Universidad Europea

TRABAJO DE FIN DE GRADO

Grado en Odontología

AETIOLOGY AND TREATMENT OF MUCOSITIS AND PERI-IMPLANTITIS: STATE OF THE ART

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SUMMARY

INTRODUCCION- Los implantes dentales pasaron a ser técnicas rehabilitadoras rutinarias. Adjunto el desarrollo de sus enfermedades creció exponencialmente. En 2017, el World Workshop Classification of Periodontal and Peri-implant disease and Conditions, tuvo lugar en Chicago. Se aclararon los conceptos de salud peri implantar, mucositis peri implantar y peri-implantitis.

OBJETIVOS- El fin de ese trabajo es estudiar los factores de riesgo, las técnicas preventivas, los tratamientos y los protocolos de mantenimiento de la mucositis peri implantar y la peri-implantitis.

METODOLOGIA- Una búsqueda en PUBMED (Medline), Academia.edu, Wiley Online Library, incluyendo artículos hasta Marzo, 2021; utilizando palabras claves.

DISCUSION- La mucositis periimplantaria y la periimplantitis son estadios progresivos de una misma enfermedad, por lo que se presentan con etiologías comunes. Son enfermedades inducidas por el biofilm, la falta de higiene bucal y de terapia de mantenimiento son los principales factores de riesgo. Se han investigado otros factores predisponentes.

Se ha observado el papel de la prevención en ambas enfermedades y hay que estructurar un protocolo adaptado a cada paciente.

Los pacientes que presenten mucositis periimplantaria deben ser tratados de forma no quirúrgica para evitar su progresión.

Los pacientes que presenten pérdida ósea también deben ser tratados previamente de forma no quirúrgica y según cada caso se debe programar un tratamiento quirúrgico. Se han estudiado varios tratamientos.

CONCLUSION- A lo largo de esta revisión de artículos se entiende que el principal factor etiológico de estas enfermedades es la acumulación de biofilm, inducida por la falta de una terapia de mantenimiento regular. Otros factores contribuyentes necesitan más investigación.

La prevención desempeña un papel fundamental para evitar estas enfermedades.

Los dentistas deben aportar un tratamiento no quirúrgico para la mucositis periimplantaria y una combinación de tratamientos no quirúrgicos y quirúrgicos para la curación de la periimplantitis.

Además, la terapia de mantenimiento es cada 6 meses.

ABSTRACT

INTRODUCTION- Dental implants became a routinely rehabilitative procedure. Alongside also the problems concerning implants increased. In 2017, the World Workshop Classification of Periodontal and Peri-implant disease and Conditions took place. Peri-implant health, peri-implant mucositis and peri-implantitis were defined exhaustively.

OBJECTIVE- The aim of this literature review is to study the risk factors, preventive methodologies, treatments and maintenance protocols of peri-implant mucositis and peri-implantitis.

MATERIALS AND METHODS- A literature search of PUBMED (Medline), Academia.edu, Wiley Online Library including articles up to March, 2021, using keywords inherent the subject.

DISCUSSION- Peri-implant mucositis and peri-implantitis are progressive stages of the same disease, reason why they present with common aetiologies. These are biofilm induced diseases, reason why the main risk factor is known to be a lack of oral hygiene and maintenance therapy. Other predisposing factors have been investigated.

The role of prevention has been observed regarding both diseases. A protocol adapted to each patient should be structured.

Patients presenting peri-implant mucositis should be treated non surgically to avoid a progression to the second stage of the disease.

Patients presenting bone loss must also be treated non surgically previously for a reduction of inflammation and according to each case a surgical treatment must be programmed. A conjunction of various treatments has been studied.

CONCLUSION- Throughout this article review it may be concluded that the main aetiological factor of these disease is a biofilm accumulation, also induced by a lack of regular maintenance therapy. Other contributory factors need further research for the obtention of an agreement.

Prevention plays a key role in the avoidance of these disease.

Dentists should bring along a non surgical treatment for peri-implant mucositis and a combination of non surgical and surgical for the cure of peri-implantitis.

Furthermore patients should comply to their maintenance therapy every 6 months.

PAGINATED INDEX

INTRODUCTION

During the last years, dental implants use increased rapidly and implantology became a worldwide therapy for the rehabilitation of dental loss. As stated by the American National Institute of Health, since 1999 dental implants placement raised. Values, like for the US, of an increase in implants surgeries from 0.7% in 1999 to 5.7% in 2016 help us understand the exponential curve that these treatments are encountering. This branch of dentistry, although, has not yet finished its development. The number of total dental implants is expected to increase by a 23 percent before 2026 (1). With this observation in mind, implantology is increasing exponentially, on the other end is also showing an increasing number of problems associated to it. Concerning peri-implant mucositis values range between 19% and 65%, while peri-implantitis between 1% and 47% and it compromises the survival rate of implants, due to failure (2). These data imply that one third of the patients treated through implant surgery and one fifth of the implants themselves experience periimplantitis throughout their presence in the implanted sites (3). The high currency of peri-implant disease is given to a more liable tissue surrounding the implant, characterized by a decreased amount of blood vessels and a higher collagen fibers to fibroblast proportion in comparison with those found in the naturally formed periodontal tissue (4).

To investigate peri-implant lesions, becomes of mayor importance being able to differentiate the disease from a state health. Peri-implant health, along with peri-implant mucositis and periimplantitis are concepts that have been addressed since 1993. During this year the First European Workshop of Periodontology was held in Ittingen. The definition of these terms has constantly mutated, until 2017, when the World Workshop Classification of Periodontal and

Peri-implant disease and Conditions took place in Chicago. Peri-implant diseases concepts as unprecedently seen took part in a classification (5)(6)(7)(8).

PERI-IMPLANT HEALTH

Following implant surgery, the affected area proceeds to a healing period during which the soft and hard tissue undergo several changes. The bone grows around the dental implant starting the osseointegration; term coined by Brånemark et al. describing the bone to implant contact under loading condition (9). While the mucosa builds up a junctional epithelium with hemidesmosome attachment, and the connective tissue layer facing the implants outward aspect (4). A healthy peri-implant mucosa, is therefore, at its deepest aspects connective tissue concealed by keratinized or non-keratinized epithelium. It is still under investigation weather a 2mm keratinized mucosa covering the implant may be considered as protective factor for the avoidance of plaque build-up and marginal inflammation. Peri-implant tissue health is fundamental for implant success, the mucosa protects the underlying bone which secures the implant stability (9). Peri-implant health refers to, an area proximal to the dental implant, characterized by the absence of inflammatory signs. Peri-implant health may be present at a site with reduced bone support. This scenario, for instance, may appear in a patient who was successfully treated and healed from periimplantitis (8). The mucosa surrounding the implant, should be 3/4mm high and has an epithelium 2mm long (9). The clinical appearance of the peri-implant tissue to be classified as healthy should be of pink colour, firm and not affected by swelling, suppuration or erythema. A critical manifestation of health is the lack of bleeding on probing, always considering a force of 25N or less while conducting the inspection. If while probing this force is exceeded, the bleeding dot is not truthful as it could be caused by a traumatic exploration. This is justified by the knowledge

that the tissue surrounding the implant presents with an increased susceptibility to probing when compared to the adjacent gingiva surrounding teeth. The reduced resistance is given by the absence of cement on the implant surface and a difference in the fibers orientation in comparison to periodontal tissue (9). Probing depth is also a clinical finding which should be observed for the differentiation of the conditions. As a general consensus are to be considered healthy, those implants with a probing depth of less than 5mm. Probing depth, is although a controversial clinical observation as it differs according to baseline values. Bone loss may also be considered a helpful parameter in the recognition of peri-implant health. A healthy implant should undergo no bone loss further to 2mm after initial healing (6)(5)(9). The 2mm range of crestal bone loss, previous to complete healing of the implant, are those considered as bone remodelling during the loading period. A vertical bone loss inferior to 0.2mm per year is a characteristic criteria for implant success (10).

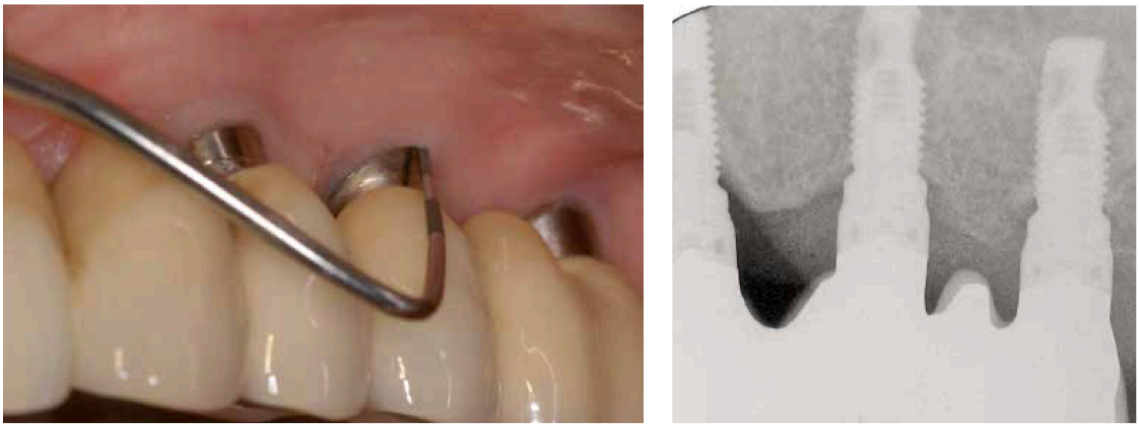

Figure 1: Clinical image of healthy peri-implant tissue. Radiological image of a healthy loaded implant (8).

PERI-IMPLANT MUCOSITIS

The intervention of the various risk factors and the accumulation of bacteria on the implant surface disrupts the balance and causes the initial stage of the illness, classified as peri-implant mucositis. What is known as mucositis develops due to an aggregation of biofilm (11). Peri-implant mucositis was defined by the American Academy of Periodontology during 2017 as the "inflammation of the soft tissue surrounding a dental implant, without additional bone loss after the initial bone remodelling that may occur during the healing following the surgical placement" (5). The inflammation may be encountered histologically "lateral to the junctional/pocket epithelium". It does not affect the area of connective tissue above the alveolar crest (8). It is considered a lesion confined to the peri-implant mucosa and not affecting the neighbouring hard structures. This stage of the disease may be considered reversible. This claim is sustained by various experimental studies on dogs, which were then confirmed on human patients. These studies were usually structured teaching the oral hygiene instructions to patients to reach similar baseline conditions and evaluate their efficacy on each individual. This same population was then instructed to terminate all oral hygiene measures. As expected after a period of undisturbed plaque accumulation, peri-implant mucositis lesions appeared. To confirm the reversibility of these lesions, patients were informed to restart the oral hygiene instructions given previously. As a consensus, it is known that peri-implant mucositis lesions are reversible but may take longer than 3 weeks to heal. To corroborate the outcomes of a clinical examination, the levels of Interleukins 1B (IL-1β) were assessed. The levels of IL-1β increased during the 3 weeks lacking oral hygienic measures and then decreased when sites affected by the inflammatory lesions were cured (11). The treatment of

this condition is also considered the prevention of the progression to the second stage of the disease, which is known as peri-implantitis.

