to surgery patients received supra gingival debridement and oral hygiene instructions. Antibiotic therapy for groups 1 and 2 involved a 10 day course of amoxicillin 750mg taken twice daily for 3 days prior to surgery and 7 days following surgery. Screw retained prostheses were removed before treatment, granulation tissue was removed along with osseous recontouring. Titanium curettes were used to scale the implant surfaces and decontamination was performed with gauze soaked in either 0.2% CHX (groups 1 and 3) or saline (groups 2 and 4). Following surgical treatment the prostheses were reinserted and patients instructed on 0.2% CHX post operative mouth wash 1min twice daily for 14 days. Patients were reviewed with oral hygiene reinforcement and supragingival polishing at 3 monthly intervals. Treatment included non-modified and modified surface implants. The 1-year results showed the control group with local saline without systemic antibiotics was least effective with a mean PD reduction of 1.69 + 2.22 mm. Results improved with the addition of local CHX (group 3) to 2.16 + 1.79 mm. However this difference equates to a low clinically significant value of ~0.5 mm between use of CHX and saline. When combining systemic antibiotics the results improve further 2.8 + 1.87 mm (group 1). However, greatest PD reduction was observed with a combination of systemic amoxicillin and local saline 3.44 + 1.66 mm (group 4) (29). Overall, this study showed the adjunctive local application of antimicrobial agent CHX, does not play a significant role in the clinical outcome of surgical management of peri-implantitis.

Resective approach: Combination systemic and local antimicrobials with implantoplasty

Systemic amoxicillin and Local metronidazole and tetracycline Gel

Romeo et al. (2005) considered the role of implant surfaces in peri-implant outcomes and carried out a longitudinal RCT comparing resective surgery with implant surface modification via implantoplasty compared to resective surgery without implantoplasty. Adjunctive antimicrobials were used in this study. however they were not the primary focus. 17 patients contributing 35 implants with peri-implantitis (BOP with >4mm PD and horizontal bone loss) were randomly assigned to the test (implantoplasty) group (n = 10) and to the control group (without implantoplasty) (n = 7). Before surgery patients' received an 8 day course of amoxicillin. On the day of surgery, apical repositioned flaps were made with soft tissue resection. Hard tissue alveolar bone peaks were removed with chisels. Local antimicrobial delivery of metronidazole gel followed by tetracycline hydrochloride was rubbed onto the implant surfaces for 3mins and then rinsed with saline. The control group's decontamination procedure was completed. While the test group subjects received implantoplasty with diamond burs, Arkansas burs and silicone polishers. Flaps were then repositioned and sutured. Post operative 0.2% CHX mouth rinse was given 3 times a day for 2 weeks. The results showed outcomes made at 24 months for control group and 36 months for the test group. The test (implantoplasty) group showed a mean PD reduction of 2.58mm compared to the control group's mean PD reduction of 1.02mm. Furthermore, the implant survival for the test group was 100% compared to 87.5%

in the control group (30). Within the limitations of this study including a discrepancy of review time between the control and test groups, this study showed clinical benefits for implantoplasty to manage peri-implantitis. These cases involved predominately TPS Straumann ITI implants. A further consideration for this study was the use of systemic and local antibiotics which may have acted synergistically with the implantoplasty procedure. Another study by Lasserre et al. (2020) examined decontamination protocols involving implantoplasty without use of systemic or local antimicrobials and their 6 month findings showed no significant difference between groups treated with or without implantoplasty (31).

A follow up study by Romeo et al. (2007) examined the marginal bone level (MBL) changes around implants receiving implantoplasty compared to those without. The 3yr results showed MBL change in the test group was stable with no bone level changes mesially and distally. However, in the control group mean MBL loss for the mesial was 1.9mm and distal 1.93mm. While proximal marginal bone height alone does not tell the full story of peri-implantitis, it is a marker of peri-implantitis diagnosis and disease progression and this radiographic study shows the TPS implants treated with resective surgery and implantoplasty showed greater marginal bone stability than resective surgery alone (32).