While inspection of sites affected by peri-implant mucositis the professional should detect local swelling, shininess, erythema and colour change in the keratinized gum (5)(6)(11). The presence of suppuration is also assessed during the peri-implant mucositis lesions investigations. Wang et al. demonstrated that sites affected by suppuration had a distinct submucosal microbiome, in comparison with peri-implant mucositis non suppurating sites. The bacterial flora of the suppurating sites is characterized by a higher pathogenicity. This may increment the threat of progression of mucositis lesions to peri-implantitis disease. Furthermore, the bacterial types and metabolism varied, with a predominance of gram negative, anaerobic and spiral shaped bacteria at sites with suppuration; such as: *Fusobacterium* and *Tannerella* (12). The professional studying the lesions, will also perform a gentle probing of the area with a force of less than 25N. The detection of a bleeding dot or line should be considered as a crucial proof for the definition of the disease, especially if accompanied by the previously listed signs. To exclude the presence of peri-implantitis, intra-oral radiographs should also be performed to compare the bone level when peri-implant mucositis is assessed and at baseline. The general consensus defined the existence of the disease at its first stage if the change in the bone level after placement does not exceed a quantity of 2mm. The accepted 2mm, as stated previously, is a physiological remodelling of the bone during loading period. The probing depth may be assessed as an additional parameter. The presence of an increased probing depth is characteristic of peri-implant mucositis lesions, it is due to a swelling of the mucosa or a decreased resistance at probing (5)(6)(11).

Peri-implant mucositis and gingivitis are comparable diseases. It is also useful to draw an analogy between their respective progressions. During early host response peri-implant mucositis lesions progression may equated with gingivitis lesions development. This statement is not applicable after a 9 months plaque accumulation, as peri-implant mucositis lesions have an increased apical progression and magnitude of the inflammatory penetration set side by side with those found in gingivitis. This represents that in vitro biofilm accretion around implants harvest a more substantial inflammation in comparison with normal teeth (13).

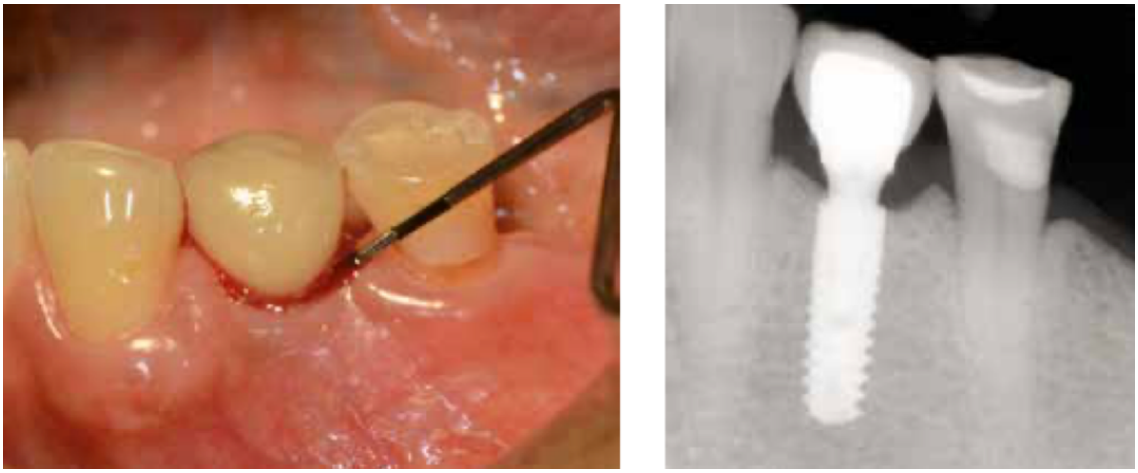

Figure 2: Clinical image of peri-implant tissue distressed by peri-implant mucositis. Radiological image of a loaded implant troubled by peri-implant mucositis (8).

PERI-IMPLANTITIS

Along with the studies it has been stated that peri-implant disease has a second transition, from mucositis to peri-implantitis lesions; imitating the advancement of gingivitis to periodontitis. As previously done an analogy may be seen between periodontitis and peri-implantitis. Comparative analysis between the two pathologies discloses distinct entities from

a histopathological perspective. In comparison with periodontitis, peri-implantitis lesions reveal a more aggressive pattern of tissue destruction (13). It has been demonstrated that peri-implantitis has a faster and non-linear progression in comparison with periodontitis (14).

The long term effect of peri-implant mucositis was mostly studied on animal or through retrospective observational studies, due to the obvious ethical reasons (14). It was assessed that the peri-implant mucositis lesions are more prone to progression to peri-implantitis lesions in patients who do not comply to the supportive peri-implant therapy (11). Peri-implantitis often occurs early; it amounts to a 70% of the implants that demonstrate bone loss after 2 years, and an 81% at 3 years from placement. Peri-implantitis is an illness developing in tissues neighbouring the dental implants, consisting of inflammation of the mucosa and loss of the surrounding bone (14). Lesions will be characterized by the typical inflammatory signs, as the areas affected by peri-implant mucositis, combined once again with bleeding on probing. Several consensus statements agreed on the presence of suppuration at sites affected by peri-implantitis. In addition, professionals will encounter an increased pocket depth and a bone loss superior to 2mm compared to baselines values. In case of absence of baselines radiographies, as a consensus it was taken that site with pocket depths superior to 6mm and bone loss superior to 3mm were to be considered affected by peri-implantitis (5)(6)(4). Peri-implantitis lesions broaden beyond the junctional epithelium and are bigger than those at peri-implant mucositis (8).

Based on several studies, the characteristic bone loss of peri-implantitis lesions is the circumferential progression, affecting the four implant aspects (14). Implant mobility is suggestive of advanced peri-implantitis and it corresponds to de-

osseointegration. The absence of osseointegration and the presence of a peri-implant radiolucency is characteristic of implant failure and the elective treatment is implant removal (10).

The histopathological characteristics of the peri-implantitis lesions in relation with sites affected by peri-implant mucositis, “harboured more neutrophils granulocytes and larger proportions of B cells”. Plasma cells, lymphocytes, polymorphonuclear leukocytes and macrophages prevailed at the sites affected by peri-implantitis. According to the microbiological characteristics, peri-implantitis sites were found to have a higher count of several bacteria species in comparison to healthy peri-implant sites, such as *Porphyromonas gingivalis* and *Tarrenella forsythia*. In regard to peri-implantitis immunologic characteristics, an increase in the IL-1β was reviled; as in peri-implant mucositis sites. Tumor Necrosis Factor-α (TNF- α) levels were also elevated in the areas affected by peri-implantitis (14).

Figure 3: Clinical image of peri-implant tissue affected by peri-implantitis, obvious deep probing depth. Radiological image of loaded implant affect by peri-implantitis with radiolucent area indicating bone loss (8).

Due to the strict correlation between the two stages of the disease it is of extreme importance to understand their aetiology and risk factors, to carry out an effective preventive protocol. To define a risk factor interventional longitudinal studies are necessary. Observational, cross-sectional and retrospective studies only define the risk indicators of these diseases (14). Professionals will first aim to prevention of the peri-implant disease, by eliminating the predisposing elements, to later avoid the need of a more aggressive treatment. Nowadays, professionals embrace different treatment techniques to cure this illness. It has been reported a lack of universal approach due to insufficient evidence to provide a gold standard therapeutic protocol (15). By understanding the difference between the stages of the disease, dentist will be able to carry out the correct treatment election according to the severity of each case. As implant loss still accounts to a range of 0 to 13.6% of the patients, it is widely agreed that prevention and an effective treatment are key to the avoidance of the feared outcome of these diseases (2).

OBJECTIVES

Main objective

To examine the literature inherent the aetiology and the risk factors of peri-implant mucositis and peri-implantitis.

Secondary objective

To describe the most effective methods of prevention of peri-implant mucositis and peri-implantitis.

Tertiary objective

To investigate the most updated surgical and non-surgical treatment options of peri-implant mucositis and peri-implantitis.

To briefly explain the maintenance protocol following the treatment of the peri-implant disease.

METHODOLOGY

A literature search of PUBMED (Medline), Academia.edu, Wiley Online Library including articles up to March, 2021, was carried out using the search strategy: “peri-implant health”, “peri-implant disease classification”, “peri-implant mucositis”, “peri-implantitis”, “peri-implant disease aetiology”, “peri-implant disease risk factors”, “peri-implant disease prevention”, “peri-implant mucositis treatment” and “peri-implantitis treatment”. Reviews, cross sectional studies, cohort studies, retrospective and prospective studies inherent the aetiology and risk factors of the peri-implant disease, its prevention and treatments, were included in the bibliography.

Inclusion criteria

To be included in this research the articles had to:

1. Be written in English, Spanish and Italian language
2. Be published after year 2015
3. Be published in International peer-reviewed journals inherent to the field of Periodontology and Implantology
4. They should meet the aetiology, the definition and/or treatment of peri-implant mucositis and peri-implantitis

Exclusion criteria

1. Articles written before year 2015
2. Articles without a clear definition of peri-implant mucositis or peri-implantitis
3. Articles exclusively analysing in vitro studies
4. Articles exclusively analysing animal studies

Publication	**Reason for exclusion**
Dental Implants Facts and Statistics [Internet]. Trend Statistics. 2019 [cited 29 November 2020]. Available from: https://www.trendstatistics.com/health/dental-implants-facts-statistics/	Published in a non-pear reviewed website/journal

Sato J, Gomi K, Makino T, Kawasaki F, Yashima A, Ozawa T et al. The evaluation of bacterial flora in progress of peri-implant disease. Australian Dental Journal. 2011;56(2):201-206.	Published in 2010
Renvert S, Roos-Jansåker A, Claffey N. Non-surgical treatment of peri-implant mucositis and peri-implantitis: a literature review. Journal of Clinical Periodontology. 2008;35:305-315.	Published in 2008
Benli M, Petit C, Tenenbaum H, Huck O. In vitro Assessment of Peri-implantitis Treatment Procedures: A Review. The Open Dentistry Journal. 2019;13(1):267-273.	In vitro study. Low level of evidence.
Sun J, Eberhard J, Glage S, Held N, Voigt H, Schwabe K et al. Development of a peri-implantitis model in the rat. Clinical Oral Implants Research. 2019;31(3):203-214.	Animal study. Low level of evidence.
Reinedahl D, Chrcanovic B, Albrektsson T, Tengvall P, Wennerberg A. Ligature-Induced Experimental Peri-Implantitis—A Systematic Review. Journal of Clinical Medicine. 2018;7(12):492.	Systematic review of animal studies. Low level of evidence
YANG Y, GUO J, ZHOU X, LIU Z, WANG C, WANG K, et al. A novel cold atmospheric pressure air plasma jet for peri-implantitis treatment: An in vitro study [Internet]. Dental Materials Journal. The Japanese Society for Dental Materials and Devices; 2018 [cited 2020Nov29]. Available from: https://www.jstage.jst.go.jp/article/dmj/37/1/37_2017-030/_article	In vitro study. Low level of evidence.
Hämmerle C, Tarnow D. The etiology of hard- and soft-tissue deficiencies at dental implants: A narrative review. Journal of Clinical Periodontology. 2018;45:S267-S277.	Not inherent information
Figuero E, Graziani F, Sanz I, Herrera D, Sanz M. Management of peri-implant mucositis and peri-implantitis. Periodontology 2000. 2014;66(1):255-273.	Published in 2014