Resective surgery: Combination systemic and local antimicrobials without implantoplasty

Systemic amoxicillin and Local chlorhexidine

Carcuac et al. (2016) of which was discussed earlier (section resective surgery with local antimicrobials) reported on two parts both local and systemic antimicrobial activity. Treatment was provided in 4 groups 1) systemic antibiotics + CHX, 2) systemic antibiotics + saline, 3) CHX without systemic antibiotics, 4) saline without systemic. Antibiotic therapy involved amoxicillin 750mg taken 3 times daily for 7 days. At 1 year the results showed PD reduction was greater in group 2 (systemic amoxicillin + local saline) than groups 3 and 4 (without systemic antibiotics). Furthermore bone gain was observed in groups 1 and 2 (systemic antibiotic group) while additional bone loss occurred in groups 3 and 4 (absence of systemic antibiotics). On an implant level treatment, success was greater with non-modified surface implants 79% compared to modified surface implants 34%. Interestingly, the addition of systemic antibiotics had little effect on non-modified implant surfaces (OR 0.27). while the authors claimed systemic antibiotics had a significant effect on modified surface implants with an OR 144, however their confidence interval was wide 1.12-18,510.09. Therefore, definitive conclusions about antibiotic therapy combined with modified implant surfaces cannot be made from this study (29). A follow up study by the same group Carcuac et al. (2017) reported on a 3 year follow up of which 83 patients were available for re-examination. Using regression analysis Carcuac and co-workers examined if the initial benefits of antibiotics were sustained over a 3 year period. The results showed no significant difference between the antibiotic and non-antibiotic group between 1 and 3 years. This suggested the initial benefits of antibiotic therapy seen within the first year of surgical treatment were not sustained beyond that first year (33).

Reconstructive Surgery: Local antimicrobials

Local CO_2 laser

Use of CO_2 laser has a high water absorption and low absorption to metallic surfaces and has been considered for decontamination of implant surfaces (34). A study by Deppe et al. (2007) investigated the efficacy of CO_2 laser assisted implant decontamination combined with a reconstructive approach to management of peri-implantitis. 32 patients with 73 implants were included. Before surgery 0.3% CHX was used for 3 weeks. Treatment included 4 groups; 1) conventional decontamination + resection, 2) conventional decontamination + reconstruction, 3) laser decontamination + resection, 4) laser decontamination + bone augmentation. The treatment protocol for all groups involved removal of screw retained prosthesis, while cemented restorations were not removed. Raised flaps, granulation tissue removal, all implant were treated supracrestally by AAD (prophy-jet, dentsply) for 60secs. Decontamination was finished for groups 1 and 2. Groups 3 and 4 proceeded to have CO2 laser treatment (using continuous wave mode). Groups 2 and 4 subsequently received grafting with resorbable beta-tricalcium phosphate. (Cerasorb, Curasan, Germany) mixed with autogenous bone from the maxillary tuberosity. A submerged healing protocol was made for screw retained implants. The results showed at 4 month no significant difference between groups suggesting no one treatment was more effective than the other (35).

Reconstructive surgery: Combination systemic and local antimicrobials

Systemic amoxicillin and local Ozone

Based on the associated anaerobic bacteria present in peri-implantitis there is a rationale for the use of an oxidising

agent. Ozone treatment has potent antimicrobial activity through oxidization. A study by Isler et al. (2018) investigated over 12 months the use of ozone therapy for management of peri-implantitis. 41 patients with each presenting 1 implant with peri-implantitis were allocated to receive either saline irrigation with ozone or saline irrigation alone. Following non-surgical therapy, Surgical intervention was performed of which involved use of titanium curettes, irrigation with sterile saline for 3mins (control group). The test group received ozone treatment via an ozone generator (ozone 2,11ppm P) at 6 sites for 30 secs each. Grafting was subsequently performed (Bio-Oss® 0.25-1mm, Geistlich, Switzerland). Ozone treatment involved 80% oxygen for 30 secs per day, for 3 days over 1 week. Surface decontamination was repeated at days 2 and 4. Patients were then prescribed a course combination of Amoxicillin 500mg and Metronidazole 500mg for 3 times a day for 7 days. 0.12% CHX post operative mouth rinse was advised for twice daily for 14 days. Follow up reviews were made at 1, 3, 6, 9, and 12 months. The results showed a PD reduction in the test group was 3.52mm and control group of 2.39mm (36). A positive trend was shown for the ozone group warranting more research into this area to confirm the validity of these findings.

Combination (Resective and Reconstructive) Therapy: Combination systemic and local antimicrobials

Systemic antibiotics and local laser therapy

A long-term 7 year study by Shwarz et al. (2017) investigated two different decontamination methods as part of a combination of resective and reconstructive approaches to the management of peri-implantitis. 15 patients with supra and intrabony defects were treated and reviewed over 7 years. Treatment included access flap surgery, removal of granulation tissue, implantoplasty at the buccal and supracrestal components and then random allocation of decontamination procedures with either Er:YAG laser or plastic curettes with cotton pellets and sterile saline. Grafted sites were treated with deproteinised bovine bone mineral (DBBM) with granule sizes 0.25-1mm (Bio-Oss® Geistlich) and covered with a porcine collagen membrane (Bio-Gide® Geistlich). A transmucosal healing approach was taken and supportive antibiotics perioperatively and postoperatively over 5 days. However, the class and frequency of antibiotics was not specified. The results recorded compared baseline and 7 years. Overall, the results showed significant improvements from baseline. However, PD reduction changes were more pronounced in the control group 2.55 + 1.67 compared to the test group 0.74 + 1.89mm. This study shows in long term outcomes of surgical management of peri-implantitis are not determined by the decontamination protocol (37).

Systemic amoxicillin/metronidazole and local hydrogen peroxide 3% (with titanium brush)

Combination of titanium brush with antimicrobial therapy has been gaining interest within the literature. Cha et al. (2019) used titanium brush with local minocycline and found improved clinical outcomes. However, this study examined treatment in a non-reconstructive approach. De Tapia et al. (2019) conducted a 12-month RCT comparing clinical and radiographic outcomes of decontamination with titanium brush against ultrasonic debridement and 3% hydrogen peroxide as part of a resective and reconstructive surgical management of peri-implantitis. 30 patients each contributing 1 implant with peri-implantitis initially received oral hygiene instructions and non-surgical debridement with plastic curettes and irrigation with 0.12% CHX. Surgical intervention involved raising mucoperiosteal flaps, granulation tissue removal with curettes and an ultrasonic teflon coated tip. For both groups Implantoplasty was performed on supracrestal exposed threads with a diamond bur and intrabony components were decontaminated with plastic ultrasonic scalers and rinsed with 3% hydrogen peroxide (H2O2). No further decontamination was performed in the control group. The test group however received additional treatment with an oscillating titanium brush (Ti-Brush Straumann) 900rpm. Subsequently both test and control groups received reconstructive treatment involved alloplastic graft material (boneCeramic™, Straumann®, Switzerland) and then covered with a collagen membrane (cytoplast™, Osteogenics®, USA). Flaps were repositioned and sutured with a non-submerged healing protocol. Post operative 0.12% CHX was given for 2 weeks, twice daily. A post operative course of antibiotics amoxicillin 500mg and metronidazole 500mg were given to both groups 3 times a day for 7 days. Patients were reviewed weekly for the first 4 weeks and then 3 monthly until 12 months where follow up clinical parameters were recorded. Both groups showed improvement from baseline. When, comparing between groups the deepest sites showed a statistically significant PD reduction change of 4.87 + 1.55mm in the test group over the control group at 2.85 + 1.91mm. However, when comparing mean PD changes between groups there was no significant difference (test 2.84 + 0.93mm v control 2.19 +

1.31mm). based on deepest pocketing sites the Titanium brush was associated with the most improved clinical outcomes at 12 months (38). Whilst titanium brush showed better outcomes, confounding interactions with systemic and local antimicrobials needs to be considered. Toma et al. (2019) showed titanium brush used in a non-reconstructive approach without systemic or local antimicrobials was more effective than using plastic curettes. However, results were still presenting an overall low success rate of 33% (39). In comparison, Cha et al. (2019) combined titanium brush with systemic and local antimicrobials and achieved a 67% success rate (criteria for success <5mm PD, without BOP and no bone loss >0.5mm) (24).