Associate C, Practice P, Wales N. Complications with excess cement & dental implants : Diagnosis , recommendations & treatment of 7 clinical cases . 2014;1:51–9.	Published in 2014

TABLE 1: Excluded articles and reason for exclusion

Publication	Author	Reason for inclusion	Journal
Elani HW, Starr JR, Da Silva JD, Gallucci GO. Trends in Dental Implant Use in the U.S., 1999–2016, and Projections to 2026. J Dent Res. 2018;97(13):1424–30.	H.W. Elani J.R. Starr, J.D. Da Silva, and G.O. Gallucci	"Cross-sectional stratified multistage probability-sampled survey of the civilian noninstitutionalized population of the United States"	J Dent Res
Derks J, Tomasi C. Peri-implant health and disease. A systematic review of current epidemiology. J Clin Periodontol. 2015;42(S16):S158–71.	Jan Derks and Cristiano Tomasi	Systematic review	Journal of Clinical Periodontology
Belibasakis GN, Manoil D. Microbial Community-Driven Etiopathogenesis of Peri-Implantitis. J Dent Res. 2020;	G.N. Belibasakis[1] and D. Manoil[1]	Critical review	Journal of Dental Research
K AN. Periimplantitis- A review. 2015;27(June):101–4.	Aws Nabeel K, B.D.S and Saif Seeham Saliem, B.D.S., M.Sc.	Review article	J Bagh Coll Dentistry
Renvert S, Persson GR, Pirih FQ, Camargo PM. Peri-implant health, peri-implant mucositis, and peri-implantitis: Case	Stefan Renvert, G. Rutger Persson, Flavia Q.	Review article	Journal of Clinical Periodontology

definitions and diagnostic considerations. J Clin Periodontol. 2018;45(February):S278–85.	Pirih and Paulo M. Camargo		
Berglundh T, Armitage G, Araujo MG, Avila-Ortiz G, Blanco J, Camargo PM, et al. Peri-implant diseases and conditions: Consensus report of workgroup 4 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. J Periodontol. 2018;89(December 2017):S313–8.	Tord Berglundh, Juan Blanco, Elena Figuero, Vincent Iacono, Marc Quirynen, Dennis Tarnow, Gary Armitage, Mauricio G. Araujo, Gustavo Avila-Ortiz, Paulo M. Camargo, Stephen Chen, David Cochran, Jan Derks, Christoph H.F. Hämmerle, Lisa J.A. Heitz-Mayfield, Guy Huynh-Ba, Ki-Tae Koo, Stefan Renvert, Cristiano	Consensus report of Workshop 4 of 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions	Journal of Periodontology

	Tomasi, France Lambert, Giovanni E. Salvi, Hom-Lay Wang, Laurie McCauley, Frank Schwarz and Nicola Zitzmann		
Ghoulbzouri H El, Ayachi H El, Ennibi O, Cherkaoui A. Peri-implantitis: Better understanding, better treatment! IOSR J Dent Med Sci e-ISSN [Internet]. 2019;18(5):12–21. Available from: www.iosrjournals.org	Houda El Ghoulbzouri, Houda El Ayachi, OumKeltoum Ennibi and Amine Cherkaoui	Overview	IOSR Journal of Dental and Medical Sciences
Zabalegui I. NEW CLASSIFICATION OF PERIODONTAL AND PERI-IMPLANT DISEASES. Sci J Soc Española Periodoncia Int. 2019;15.	Mariano Sanz y Panos N. Papapanou	Monographic issue	Scientific Journal of the Sociedad Espanola de Periodoncia Internation Edition
Maria Regi B, Savita S, Kaimal G. Peri implantitis: An overview. IP Int J Periodontol Implantol. 2020;5(1):11–5.	Benita Maria Regi , S Savita, Gautami Kaimal	Overview	IP International Journal of Periodontology and Implantology
Heitz-Mayfield LJA, Salvi GE. Peri-implant mucositis. J Clin Periodontol. 2018;45(September	Lisa J.A. Heitz-Mayfield	Narrative review	Journal of Clinical Periodontology

2017):S237–45.	Giovanni E. Salvi		
Wang Q, Lu H, Zhang L, Yan X, Zhu B, Meng H. Peri-implant mucositis sites with suppuration have higher microbial risk than sites without suppuration. J Periodontol. 2020;(November 2019):1284–94.	Wang Q, Lu H, Zhang L, Yan X, Zhu B, Meng H	Retrospective analysis	Journal of Periodontology
Salvi GE, Cosgarea R, Sculean A. Prevalence and Mechanisms of Peri-implant Diseases. J Dent Res. 2017;96(1):31–7.	Salvi GE, Cosgarea R, Sculean A.	Critical review	Journal of Dental Research
Schwarz F, Derks J, Monje A, Wang HL. Peri-implantitis. J Periodontol. 2018;89(September 2017):S267–90.	Schwarz F, Derks J, Monje A, Wang HL	Narrative review	Journal of Periodontology
Papathanasiou E, Finkelman M, Hanley J, Parashis AO. Prevalence, Etiology and Treatment of Peri-Implant Mucositis and Peri-Implantitis: A Survey of Periodontists in the United States. J Periodontol. 2016;87(5):493–501.	Papathanasiou E, Finkelman M, Hanley J, Parashis AO	Survey	J Periodontol
Rokaya D, Srimaneepong V, Wisitrasameewon W, Humagain M, Thunyakitpisal P. Peri-implantitis update: Risk indicators, diagnosis, and treatment. Eur J Dent. 2020;14(4):672–82.	Rokaya D, Srimaneepong V, Wisitrasameewon W, Humagain M, Thunyakitpisal P	Review article	European Journal of Dentistry

Cortellini S, Favril C, De Nutte M, Teughels W, Quirynen M. Patient compliance as a risk factor for the outcome of implant treatment. Periodontol 2000. 2019;81(1):209–25.	Cortellini S, Favril C, De Nutte M, Teughels W, Quirynen M	Review article	Periodontology 2000
Renvert S, Polyzois I. Risk indicators for peri-implant mucositis: A systematic literature review. J Clin Periodontol. 2015;42(S16):S172–86.	Renvert S, Polyzois I	Systematic literature review	Journal of Clinical Periodontology
Hashim D, Cionca N. A Comprehensive Review of Peri-implantitis Risk Factors. Curr Oral Heal Reports. 2020;7(3):262–73.	Hashim D, Cionca N	Comprehensive review	Current Oral Health Reports
Araujo MG, Lindhe J. Peri-implant health. J Periodontol. 2018;89(July 2016):S249–56.	Mauricio G. Araujo[1] Jan Lindhe[2]	Article review	Journal of Periodontology
Dalago HR, Schuldt Filho G, Rodrigues MAP, Renvert S, Bianchini MA. Risk indicators for Peri-implantitis. A cross-sectional study with 916 implants. Clin Oral Implants Res. 2017;28(2):144–50.	Dalago HR, Schuldt Filho G, Rodrigues MAP, Renvert S, Bianchini MA	Cross sectional study	Clinical Oral Implantology
Heitz-Mayfield LJA, Heitz F, Lang NP. Implant Disease Risk Assessment IDRA–a tool for preventing peri-implant disease. Clin Oral Implants Res. 2020;31(4):397–403.	Heitz-Mayfield LJA, Heitz F, Lang NP	Article review	Clinical Oral Implant Research
Farsai PS. Supportive Therapy (SPT) Can Potentially Improve Implant Survival Rate (SR), Peri-	Farsai PS.	Systematic review and meta-analysis	Journal of evidence based dental practice

implantitis, and Peri-implant Mucositis. J Evid Based Dent Pract [Internet]. 2020;20(1):101414. Available from: https://doi.org/10.1016/j.jebdp.2020.101414			
Chrcanovic BR, Albrektsson T, Wennerberg A. Smoking and dental implants: A systematic review and meta-analysis. J Dent. 2015;43(5):487–98.	Chrcanovic BR, Albrektsson T, Wennerberg A.	Systematic review and meta-analysis	Journal of dentistry
Tsigarida AA, Dabdoub SM, Nagaraja HN, Kumar PS. The Influence of Smoking on the Peri-Implant Microbiome. J Dent Res. 2015;94(9):1202–17.	Tsigarida AA, Dabdoub SM, Nagaraja HN, Kumar PS	Investigation	Journal of dental research
Shabana L. Smoking as a Risk Factor for Peri-Implantitis and Dental Implant Failure -A Literature Review. Int J Sci Res [Internet]. 2018;9(2). Available from: https://www.researchgate.net/publication/339567514_Smoking_as_a_Risk_Factor_for_Peri-Implantitis_and_Dental_Implant_Failure_-A_Literature_Review	Shabana L.	Literature review	International Journal of Science and Research
Naujokat H, Kunzendorf B, Wiltfang J. Dental implants and diabetes mellitus—a systematic review. Int J Implant Dent [Internet]. 2016;2(1). Available from: http://dx.doi.org/10.1186/s40729-016-0038-2	Naujokat H, Kunzendorf B, Wiltfang J.	Systematic Review	International Journal of Implant Dentistry