Systemic amoxicillin and local 3% hydrogen peroxide/chlorhexidine

A more recent 2 year retrospective study by Monje et al (2022) revisited the treatment concept of implantoplasty management of peri-implantitis combined with resective and reconstructive approaches. 135 implants from 43 patients had received treatment. Defect morphology was identified for reconstructive assessment. Treatment first involved a non-surgical phase with OHI and debridement for all patients 6 weeks prior to surgery. Debridement included use of an ultrasonic device and Gracey curettes sub-gingivally. 0.12% CHX was irrigated sub-gingivally. Superstructures were replaced 2 weeks prior to surgery with cover screws allocated to implant receiving reconstructive therapy and healing abutment for implant receiving resective therapy. The resective group (sites with class Ia, II, IIIa (40)) received hard and soft tissue recontouring to achieve a flat architecture and apically repositioned flaps to achieve pocket reduction. Implantoplasty was performed with a tungsten carbide bur and Arkansas bur. Sites with insufficient KT were grafted simultaneously with autogenous free gingival grafts. The reconstructive group (site with class Ib IIIb IIIc (40)) received treatment in the form of granulation tissue removal, Gracey curette treatment, decontamination with NiTi brushes, and implantoplasty performed on supracrestal components. Furthermore, antimicrobial implant surface treatment involved 2min application of 3% hydrogen peroxide, followed by irrigation with 0.12% CHX. Grafting of the intrabony component was then performed using a mixture of autogenous bone and xenogenic graft material 50:50 mix. A porcine collagen membrane was applied and fixed with tacs. Post operative management included CHX gel 3 times daily for 2 weeks. Amoxicillin 750mg twice daily for day 7days along with ibuprofen 600mg 1 tab 5-6hrs for 5 days. Sutures were removed after 2-3 weeks. Superstructure prostheses were reconnected at 8+ weeks following surgery. Patients were recalled 2 weekly for the first 2 months then 3 monthly for the first 12 months and then 6 monthly following. Treatment success was defined in two ways; dichotomous and alternative, delineated by lack of bleeding in the dichotomous definition and <2 dots of light bleeding under gentle probing (0.2N) in the alternative definition. The 12 month results showed on an implant level the reconstructive treatment success was reached for the dichotomous definition 66% and 79.5% for the alternative definition. While the resective group with apical repositioned flap reached a higher success rate of 72% for the dichotomous definition and 87% for the alternative definition (41). A limitation of this study was the retrospective nature and therefore non standardised methodology of implant surface decontamination for the resective and reconstructive groups. Hydrogen peroxide 3% and titanium brushes were used in the reconstructive group but not the resective group.

Implantoplasty does carry some controversy. There are potential concerns about overheating, release of titanium particles and decreased fracture resistance, particularly in narrow diameter implants (42). Stavropoulos et al. (2019) conducted a systematic review on complications following implantoplasty and found when water cooling is used, overheating does not occur. While pre-clinical studies have shown titanium particles can be released into the surrounding tissues there has not been any clinical studies showing evidence of complications except for soft tissue pigmentation. Regarding fracture resistance, laboratory studies show minimal effect on wide diameter implants and variable effect on regular and narrow diameter implants. No clinical studies have reported complications of implant fracture with implantoplasty (42). However, a cautious approach should be taken when considering implantoplasty on a case-by-case basis.

Part B Conclusions: Surgical management of peri-Implantitis with adjunctive antimicrobials

Regarding antimicrobials in combination with a surgical approach to management of peri-implantitis the literature shows systemic antimicrobials used in combination with OFD have shown efficacy up to ~63% efficacy (43). Combination with systemic and local antimicrobials and use of additional

decontamination methods with titanium brush have shown efficacy increases to ~67% (24). However other data have shown local antimicrobial methods for decontamination appear to play less of an impact to the final results (29, 37). Furthermore, long term data from Carcuac et al. (2017) and Berglundh et al. (2018) have shown systemic antibiotics do not have any significant sustained effects. What appears to play a greater role in the outcome of treatment is the implant surface. Non-modified surfaces appear to respond better long term to surgical intervention than modified surfaces (25, 29). A resective approach with implantoplasty and combination systemic and local antimicrobials has shown to improve implant survival and marginal bone levels (30, 32). Furthermore, combination of resective and reconstructive approaches with implantoplasty and use of systemic and local antimicrobials have shown increasing favourable outcomes (38, 41). An area showing some promise is the combination of systemic antibiotics with local ozone treatment in a reconstructive approach (36). This area may warrant further research.