Monje A, Catena A, Borgnakke WS. Association between diabetes mellitus/hyperglycaemia and peri-implant diseases: Systematic review and meta-analysis. J Clin Periodontol. 2017;44(6):636–48.	Monje A, Catena A, Borgnakke WS.	Systematic review and meta-analysis	Journal of clinical periodontology
Sanz-Martín I, Sanz-Sánchez I, Carrillo de Albornoz A, Figuero E, Sanz M. Effects of modified abutment characteristics on peri-implant soft tissue health: A systematic review and meta-analysis. Clin Oral Implants Res. 2018;29(1):118–29.	Sanz-Martín I, Sanz-Sánchez I, Carrillo de Albornoz A, Figuero E, Sanz M.	Systematic review and meta-analysis	Clinical Oral Implant Research.
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Berglundh T, Jepsen S, Stadlinger B, Terheyden H. Peri-implantitis and its prevention. Clin Oral Implants Res. 2019;30(2):150–5.	Berglundh T, Jepsen S, Stadlinger B, Terheyden H.	Perspective article	Clinical Oral Implant Research.
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Part IF, Maintenance I. A Peer Reviewed Publication by Hu-Friedy.	Mauro Labanca, Lee Silverstein, Jon Suzuki, Carlos Quinones, Istvan Urban	Peer Reviewed Publication	Hu-Friedy
Sheth N, Tabassum R, Mistry G, Shetty O. Dental-Implant Maintenance: A Critical Factor in Long-Term Treatment Success. Int J Life-Sciences Sci Res. 2018;4(1):1585–8.	Sheth N, Tabassum R, Mistry G, Shetty O.	Review article	Int J Life-Sciences Sci Res.
Clark D, Levin L. Dental implant management and maintenance: How to improve long-term implant success? Quintessence Int [Internet]. 2016;47(5):417–23. Available from: http://www.ncbi.nlm.nih.gov/pubmed/27110604	Clark D, Levin L.	Review article	Quintessence International
Renvert S, Hirooka H, Polyzois I, Kelekis-Cholakis A, Wang HL. Diagnosis and non-surgical treatment of peri-implant diseases and maintenance care of patients with dental implants – Consensus report of working group 3. Int Dent J. 2019;69(S2):12–7.	Renvert S, Hirooka H, Polyzois I, Kelekis-Cholakis A, Wang HL.	Supplement article	International dental journal
Korsch M, Walther W, Bartols A. Cement-associated peri-implant mucositis. A 1-year follow-up after excess cement removal on the peri-implant tissue of dental	Korsch M, Walther W, Bartols A.	Retrospective observational study	Clin Implant Dent Relat Res.

implants. Clin Implant Dent Relat Res. 2017;19(3):523–9.			
Terra E, Berardini M, Trisi P. Nonsurgical Management of Peri-implant Bone Loss Induced by Residual Cement: Retrospective Analysis of Six Cases. Int J Periodontics Restorative Dent. 2019;39(1):89–94.	Terra E, Berardini M, Trisi P.	Retrospective analysis	Int J Periodontics Restorative Dent.

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Pesce P, Canullo L, Grusovin MG, De Bruyn H, Cosyn J, Pera P. Systematic review of some prosthetic risk factors for periimplantitis. J Prosthet Dent [Internet]. 2015;114(3):346–50. Available from: http://dx.doi.org/10.1016/j.prosdent.2015.04.002	Pesce P, Canullo L, Grusovin MG, De Bruyn H, Cosyn J, Pera P.	Systematic review	Journal of Prosthetic Dentistry
Staubli N, Walter C, Schmidt JC, Weiger R, Zitzmann NU. Excess cement and the risk of peri-implant disease – a systematic review. Clin Oral Implants Res. 2017;28(10):1278–90.	Staubli N, Walter C, Schmidt JC, Weiger R, Zitzmann NU.	Systematic review	Clinical Oral Implants Research
Souza AB, Tormena M, Matarazzo F, Araújo MG. The influence of peri-implant keratinized mucosa on brushing discomfort and peri-implant tissue health. Clin Oral Implants Res.	Souza AB, Tormena M, Matarazzo F, Araújo MG.	Cohort study	Clinical Oral Implants Research

2016;27(6):650–5.			
Nicholls J. The management of periodontal and peri implant disease. BDJ Team. 2020;7(6):34–6.	Nicholls J.	Article review	BDJ Team
Wingrove SS. Two Keys to Periodontal and Peri-Implant Treatment Success. 2016;20–2.	Wingrove SS.	Article review	Hygiene Town
Monje A, Wang H. Therapy Compliance and Peri-Implant. 2017;88(10).	Monje A, Wang H	Cross sectional study	J Periodontology
Renvert S, Polyzois IN. Clinical approaches to treat peri-implant mucositis and peri-implantitis. Periodontol 2000. 2015;68(1):369–404.	Renvert S, Polyzois IN	Article review	Periodontology 2000
Daly A, McCracken G. Peri-implant disease part 2: Management of peri-implant disease. Dent Update. 2019;46(10):986–92.	Daly A, McCracken G	Article review	Dental Update
Feldman B, Contreras A. Láser Er:YAG en el tratamiento de la periimplantitis: revisión de la literatura. Rev Clínica Periodoncia, Implantol y Rehabil Oral [Internet]. 2016;0–5. Available from: http://dx.doi.org/10.1016/j.piro.2016.04.003	Feldman B, Contreras A.	Article review	Revista Clínica de Periodoncia, Implantología y Rehabilitación Oral

Murga C. Enfermedades periimplantarias iii : tratamiento also be used. 2016;13:177–81.	Murga C.		Cient. dent. VOL. 13 NÚM. 3 SEPTIEMBRE-OCTUBRE-NOVIEMBRE-DICIEMBRE 2016. PÁG. 177-181
Roehling S, Gahlert M, Janner S, Meng B, Woelfler H, Cochran D. Ligature-Induced Peri-implant Bone Loss Around Loaded Zirconia and Titanium implants. Int J Oral Maxillofac Implants. 2019;34(2):357–65.	Roehling S, Gahlert M, Janner S, Meng B, Woelfler H, Cochran D.	Animal study	Int J Oral Maxillofac Implants.
Safioti LM, Kotsakis GA, Pozhitkov AE, Chung WO, Daubert DM. Increased Levels of Dissolved Titanium Are Associated With Peri-Implantitis – A Cross-Sectional Study. J Periodontol. 2017;88(5):436–42.	Safioti LM, Kotsakis GA, Pozhitkov AE, Chung WO, Daubert DM.	Cross-Sectional Study	J Periodontol
Schwarz F, Sanz Sánchez I. Tratamiento quirurgico combinado de cirugia resectiva y regenerativa en el tratamiento de periimplantitis. Periodoncia Clínica [Internet]. 2013;27–34.	Schwarz F, Sanz Sánchez I.		Periodoncia Clínica
Menezes KM, Fernandes-Costa AN, Silva-Neto RD, Calderon PS, Gurgel BCV. Efficacy of 0.12% Chlorhexidine Gluconate for Non-Surgical Treatment of Peri-Implant Mucositis. J Periodontol.	Menezes KM, Fernandes-Costa AN, Silva-Neto RD, Calderon PS, Gurgel BCV	Controlled randomnized doublé masked clinical trial	J Periodontol.

2016;87(11):1305–13.			
Riben-Grundstrom C, Norderyd O, André U, Renvert S. Treatment of peri-implant mucositis using a glycine powder air-polishing or ultrasonic device: A randomized clinical trial. J Clin Periodontol. 2015;42(5):462–9.	Riben-Grundstrom C, Norderyd O, André U, Renvert S	A randomized clinical trial	J Clin Periodontol
Jepsen S, Berglundh T, Genco R, Aass AM, Demirel K, Derks J, et al. Primary prevention of peri-implantitis: Managing peri-implant mucositis. J Clin Periodontol. 2015;42(S16):S152–7.	Jepsen S, Berglundh T, Genco R, Aass AM, Demirel K, Derks J, et al.		J Clin Periodontol.
Caneiro L, Pico A. Periimplantitis : ¿ Conflicto Académico O Problema Clínico ? Bases Y Pautas En El Tratamiento.	Caneiro L, Pico A.	Resumen divulgativo	Fundacion española de periodoncia y implantes dentales

Table 2: Included articles and reason for inclusion

DISCUSSION

AETIOLOGY AND RISK FACTORS/INDICATORS OF PERI-IMPLANT MUCOSITIS AND PERI-IMPLANTITIS

Peri-implant mucositis and peri-implantitis are progressive stages of the same disease and they shear common aetiology and risk factors. At a preceding World Workshop on Periodontology risk factor was intended as a factor that when present aggravated the likelihood of a appearance of a illness, all of this is always confirmed by the chronological order

of occurrence (11). The study of risk factors requires prospective studies, as these are not always available and to achieve a wider prospective of the associated risks to these diseases, in this paper its going to be referred as “risk” all of those factors which are associated to peri-implant mucositis and peri-implantitis. These are to be considered indicators of risk (11)(16).

ORAL HYGIENE

Oral hygiene is relevant to the whole population for the maintenance of a healthy oral environment. This concept, however, must be particularly stressed in patients rehabilitated with implant supported prosthesis. Implants are extremely susceptible to plaque accumulation. It has been demonstrated a stronger response to biofilm accumulation around implants in comparison to teeth (13)(16)(17). This is why patients undergoing implant rehabilitation must be made aware of the risks they will undergo by permitting biofilm accumulation on a implant surface. The outcome of various studies confirm the association between biofilm accumulation and the presence of peri-implant mucositis and peri-implantitis makes this the principal aetiology of these disease (11)(4). Clinical results demonstrate the evolution of the inflammatory lesions neighbouring dental implant after 3 weeks plaque accumulation after termination of the oral hygiene measures on the patients studied. Results also prove a subsequent progression of the lesions into deeper areas of the gingival margin when patients were requested to quit their oral hygiene measures for longer time (18). During this study it has been proven a dose relations among the amount of biofilm and the severity of the lesion (17). Authors, divulge the influence that the number of bacteria accumulated in the pocket area and on the implant surface, has on the peri-implant mucositis stage. Additionally its subsequent progression towards peri-implantitis may be influence by this quantity (18)(11). Is however important to underline that the progression of the lesions is not

certain even in presence of a extensive amount of bacterial accumulation (19). The conversion is not yet totally clear at the experts eyes, but it is understood that many factors may possibly influence it, such as a failure in the compliance to a regular maintenance (19). Multiple factors are at play in the development of peri-implantitis, but it is recognized that plaque collection intervenes as the most relevant one (17).

LACK OF MANTAINANCE THERAPY

As bacterial biofilm is found to be the main cause of occurrence of periodontal and peri-implant disease, it is to deduce as a consequence that a lack of maintenance therapy of this rehabilitative technique is also a predisposing factor in teeth and implant mortality (7). According to a systematic review and meta-analysis concerning supportive therapy in preventing peri-implant disease (SPT) carried out in 2020, health and survival rate of implants is significantly improved by SPT (20). A prevalence of 48% of peri-implant mucositis was recorded in patients not attending SPT by Heitz-Mayfield et at. In the same study implants affected by peri-implant mucositis and not adhering to maintenance therapy were associated to a higher progression towards peri-implantitis disease. Thence, early treatment of peri-implant mucositis is deemed as feature avoiding the disease progression (11).

According to Hashim et al. maintenance therapy should be carried out in patients according to their specific needs every 5-6 months (19). To know the adequate time interval and procedures to carry out during the check-up visits is necessary to perform a risk assessment on each patient through the evaluation of clinical signs and risk factors. The risk assessment evaluation may be performed through IDRA (Implant disease risk assessment) (21). This technique will be furtherly discussed later on in this review.

HISTORY OF PERIODONTAL DISEASE

Active periodontal disease is considered a absolute contraindication for a patient willing to face a implant surgery. One of the basic requirements previous to a implant surgery is for the patient to achieve a state of periodontal health. As a consequence of this statement and as peri-implantitis is similar, both in characteristics and in microbiota, to periodontal disease is important to investigate the possibility of a association of risk.

Daubert et al. led a cross sectional study, researching various predisposing factors involved in the appearance of peri-implantitis. This study achieved the evidence to state the association of risk between the presence of a preceding grave periodontitis (PD>5mm) and the appearance of peri-implantitis. Dalago et al., Derks et al. also conducted cross sectional studies in the years 2016 and 2017 with results supporting the previous finding. The association of risk may be due to the presence of periodontal microorganism which colonized the implant surface. Genetic is also a factor which should be kept into consideration while assessing the risk of occurrence of peri-implantitis. The statement is supported by the known relation between genetics and the risk of developing periodontal disease (22). The majority of publication agree that the presence of a history of periodontitis may be considered a predisposing feature in the development of peri-implantitis. It should although be noted that studies disagreeing with the previous statement do exist but are the minority (14).

SMOKING

Smoking is among the most recognised risk factor in development and progression of periodontitis. In recent studies smoking was also increasingly associated with early implant

loss, marginal bone loss and infections. The failure rates increased in smokers due to the effect of this habit of osteogenesis and angiogenesis (23).

Concerning peri-implant disease conflictual opinions of the rates of appearance of the disorder in smokers and non-smokers should be investigated. No certain affirmation may be yet stated, although most literature succeed in the detection of the association of risk (24). Ronvert et al. in a systematic literature review aimed to the examination of the existing evidence in the definition of the peri-implant mucositis risk factors. While analysing the results of three experiments a agreement was found on the association between smoking and the appearance of the disease (18).

Tsigarida et al. investigates the peri-implant microbiome in smokers and non-smokers patients. Demonstrates lower diversity of bacteria species in patients presenting the habit compared to those not affected by the habit; it is, although, not possible to associate this to a pathogenic mechanism (25).

Lone et al. literature review aiming to the investigation of smoke as a risk factor in peri-implantitis appearance concludes that most articles establish a association of risk. Few analysed articles failed in establishing an association. Deprivation of implant therapy in smokers is not the solution to the problem, patients should be although advised of the need of cessation. Smoking habit should be considered a “controllable risk factor” (24).

DIABETES MELLITUS

Diabetes Mellitus is a increasingly frequent disease causing hyperglycaemia to the patients affected by it. According to the International Diabetes Federation 415 million adults around the world are affected by this condition (19)(26). Considering the exponential increasing

prevalence of this disease, the consequences of this illness are soundly investigated. It has already been confirmed the worsening role of Diabetes with respect to the progression of periodontal disease (19). As claimed by Monje et al. there is no relative risk worsening in patients with high glycaemic levels in comparison with those normoglycemic in the appraising of peri-implant mucositis. On the contrary it is to consider hyperglycaemia a worsening factor in the appearance and severity of peri-implantitis (19)(26). As obesity is to be deemed as a predisposing factor in the advancement of Diabetes Mellitus type 2, this may also be contemplated in the indicators of risk for peri-implant progression and degeneration. Furthermore the hazard of developing peri-implantitis with deeper probing depth, increased BOP and a severe bone reabsorption is 46% greater in those patients not managing correctly this condition (19).

According to a systematic review about the relation between Diabetes and peri-implantitis, Naujokat et al. observed no endangerment in the rate of survival by the condition withing the 6 years, while the endurance after 20 years is compromised by the illness (27). According to Derks et al. in 2016, Rokn et al. in 2017 no relation among the possible hazard indicator and peri-implant disease may be found (14).

The effects of Diabetes Mellitus on peri-implant disease should be more thoroughly investigated as many authors state, such as Ghoulbzouri et al (7). The evidence is to be considered inconclusive and no unanimous declaration may be emitted as many authors are in disagreement (28).

SURFACE CHARACTERISTICS

Surface roughness of the implant may be described as the “height of the surface structure” and may be seen as two dimensional or three dimensional. Implants roughness may be classified into four categories (29). Most implants used nowadays are to be considered as moderately rough when grouped according to their surface characteristics (7). Strong evidence is gathered that implants of this category present with better survival rate in comparison to previous placed implants which outcomes are less predictable. There are mainly two techniques which modify the roughness of the implant; etching or blasting which are subtractive methods or the additive procedures (29). The evidence gathered regarding the surface roughness and the subsequent appearance of the two stages of the peri-implant disease is limited (11). According to the systematic investigation of Sanz-Martin et al. structured to analyze the sway of the abutments surface characteristics on the tissue surrounding the implant, no risk association was found (30). Surface roughness does not influence the amount of bleeding on probing of the mucosa proximal to the implant (11). Regarding a possible subsequent appearance of peri implant bone loss not enough evidence was found to state a association of risk with the surface roughness (7).

Nevertheless it is common thought that further investigation should be carried out before emitting a common consensus regarding the surface characteristics affecting the peri-implant mucosa (19).

RESIDUAL CEMENT

Implant retained prosthesis may be screwed or cemented and a accurate study of the individual risk should be brought along previous to the choice of retention (31). In a cemented

rehabilitation it is the job of the dentist to check thoroughly whether material leftovers may be seen in the area. It has been investigated the influence of the residual cement on the inflammation of the tissue surrounding the implant (18). A correlation is recognized between the increased rates of peri-mucositis and peri-implantitis in those patients in which residual material is seen in the checkup x-rays or through a dental endoscope (31). Often cement will be seen through direct vision after trying to treat through surgery the disease itself; also in case of a biopsy of the tissues surrounding the implant a histological examination will confirm the presence of the excess (32). It is proven that detection of cement excess and complete removal of it following the initial cementation of the prosthesis is a complicated and time expensive procedure. In case of cemented prosthesis it is serious in the avoidance of excess leftovers the collocation of supragingival of yuxtagingival margins of the restoration to achieve a removal with direct vision (11). Cement excess influences the accumulation of plaque as it increases the surface roughness of the rehabilitation and creates an optimal bacteriological niche (31).

IMPLANT MATERIAL

Many materials have been investigated to be implemented as implants. Titanium has been used since 1977, when Branemark coined the term and concept of osseointegration (33). According to new researches within the ceramic world, Zirconia has been proven to possess remarkable biocompatibility. Along with this characteristic many other advantages have been investigated for this material transforming it in a good option for implants (19).

Previously to various studies, dentists thought that this material was exempt from any inflammation and as a consequence that this could solve the problem of peri-implantitis.

Along with further investigations this idea vanished but it has been proven that significantly less bone loss affected Zirconium implants in comparison with Titanium implants (34).

Studies regarding Titanium have also been brought along during the years in which this material has been used. Researchers investigated how dissolute Titanium particles were found in the submucosal plaque of implants affected by peri-implant mucositis and peri-implantitis. Corrosion processes of this material were often triggered by acids involved in the mucosal inflammation (33).

AMOUNT OF KERATINIZED TISSUE

Keratinized tissue surrounding the implant helps the control of the tissue inflammation and the future bone loss. It is requirement of health a 2mm height of keratinized tissue, this will help the plaque control. (19) Implants with diminished keratinized tissue are subjected to severer peri-implant mucositis and bone loss. (35) A factor that is remarkably relevant in the development of the peri-implant disease, as previously said, is the accumulation of plaque. It has been demonstrated that patients with less than 2mm of keratinized tissue have a worst plaque control due to the discomfort that mechanical cleaning brings them. (36)

Soft tissue recessions must be avoided due to the consequential exposure of the rough surface of the implant. These characteristic compromises an easy and effective plaque control. Recessions are often associated to thin phenotype, making this also a risk indicator for peri-implant disease associated to biofilm accumulation. (19)

PREVENTION OF PERI-IMPLANT MUCOSITIS

Implant disease affect routinely our patients and according to the treatment methods and their outcome it is agreed by dentists that prevention of these conditions is better than

reparation, both for the effort invested and the future survival rate of the implants. Patients rehabilitated with implants should be widely motivated towards a lifestyle change and must be continuously diagnosed and instructed. It should be primary concern of the dentist to know the risk parameters and protective parameters that their patients embrace to establish a future risk assessment of the disease and an individualized and effective preventive program (37).

HYGIENE INSTRUCTIONS FOR IMPLANT REHABILITATED PATIENTS

Correct oral hygiene of the patient rehabilitated with dental implants is mandatory and plays a major role in their survival. The patient must be instructed by their dentist for the achievement of the most adequate technique (37). Within the first year every three months a check-up visit must be performed. During the following years this time span may be lengthened to six months depending on the ability of each patient (38). It is demonstrated that biofilm induced implant disease has an accelerated development in comparison with periodontal disease. This is due to a disorganizations of the fibers surrounding the dental implant (39).

Mechanical cleaning of the dental implants must be taught to the patient. Provide them of an explanation of the circular or Bass technique with a typodont and with a mirror in their own mouth. Furthermore, as implants are especially sensitive to attrition, a toothbrush of soft bristles with rounded edges should be used twice a day (39). It is accepted as golden standard the removal of plaque through automated power driven toothbrushes (40). The patient may also utilize single tufted toothbrushes , which may be bent and brought to the most unapproachable areas (39). Interproximal cleaning of the implant is of primary importance.

The looping technique may be instructed for the facial and lingual areas. Various types of dental floss are found on the market, such as: plastic floss, braided floss, woven or satin floss and dental tapes. The choice is within the clinician hands and might be adjusted according to the clinical picture and indications. Dental floss may also be used for the delivery of topical chemotherapeutic. Contingently on the clinical picture of each patient's interproximal brushes with a plastic-coated wire may be advised according to the size of the interproximal space. While considering the ability of each, instruction for the use of an oral irrigator with Chlorhexidine may be given; as this may cause peri-implant tissue injury when used incorrectly (41). Floss pressurized water flossing has been demonstrated of concrete help in the easy removal of biofilm and avoidance of the peri-implant disease. (42) Alongside all of the these instructions patients may help themselves reduce the peri-implant plaque amount by using antimicrobials mouthwashes sporadically, as these may cause staining (41).

PROFESSIONAL MECHANICAL PLAQUE REMOVAL

Prevention of peri-implant disease and the survival rates of these lasts depend on the dental hygienists. Prevention of peri-implant disease begins prior to the implant placement. All disease withing the mouth should be considered cured, especially periodontal disease, as this has been demonstrated as a predisposing feature in the future establishment of mucositis and peri-implantitis. As previously stated check-up visits must be performed every three months during the first years, while they may be reduced to every six/twelve months during the following years. During these follow up visits the at home oral care must be evaluated throughout the assessment of the oral biofilm deposit on the prosthetic restorations. Probing will be performed once a year in a healthy individual, while the active implant pockets must be probed during each visit (43).

In case of presence of biofilm supragingivally or subgingivally on dental implants restorations, an effective method for its removal is air flow/perio flow with erythol powder or glycine powder. This technique facilitates the professionals work saving him time in his everyday treatment and revisions of these patients (42)(44).