Conclusions:

There is currently no consensus on adjunctive use of antimicrobials in the management of peri-implantitis both non-surgically and surgically, attributing to inconsistency in definitions of peri-implantitis, variations in criteria for success, and insufficient high quality parallel-arm randomised control trials with sufficient statistical power. However, understanding the variations of treatment protocols in the current literature may help to navigate to the most appropriate adjunctive antimicrobial protocol in the management of peri-implantitis.

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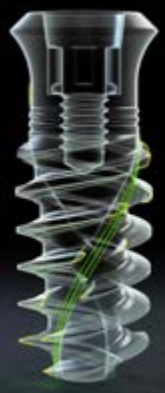

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Due to the impact of COVID-19, please check your state branch website for the most up to date event information.

ASP NSW Branch Committee Details and Meetings

President: Dr Sal Shahidi

Secretary: Dr Jeremy Vo

Treasurer: Dr Jeremy Vo

Federal Councillor: Dr Robert Fell

Admin/Secretariat: Helen Mooney

Email: helen.mooney4@gmail.com

Meeting name: ASP (NSW) Dinner Meeting

Meeting date & time: Thursday, 12 May 2023 registrations from 6:30 p.m.

Meeting location: Swissotel, 68 Market Street, Sydney NSW 2000

Speakers: Dr Jamil Alayan

Topics: Clinical decision making during maxillary sinus augmentation

Cost & other details: Members Complimentary, Country Members $90, Visitors $150, Hygienist Visitors $120

Meeting name: ASP (NSW) Dinner Meeting

Meeting date & time: Thursday, 10 August 2023 registrations from 6:30 p.m.

Meeting location: Swissotel, 68 Market Street, Sydney NSW 2000

Speakers: Prof. K-Y Zee

Topics: Periodontal disease and Chinese Medicine

Cost & other details: Members Complimentary, Country Members $90, Visitors $150, Hygienist Visitors $120

Meeting name: ASP (NSW) Full Day Meeting

Meeting date & time: Monday, 30 October 2023 (To be confirmed)

Meeting location: Swissotel, 68 Market Street, Sydney NSW 2000

Speakers: Dr Isabella Rocchietta (To be confirmed)

Topics: To be confirmed

Cost & other details: To be confirmed

ASP QLD Branch Committee Details and Meetings

President: Dr Marina Kamel

Vice President: Dr Tatiana Tkatchenko

Treasurer: Ms Aneta Zielinski

Federal Councillor: A/Prof Ryan Lee

Email: aspqld@asp.asn.au

Meeting name: ASP (QLD) Dinner Meeting

Meeting date & time: Monday 8th May 2023 at 6.30pm

Meeting location: The Inchcolm by Ovolo

Speakers: Dr Michael Lewis (Prosthodontist)

Due to the impact of COVID-19, please check your state branch website for the most up to date event information.

ASP QLD Branch Committee Details and Meetings (cont'd)

Topics: Responsibilities of both the surgical and restoring parties in implant rehabilitation

Cost & other details: $150 for non-member, Free for members

Meeting name: ASP (QLD) Dinner Meeting

Meeting date & time: Monday 24th July 2023 at 6.30pm

Meeting location: The Inchcolm by Ovolo

Speakers: Dr Rod Marshall (Periodontist)

Topics: Musings of a non-implant placing periodontist

Cost & other details: $150 for non-member, Free for members

Meeting name: ASP (QLD) Dinner Meeting

Meeting date & time: Monday 23rd Oct 2023 at 6.30pm

Meeting location: The Inchcolm by Ovolo

Speakers: TBA

Topics: Prof Mary Cullinan and Prof Greg Seymour Research Medallion Competition

Cost & other details: $150 for non-member, Free for members

ASP SA Branch Committee Details and Meetings

President: Dr Geoff Harvey

Secretary:

Treasurer:

State Branch Councillor:

Support: Leo Lander, Danny Ho, A/Prof Sushil Kaur

Email: aspsa@asp.asn.au

Meeting name: ASP SA dinner meeting #2

Meeting date & time: Wednesday 07 June 2023, 6pm for 6:30pm start

Meeting location: Picolli Piatti, 21-23 O'Connell Street, North Adelaide SA 5006

Speakers: Dr Isaac He and Dr William Mak (current perio postgrads at University of Adelaide)