Scaling and curettage of the dental implants should be performed during every dental visit, in the same way as when performed on a dentulous patient, when calculus or deposits are detected (44). Conflicting opinions are still present whether softer plastic scalars or Teflon curettes should be used to avoid modifying the surface topography of dental implants (41). According to studies and professional opinions these curettes are big and according to this characteristic they present problems in reaching certain areas. In line with some histological research, it has been demonstrated that the plastic curettes deposit biologically non compatible particles. Particular care must be taken in the avoidance of scratching the implant surface; titanium probes may be used in the calculus detection. (42) According to the opposing opinion, authors defend the use of Titanium curettes on dental implants due to their superior capacity in the removal of dental calculus and the avoidance of plastic deposit in the subgingival area (43).

PREVENTION OF PERI-IMPLANTITIS

In 2018 during the World Workshop of Periodontology the consensus that peri-implantitis is the direct continuum of peri implant mucositis was stated. It is widely proven for this reason that the main preventive technique in the appearance of peri-implant bone loss is the prevention of peri-implant mucositis and in case of its appearance at a site the prompt treatment of the inflammation of the soft tissue. Peri-implant mucositis is a curable disease of the gingival mucosa, once treated patients should be instructed about hygiene techniques for the avoidance of its recurrence (28).

IDRA – IMPLANT DISEASE RISK ASSESSMENT

When considering implants as the restorative method of choice for a patient their survival in the mouth is of primary concern to the dentist. Closely linked to this concept we may consider the prevention of peri-implant disease essential in the longevity of the implant. As been previously explained peri-implant disease is linked to many factors of risk. It is relevant to individualize within the patients those with the greater risk, so that the dentist may provide them with the correct attentions and limit the breakdown of the peri-implant tissue (22).

Heitz-Mayfield et al. introduced a hazard evaluation device known as Implant Disease Risk Assessment (IDRA). It is a diagram based on eight parameters which have been widely demonstrated to take part in the predisposition of a patient towards peri-implantitis. IDRA has been created to recognize within the populations those subjects that need particular attention in the avoidance of appearance of peri-implantitis. The eight parameters which are then combined in a octagon for the establishment of a risk profile are: previous periodontal

disease, BOP %, deeper probing depth of ≥ 5mm, bone reabsorption correlated to the age of the patient, periodontal disease predisposition, maintenance treatment for periodontal disease, profundity of the implant restoration and features associated to the prosthesis.

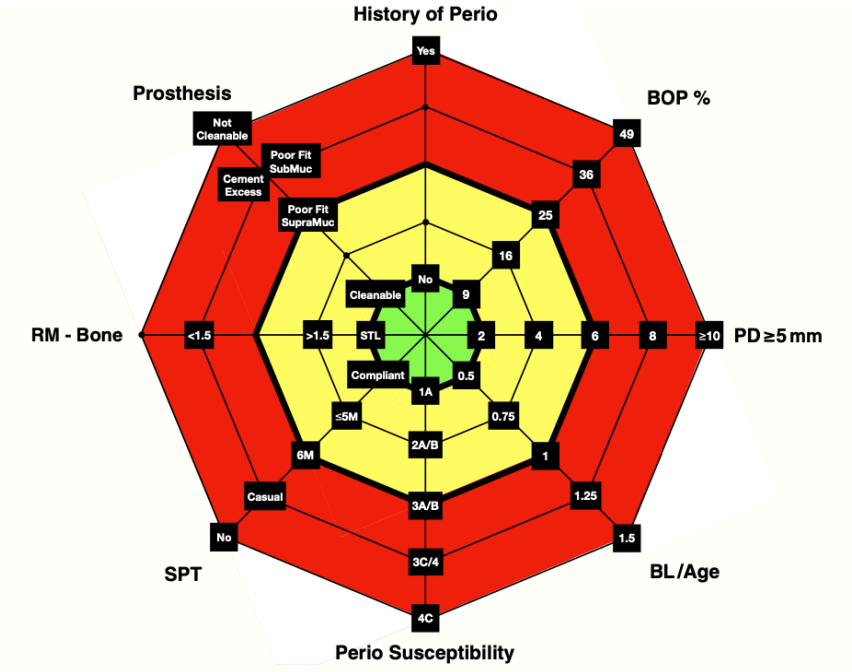

Figure 4: IDRA octagon for the patient peri-implantitis susceptibility

The patient will be then assigned to a IDRA risk category. Within the low-risk category, we may find patients with all of the values in the smallest danger or maximum a single characteristic in the medium hazard. Those patients assigned to the moderate risk will present with minimum two features within the medium danger group and not more than a sole indicator within the group with most significant danger. Those people grouped within the high IDRA risk will present with at least two features known as high risk (21).

TREATMENT OF PERI-IMPLANT MUCOSITIS

Patients affected by inflammation of the gingiva must be evaluated by a dentist. As previously said peri-implant mucositis is recognized to be a reversible disease when correctly treated, this is why a early detection is essential for its resolution (40). The dentist must evaluate whether the inflammation is profuse to the whole mouth, affecting both implants and natural teeth; or if it is limited only to implants. Furthermore, it is essential to gather a correct clinical history to evaluate the true cause of the inflammation.

If the inflammation affects the whole oral cavity the intervention of the oral hygienist is essential. It has been demonstrated that in people affected by peri-implant mucositis no complete resolution of the disease exists if only treated by patients administered measures. Therefore, professionally and patient-administered mechanical debridement must appear as the most appropriate treatment for mucositis (45)(46). Evaluation of the mechanical removal of plaque and the daily techniques of the patient is compulsory for the inflammation reduction. Furthermore if the inflammation is copious it is advisable to instruct the patient with additional techniques as explained within those for the prevention of peri-implant mucositis (46). Patients affected by profuse inflammation should also be treated non surgically through mechanical debridement. Studies have been evaluating the efficacy in the reduction of BOP and pocket depth in patients treated with glycine powder air-polishing or with ultrasonic devices. It has been revealed as a result that both methods may be considered effective in the treatment of peri-implant mucositis (47).

In addition, some type of antimicrobial is often added as an adjuvant to plaque control, such as antiseptics or local and systemic antibiotics (48). Studies involving the effectiveness of Chlorhexidine 0.12% on peri-implant mucositis treatment were brought along during the years

as this is usually the antiseptic of choice in periodontal disease. When analysing patients treated with mechanical debridement only and those with a double treatment of plaque control and Chlorhexidine 0.12%, no increased improvement in the disease was found in these patients (49). According to other studies and article reviews no agreeing opinion is yet present whether the antiseptic irrigation may bring or not a adjunctive effect in the treatment, as studies that recognize no improvement are present (40).

Cementation is the less complex method in the prosthetics restoration placement, although the main risk to consider is leaving residual cement in the pocket. The hazard of this technique usually may be prevented by using “resin-based luting cements” (50). When peri-implant mucositis appears in a limited area, such as on only one implant dentists should presume that the cause is given by an excess of residual cement in the gingival pocket. The removal of the residual cement will result in a decrease of the peri-implant inflammation (46). In the case the prosthetics restoration may be removed from the implant the residual cement may be removed directly with a ultrasound. The non surgical removal of the cement from the subgingival pocket should always be the first choice when a implant is diagnosed with residual cement excess. This procedure usually results in a decrease of the inflammation of the mucosa (51).

Often, when prosthetics restoration is not removable or the cement is excess is situated in an area not accessible by curettes. In these occasions the cement excess may be removed throughout an exploratory surgery. Following the flap elevation, the cement may be removed through an ultrasound and titanium scalers. A direct access to the deposit will provide the dentist an easier and thrower removal of all rests (46).

According to a systematic review, it has been proven that after less than one year from the cement removal the peri-implant mucosa resulted with significant decreased mucositis (50).

Supportive therapy is important in the maintenance of a healthy peri-implant mucosa. It is demonstrated that a lack of a protocol of follow up in patients that have been affected by disease result in a progression towards peri-implantitis. The supportive therapy must be brought along annually according to a gold standard but should also be personalized according to the patient's needs (52).

TREATMENT OF PERI-IMPLANTITIS

The diagnostic methodologies that may be used by the professional for the detection of this second stage of the disease are many. Periodontal probing and diagnostic x-rays should be performed. If running along with a profuse bleeding the dentist finds an amount of bone loss, he should analyse whether the implant should be maintained and treated or removed. When the choice is the maintenance of the implant in the patient's mouth, the first treatment approach should be the non-surgical, in conjunction with oral hygiene techniques instruction. In a quantity of simple cases reduction of bleeding and pathological pockets and a complete resolution of the disease may be reached (46).

In the majority of the cases the use of surgical treatments is essential in the resolution of the problem. Although it has been demonstrated that key to success is a previous stage of non-surgical therapy of the disease (46). The non-surgical therapy is brought along for the achievement of a reduction of the inflammation and a assessment of the reaction that the tissues and the oral hygiene techniques of the patient (53). This treatment technique is composed by carbon fibre scalers, ultrasound and titanium curettes. Usually, the BOP slightly

reduces and the pockets depth doesn't change or worsens. Non-surgical mechanical therapy may be co-adjuvated by the effects of local antimicrobials such as tetracycline or doxycycline. According to several studies it has been demonstrated a improvement in the clinical picture of the patient and these protocols may also be used in that part of the population affected by the disease and not suitable for surgical procedures. Also systemic antibiotics in conjunction with non-surgical therapy have been researched, but no agreeing consensus has been found (40). New non-surgical techniques have been invented throughout the years for the decontamination of the dental implants affected by disease. Studies investigating the efficiency of Er-YAG laser in curing peri-implantitis recognize a reduction of the BOP, a decrease in probing depth and a increase in the clinical insertion (54). On the other hand when comparing air abrasive devices and a normal curettage the clinical improvement is much higher in those patients treated with air abrasive techniques (40).

Peri-implantitis is characterized by a marginal bone loss and the principal goal of its therapy is stopping the progressive bone loss. The treatment is often defined as combined, resective surgery for the sanitation of the area and regenerative surgery for the improvement of the osseous defect created by the disease. Along with this protocol is also important to remember the need of a maintenance protocol for the long term success. Dentists when evaluating the factors to be taken into account for the selection of the type of treatment, the amount of bone loss, the intra-surgical anatomy of the bone defect, the graft material and the surface of the implant should be taken into account.

SURGICAL THERAPY

Peri-implantitis is characterized by a marginal bone loss and the principal goal of its therapy is stopping the progression of the defect. Dentists may choose a surgical therapy to achieve better access to the area and future outcomes (16). The treatment is often defined as a combination of: access surgery, resective surgery and regenerative surgery (48). Along with this protocol is also important to remember the need of a maintenance protocol for the long term success (46). Dentists defined the importance of creating a personalized protocol for each patient. When evaluating the factors to be taken into account for the selection of the type of treatment, the amount of bone loss, the intra-surgical anatomy of the bone defect, the graft material and the surface of the implant should be taken into account (48).

The access surgery consists in a full-thickness flap elevated to debride the granulation tissue affecting the bone defect and decontaminate the exposed implant surface with curettes, ultrasound, abrasive air systems or lasers (48). The air abrasive systems consist on sodium bicarbonate ($NaHCO_3$), calcium phosphate (Ca3(PO4)2), or the amino acid glycine ($C_2H_5NO_2$) powder spread on the implant surface through compressed air. The results of this debridement treatment depend on the chemical used and on the time of application. According to the studies analyzed no golden standard is found for this technique (16).