Topics: 1) Relationship between Covid-19 and periodontitis; 2) Orthodontic treatment and Periodontally Compromised Patients

Cost & other details: $125 for guest attendance, no additional charge for ASP SA members. RSVP via EventBrite invitation

Meeting name: ASP SA dinner meeting #3

Meeting date & time: Wednesday 16 August 2023, 6pm for 6:30pm start

Meeting location: Lion Hotel, 161 Melbourne Street, North Adelaide SA 5006

Speakers: Dr Sven Bohnstedt

Topics: Health Belief Models, Vaping, and the smoking gum

Due to the impact of COVID-19, please check your state branch website for the most up to date event information.

ASP SA Branch Committee Details and Meetings (cont'd)

Cost & other details: $125 for guest attendance, no additional charge for ASP SA members. RSVP via EventBrite invitation

Meeting name: ASP SA dinner meeting #4, including AGM

Meeting date & time: Wednesday 18 October 2023, 6pm for 6:30pm start

Meeting location: The Gallery, 30 Waymouth Street, Adelaide SA 5000

Speakers: Dr Danny Ho

Topics: Mucogingival problems: Diagnosis and Management

Cost & other details: $125 for guest attendance, no additional charge for ASP SA members. RSVP via EventBrite invitation

ASP VIC Branch Committee Details and Meetings

President: Dr Larissa Ong

Vice President: Dr Alice Huynh

Secretary/Treasurer: Dr Eugene Sheftel

Branch Councillor: Dr Sarah Chin

Email: aspvic@asp.asn.au

Meeting name: ASP (VIC) July 2023 Dinner-Lecture meeting

Meeting date & time: Wednesday 19th July 2023 6.30pm registration for a 7.00pm start

Meeting location: Woodward Centre - 10th Floor, Melbourne Law, University of Melbourne, 185 Pelham Street, Carlton Vic 3053

Speakers: Dr. Jake Ball

Topics: Supervised Neglect in Periodontics and How To Avoid It

Cost & other details: Members: Free Guests: $180

Meeting name: ASP (VIC) November 2023 Dinner-Lecture meeting

Meeting date & time: Wednesday 15th November 2023 6.00pm registration for a 6.30pm start

Meeting location: Woodward Centre - 10th Floor, Melbourne Law, University of Melbourne, 185 Pelham Street, Carlton Vic 3053

Speakers: A/Prof. Tino Mercado

Topics: Enamel Matrix Derivative, a 25-year Journey: Lecture on the Biology, Development and Clinical Indications

Cost & other details: Members: Free Guests: $180

Due to the impact of COVID-19, please check your state branch website for the most up to date event information.

ASP WA Branch Committee Details and Meetings

President: Dr Mehdi Valizadeh

Secretary: Ms Jennine Bywaters

Treasurer: Dr Samy Francis

Federal Councillor: Dr Fritz Heitz

Email: aspwa@asp.asn.au

Meeting name: ASP(WA) Lecture Meeting

Meeting date & time: Thursday, 18 May 2023 6pm

Meeting location: ADA House, Havelock St West Perth

Speakers: Dr Ahmed Saleh

Topics: Periodontal prognosis; to extract or not

Cost & other details: Members: Free Guests: $120

Meeting name: ASP(WA) Workshop and Lecture Event

Meeting date & time: Friday and Saturday, 18 and 19 August 2023

Meeting location: ADA House, Havelock St West Perth

Speakers: Dr Alberto Monje

Topics: Surgical management of periodontitis workshop

Cost & other details: Members: $900 Non-members: $1500

Meeting name: ASP(WA) End of Year Dinner Lecture

Meeting date & time: Friday, 17 November 2023

Meeting location: TBC

Speakers: Dr Lisa Heitz-Mayfield

Topics: EFP clinical guidelines for prevention and treatment of peri-implantitis: what does it all mean

Cost & other details: TBC

Due to the impact of COVID-19, please check your state branch website for the most up to date event information.

AOS NSW Committee Details and Meetings

President: Dr Eugene Foo
Secretary: Dr Cecilia So
Treasurer: Dr Bruce Munroe
Federal Councillor: A/Prof George Pal
Admin/Secretariat: Mrs Kayla Ashkar
Email: infonsw@aos.org.au

AOS QLD Committee Details and Meetings

President: Dr Peter LC Chen
Secretary: Dr Marina Kamel
Treasurer: Dr Jonathan Ng
Federal Councillor: Dr Anthony Speed
General Committee: Dr Daniel Hu
Email: aosqld@gmail.com

Meeting name: AOS QLD and ASP QLD Dinner Lecture Meeting
Meeting date & time: May 8th Monday
Meeting location: The Inchcolm by Ovolo

Speakers: Dr Michael Lewis
Topics: Responsibilities of both the surgical and restoring parties in implant rehabilitation
Cost & other details: Free for Members, $150 for non-members (co hosted with ASP Queensland Branch)

AOS SA Committee Details and Meetings

President: Dr Ramon Baba
Secretary: Mr Hab Awwad
Treasurer: Dr Chris Hodge
Federal Councillor: Dr Ramon Baba
Admin/Secretariat: Ms Francine Poole
Email: infoaos.sa@gmail.com

Meeting name: AOS (SA) Dinner Meeting
Meeting date & time: Wednesday, 24 May 2023 6.30pm
Meeting location: Intercontinental, North Terrace, Adelaide
Speakers: Dr Philip Tan
Topics: AuDentes
Cost & other details: Members: Free
Guests: $180
Register online www.aos.org.au

Due to the impact of COVID-19, please check your state branch website for the most up to date event information.

AOS SA Committee Details and Meetings (cont'd)

Meeting name: AOS (SA) Dinner Meeting

Meeting date & time: Tuesday, 22 August 2023 6.30pm

Meeting location: Intercontinental, North Terrace, Adelaide

Speakers: Professor Daniele Cardaropoli

Topics: TBC

Cost & other details: Members: Free
Guests: $180
Register online www.aos.org.au

AOS Victoria Committee Details and Meetings

President: Dr Angelos Sourial

Secretary: Dr Gaurika Sud

Treasurer: Dr Betty Lisa Matthews

Federal Councillor: Dr Gabriel Rodriguez-Ortiz

Committee Members: Mr Jason Savage, Mr Paul Fagliarone, Brandon Krapf, Dr Larissa Ong, Dr Jennifer Chantler, Dr Philip Ho

Admin/Secretariat: Ms Bella Cherkasskaya

Email: infovic@aos.org.au aosvic@gmail.com

Meeting name: Dinner meeting and online broadcasting

Meeting date & time: 04 May 2023

Meeting location: Royal South Yarra Lawn Tennis Club 310 Williams Road North, Toorak 3142

Speakers: Dr. Mahmoud Shalash BDS, MSc, PhD (Egypt)

Topics: 3D planning /immediate guided surgery and Temporisation

Cost & other details: Members- free, Students - $55, Online members (dinner) - $110, Non-members - $190

Meeting name: Online

Meeting date & time: TBA

Meeting location: Zoom

Speakers: Dr Gabriel Rodrigues Ortiz - Periodontist Melbourne.

Topics: How to integrate the implants to your dental practice. Where to start and what to do if you want to do implants?

Cost & other details: Members- free, Students - $0, Online members - $0, Non-members - $50

Due to the impact of COVID-19, please check your state branch website for the most up to date event information.

AOS WA Committee Details and Meetings

President: Dr Tony Strangio

Secretary: Dr Andrew Ziepe

Treasurer: Dr Richard Williams

Federal Councillor: Dr Roy Sarmidi

Email: infowa@aos.org.au

Meeting Name: AOS WA Dinner Meeting

Meeting date & time: Friday 19th of May 2023

Meeting location: University Club, UWA

Speakers: Dr Philip Tan

Topics: AuDentes - Pushing the boundaries of immediate implant bridges

Cost & other details: Please register online www.aos.org.au and see our website for futher detail

Find out online...

Meeting details are also available online:

Australian Society of Periodontology
https://www.asp.asn.au/

Or check with your state branch Secretary/Secretariat for further details.

Australasian Osseointegration Society
https://www.aos.org.au/

Or check with your state branch Secretary/Secretariat for further details.

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