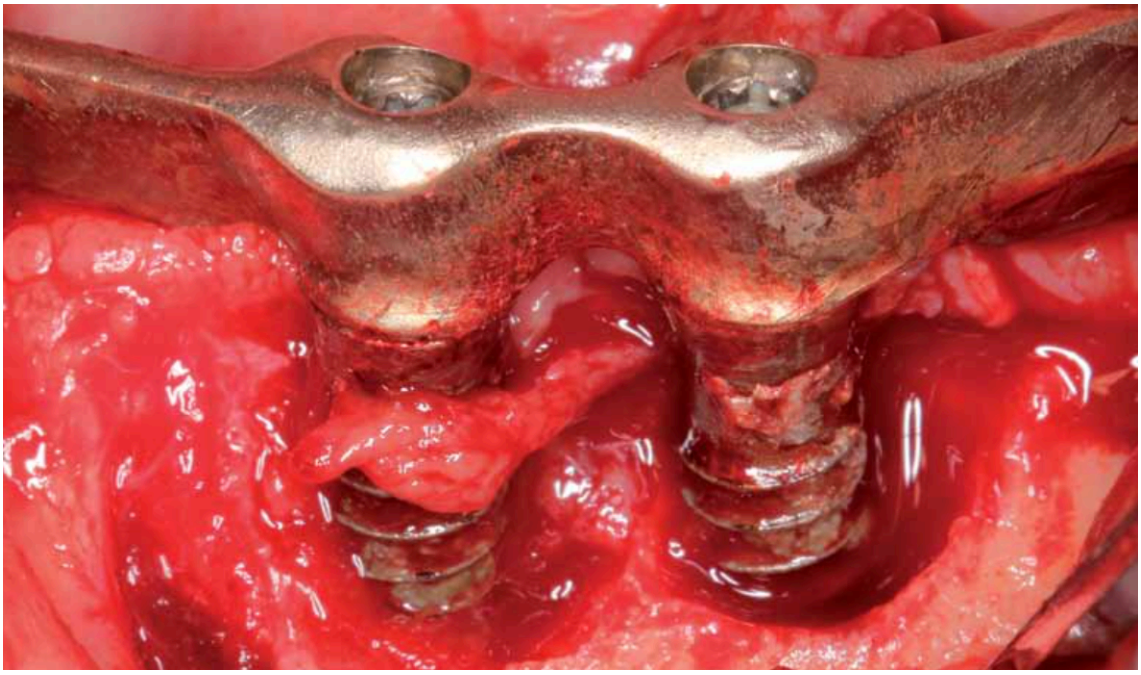

Figure 5: Clinical situation of implants affected by peri-implantitis following the access surgery and the flap elevation (48).

The resective surgery is a technique that can be applied either at the level of the implant or the peri-implant soft tissues (55). The end gaol of this technique is the reduction of the pocket depth and a better adaptation of the flap (16). When the resection of the soft tissues and the peri-implant pocket is performed, the esthetical result is compromised. It is not considered a valid procedure for an aesthetic area. This technique may be accompanied by a polishing of the implant surface achieved through an apically positions flap, called implantoplasty, performed with a diamond bur to remove the exposed and infected threads and reduce plaque accumulation. The results is a more effective treatment than when only the pocket removal procedure is performed (55).

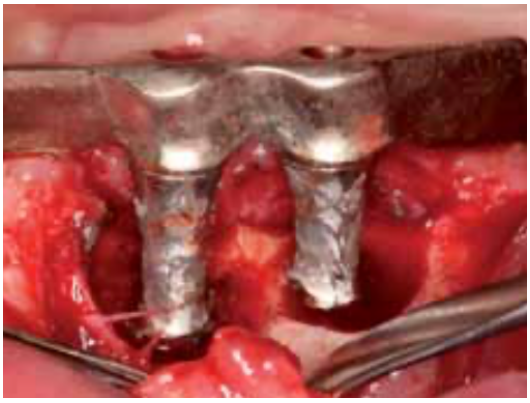

Figure 6: implants surface following implantoplasty technique (48).

The regenerative surgery's aim is to recover the lost bone at the peri-implantitis site, using a graft or bone substitute, barrier membranes or combinations of the above (48). The bone graft acts as a scaffold and the membrane protects it and provides a delimited space for the formation of the desired tissue. Most studies obtain the best regenerative results with the combination of bone graft and membrane. The use of membrane is not always necessary and should be carefully evaluated, for example in a four wall's defect the graft may be retained in the cavity and the use of the membrane may be avoided. Membranes may be resorbable and non-resorbable. The clinical outcome is comparable and the main advantage stands in the avoidance of a second surgery for the membrane removal when implementing the nonresorbable type. A complication of this technique may be considered the exposure of the membrane to the oral environment. If this should occur, the membrane must be immediately removed as it may worsen the already achieved bone regeneration (56).

Figure 7: regenerative surgery of the area previously affected by peri-implantitis with a resorbable membrane with collagen origin (48).

PROTOCOL OF FOLLOW UP

Following peri-implant disease treatment a maintenance protocol should be established to maintain a controlled situation of the patient. The check-up visits should include all diagnostic methodologies previously listed for the detection of the peri-implant disease. A throw in any case of necessity implant and natural teeth prophylaxis with the preventive techniques of the peri-implant disease should be carried out. In case of biofilm gathering on the restoration the oral hygiene techniques should be reminded to the patient. The protocol of the follow up visits should be styled by the professional according to the patient's characteristics, assessing the risk indicators of the disease and the previous situation of disease. This protocol may be modified also according to the clinical picture we may encounter in the patients mouth during the revisions (46).

Periodontal and peri-implant tissues which have been previously affected by disease are recognized to be more susceptible to recolonization than healthy tissues. This statement has

been supported by the studies in the gene expression changes. The suggested recall interval is usually five/six months (57).

CONCLUSIONS

-Peri-implant mucositis and peri-implantitis are disease characterized by similar aetiologies. These lasts are known to be biofilm induced peri-implant disease. Other than biofilm, it was possible to recognize diverse general and local contributing risk factors for these diseases.

-The lack of maintenance therapy, the history of periodontal disease and the possible residual cement are recognized in most studies as predisposing factors. Further investigation is necessary to reach an agreed consensus regarding the role that Diabetes, the smoking habit, the amount of keratinized tissue, the surface characteristic and the implant material, have on the appearance of the peri-implant disease.

-Prevention has been recognized by all studies as a key factor for implant survival, and it has been agreed that disease avoidance is better than cure. Appropriate hygiene instructions must be explained to all implant rehabilitated patients and a regular maintenance therapy comprehensive of diagnosis and scaling every less than six months increases implant survival rate.

-As peri-implantitis is known to be the second stage of the disease, prevention of peri-implant mucositis and its prompt cure is essential to circumvent the appearance of it.

-Investigations declared the treatment of choice for peri-implant mucositis as non-surgical. Treatment comprehensive of oral hygiene instructions, maintenance therapy modelled

according to the patient´s needs and in clinic techniques for the removal of biofilm from the implant.

-Patients affected by a disease which already progressed towards peri-implantitis should be treated differently according to each case and defect type. It has been agreed that a stage of non-surgical treatment comparable to that of peri-implant mucositis should be brought along to reach a reduction of the mucosal inflammation. Following this first stage ,a surgery should be programmed.

-The surgery will be different according to each patient. It may be a conjunction of access and resective surgery, to this is may be added an implantoplasty procedure and for those patients willing a rehabilitation of the bone loss due to the disease also a regenerative surgery through bone graft and membrane.

-Patients which have been rehabilitated from the disease are understood to be noticeably more susceptible to recidivism. Reason why a continuous maintenance protocol must be styled according the needs and the indicators of risk of each patient, considering a maximum interval of six months between assessments.

RESPONSIBILITY

Throughout the literature review which has been performed, it was possible to gather information regarding a disease which needs further investigation and affects the population rehabilitated by implants. The research regarding the prevention and the treatment of these biofilm induced diseases aims to curb the implant failure caused by peri-implant mucositis and peri-implantitis.

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ANNEXES

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2017 WORLD WORKSHOP

Peri-implant diseases and conditions: Consensus report of workgroup 4 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions

Tord Berglundh[1] | Gary Armitage[2] | Mauricio G. Araujo[3] | Gustavo Avila-Ortiz[4] | Juan Blanco[5] | Paulo M. Camargo[6] | Stephen Chen[7] | David Cochran[8] | Jan Derks[1] | Elena Figuero[9] | Christoph H.F. Hämmerle[10] | Lisa J.A. Heitz-Mayfield[11] | Guy Huynh-Ba[8] | Vincent Iacono[12] | Ki-Tae Koo[13] | France Lambert[14] | Laurie McCauley[15] | Marc Quirynen[16] | Stefan Renvert[17] | Giovanni E. Salvi[18] | Frank Schwarz[19] | Dennis Tarnow[20] | Cristiano Tomasi[1] | Hom-Lay Wang[15] | Nicola Zitzmann[21]

[1]Department of Periodontology, Institute of Odontology, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden
[2]University of California San Francisco, San Francisco, CA, USA
[3]State University of Maringa, Parana, Brazil
[4]University of Iowa, Iowa City, IA, USA
[5]Universidad Santiago de Compostela, Santiago, Spain
[6]University of California Los Angeles, Los Angeles, CA, USA
[7]University of Melbourne, Melbourne, Australia
[8]University of Texas Health Science Center, San Antonio, TX, USA
[9]Universidad Complutense, Madrid, Spain
[10]Clinic of Fixed and Removable Prosthodontics and Dental Material Science, University of Zurich, Zurich, Switzerland
[11]University of Sydney, Sydney, Australia
[12]Stony Brook University, Stony Brook, NY, USA
[13]Seoul National University, Seoul, South Korea
[14]Department of Periodontology and Oral Surgery, University of Liège, Liège, Belgium
[15]School of Dentistry, University of Michigan, Ann Arbor, MI, USA
[16]Leuven University, Flanders, Belgium
[17]Kristianstad University, Kristianstad, Sweden
[18]Department of Periodontology, University of Bern, Bern, Switzerland
[19]Department of Oral Surgery and Implantology, Carolinum, Goethe University, Frankfurt, Germany
[20]Columbia University, New York, NY, USA
[21]Department of Reconstructive Dentistry, University of Basel, Basel, Switzerland

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Journal of Clinical Periodontology

Peri-implant health and disease. A systematic review of current epidemiology

Jan Derks and Cristiano Tomasi

Department of Periodontology, Institute of Odontology, The Sahlgrenska Academy at University of Gothenburg, Gothenburg, Sweden

Derks J, Tomasi C. Peri-implant health and disease. A systematic review of current epidemiology. J Clin Periodontol 2015; 42 (Suppl. 16): S158–S171. doi: 10.1111/jcpe.12334.

Abstract

Background: To develop preventive strategies addressing peri-implant diseases, a thorough understanding of the epidemiology is required.

Aim: The aim was to systematically assess the scientific literature in order to evaluate the prevalence, extent and severity of peri-implant diseases.

Material & Methods: Data were extracted from identified studies. Meta-analyses for prevalence of peri-implant mucositis and peri-implantitis were performed. The effect of function time and disease definition on the prevalence of peri-implantitis was evaluated by meta-regression analyses. Data on extent and severity of peri-implant diseases were estimated if not directly reported.

Results: Fifteen articles describing 11 studies were included. Case definitions for mucositis and peri-implantitis varied. The prevalence of peri-implant mucositis and peri-implantitis ranged from 19 to 65% and from 1 to 47%, respectively. Meta-analyses estimated weighted mean prevalences of peri-implant mucositis and peri-implantitis of 43% (CI: 32–54%) and 22% (CI: 14–30%), respectively. The meta-regression showed a positive relationship between prevalence of peri-implantitis and function time and a negative relationship between prevalence of peri-implantitis and threshold for bone loss. Extent and severity of peri-implant diseases were rarely reported.

Conclusion: Future studies on the epidemiology of peri-implant diseases should consider (i) applying consistent case definitions and (ii) assessing random patient samples of adequate size and function time.

Key words: Incidence; Peri-implant disease; Prevalence

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Peri-implant mucositis is defined as the presence of a plaque-related inflammatory soft tissue infiltrate without concurrent loss of peri-implant bone tissue, while peri-implantitis should demonstrate inflammation in combination with bone loss (Albrektsson & Isidor 1994, Zitzmann & Berglundh 2008).

Conflict of interest and source of funding statement

The authors declare no conflict of interest. The study was self-funded.

At the 7th EWOP, similarities and differences between periodontal and peri-implant diseases were addressed, focusing on host response and bacterial challenge characteristics (Lang & Berglundh 2011). The importance of prevention was highlighted, as mucositis was found to be potentially progressing into peri-implantitis if left untreated, but reversible if adequately treated.

At the 6th European Workshop on Periodontology (EWOP), issues related to peri-implant diseases were discussed. Mucositis was found to occur in more than 50% of all implant-carrying subjects, while peri-implantitis was found to affect between 28% and 56% of subjects (Lindhe & Meyle 2008). The observed variability for reported prevalence of peri-implant diseases between different studies may be explained, in part, by methodological issues, such as the heterogeneous use of case definitions (Tomasi & Derks 2012).

At the 8th EWOP, the occurrence of biological complications at dental implants was identified as a main outcome domain when evaluating the efficacy of implant therapy (Tonetti & Palmer 2012). To facilitate future

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Trends in Dental Implant Use in the U.S., 1999–2016, and Projections to 2026

H.W. Elani,[1] J.R. Starr,[2,3] J.D. Da Silva,[1] and G.O. Gallucci[1]

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Associated Data

Supplementary Materials

ABSTRACT

Go to:

Dental implants have become an increasingly popular treatment choice for replacing missing teeth. Yet, little is known about the prevalence and sociodemographic distribution of dental implant use in the United States. To address this knowledge gap, we analyzed data from 7 National Health and Nutrition Examination Surveys from 1999 to 2016. We estimated dental implant prevalence among adults missing any teeth for each survey period overall as stratified by sociodemographic characteristics. We calculated absolute and relative differences from 1999–2000 to 2015–2016 and fit logistic regression models to estimate changes over time. We also used multivariable logistic regression to estimate independent associations of sociodemographic covariates with the presence of any implant. We projected the proportion of patients treated with dental implants into the year 2026 under varying assumptions of how the temporal trend would continue. There has been a large increase in the prevalence of dental implants, from 0.7% in 1999 to 2000 to 5.7% in 2015 to 2016. The largest absolute increase in prevalence (12.9%) was among individuals 65 to 74 y old, whereas the largest relative increase was ~1,000% among those 55 to 64 y old. There was an average covariate-adjusted increase in dental implant prevalence of 14% per year (95% CI, 11% to 18%). Having private insurance (vs. none or public insurance) or more than a high school education (vs. high school or less) was each associated with a 2-fold increase in prevalence, with an almost 13-fold (95% CI, 8 to21) increase for older adults. Dental implant prevalence projected to 2026 ranged from 5.7% in the most conservative scenario to 23% in the least. This study demonstrates that dental implant prevalence among US adults with missing teeth has substantially increased since 1999. Yet access overall is still very low, and prevalence was consistently higher among more advantaged groups.

Keywords: endosseous dental implantation, prevalence, National Health and Nutrition Examination Survey, projection, cross-sectional studies, dental care

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2017 WORLD WORKSHOP

WILEY Journal of Clinical Periodontology

Peri-implant health, peri-implant mucositis, and peri-implantitis: Case definitions and diagnostic considerations

Stefan Renvert[1,2,3] | G. Rutger Persson[1,4] | Flavia Q. Pirih[5] | Paulo M. Camargo[5]

[1]School of Health and Society, Department of Oral Health Sciences, Kristianstad University, Kristianstad, Sweden

[2]School of Dental Science, Trinity College, Dublin, Ireland

[3]Blekinge Institute of Technology, Karlskrona, Sweden

[4]Departments of Periodontics and Oral Medicine, School of Dentistry, University of Washington, Seattle, WA, USA

[5]School of Dentistry, Section of Periodontics, University of California, Los Angeles, Los Angeles, CA, USA

Correspondence
Prof. Stefan Renvert, Department of Health Sciences, Kristianstad University, 29188 Kristianstad, Sweden.
Email: stefan.renvert@hkr.se

The proceedings of the workshop were jointly and simultaneously published in the *Journal of Periodontology* and *Journal of Clinical Periodontology*.

Abstract

The objective of this review is to identify case definitions and clinical criteria of peri-implant healthy tissues, peri-implant mucositis, and peri-implantitis. The case definitions were constructed based on a review of the evidence applicable for diagnostic considerations. In summary, the diagnostic definition of peri-implant health is based on the following criteria: 1) absence of peri-implant signs of soft tissue inflammation (redness, swelling, profuse bleeding on probing), and 2) the absence of further additional bone loss following initial healing. The diagnostic definition of peri-implant mucositis is based on following criteria: 1) presence of peri-implant signs of inflammation (redness, swelling, line or drop of bleeding within 30 seconds following probing), combined with 2) no additional bone loss following initial healing. The clinical definition of peri-implantitis is based on following criteria: 1) presence of peri-implant signs of inflammation, 2) radiographic evidence of bone loss following initial healing, and 3) increasing probing depth as compared to probing depth values collected after placement of the prosthetic reconstruction. In the absence of previous radiographs, radiographic bone level ≥3 mm in combination with BOP and probing depths ≥6 mm is indicative of peri-implantitis.

KEYWORDS
diagnosis, peri-implant health, peri-implant mucositis, peri-implantitis

INTRODUCTION

Osseointegrated dental implants have become an increasingly popular modality of treatment for the replacement of absent or lost teeth. Dental implants have high rates of long-term survival (≥10 years) when used to support various types of dental prostheses. However, the long-term success of dental implants is not the same or as high as their survival, as functional implants and their restorations may be subject to mechanical and biological complications.[1]

It is recognized that there are also unusual peri-implant problems (e.g., peri-implant peripheral giant-cell granuloma, pyogenic granuloma, squamous cell carcinoma, metastatic carcinomas, malignant melanoma) or other conditions such as implant fractures that may mimic or share certain clinical features with biofilm-associated peri-implant diseases. With such context in mind, the reader is to be reminded that this manuscript focuses solely on biofilm-induced inflammatory lesions around dental implants.

Biological complications associated with dental implants are mostly inflammatory conditions of the soft tissues and bone surrounding implants and their restorative components, which are induced by the accumulation of bacterial biofilm. Such conditions, which have been named peri-implant mucositis and peri-implantitis, need to be clearly defined and differentiated from a state of peri-implant health, so that the clinician may assign a proper diagnosis and select a proper treatment modality in cases where disease is present.

In a survey of registered specialists in periodontology in Australia and the United Kingdom about the etiology, prevalence, diagnosis and management of peri-implant mucositis and peri-implantitis,

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Journal of Clinical Periodontology

Risk indicators for peri-implant mucositis: a systematic literature review

Stefan Renvert[1,2,3] and Ioannis Polyzois[3]

[1]Department of Health Sciences, Kristianstad University, Kristianstad, Sweden; [2]Blekinge Institute of Technology, Karlskrona, Sweden; [3]Dublin Dental University Hospital, Trinity College, Dublin, Ireland

Renvert S, Polyzois I. Risk indicators for peri-implant mucositis: a systematic literature review. J Clin Periodontol 2015; 42 (Suppl. 16): S172–S186. doi: 10.1111/jcpe.12346.

Abstract

Objectives: To examine the existing evidence in identifying risk indicators in the aetiology of peri-implant mucositis.

Material and Methods: A search was performed in PubMed, Web of Science (WOS) and The Cochrane Library databases for articles published until June 2014.

Results: This search gave 3135 results of which 15 studies fulfilled the inclusion criteria. The current review revealed that only a few studies provided data on risk indicators for the development of peri-implant mucositis. Based on the data available, there is evidence that plaque is a risk indicator for peri-implant mucositis. Smoking has also been identified as an independent risk indicator whereas the overall evidence for surface roughness, residual cement, the dimension of the keratinized tissue and time of implant in function is weak. There are limited data available to support systemic conditions as risk indicators for peri-implant mucositis.

Conclusions: Plaque accumulation at implants will result in development of peri-implant mucositis. Smoking should also be considered as a risk indicator for the development of peri-implant mucositis.

Key words: peri-implant mucositis; plaque; risk indicators; smoking

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Peri-implant mucositis has been defined as "a reversible inflammatory change in the peri-implant soft tissue without bone loss" (Albrektsson & Isidor 1994) and it usually presents as inflammation with erythema, swelling and bleeding on probing around the head of the dental implant (Lindhe & Meyle 2008). A more clinical based definition presented by Zitzmann & Berglundh (2008) identified peri-implant mucositis as "the presence of inflammation in the mucosa at an implant with no sign of loss of supporting bone". Prevalence of peri-implant mucositis has been reported in 80% of subjects and 50% of implants (Roos-Jansåker et al. 2006a) and there is currently some emerging evidence to suggest that peri-implant mucosititis is the precursor of peri-implantitis (Costa et al. 2012).

Although there is only a small number of studies available addressing risk indicators/factors in peri-implant mucositis, smoking, residual cement, bacterial micro-leakage between the implant abutment interface, implant surface characteristics, type of the prosthetic supra-structure and diabetes, have been proposed to play a role in the aetiology of peri-implant mucositis (Broggini et al. 2003, Ferreira et al. 2006, Pongnarisorn et al. 2007, Karbach et al. 2009, Wilson 2009, Koutouzis et al. 2013). A risk factor as defined by Genco et al. (1996) is "an environmental, behavioural or biological factor that if present directly increases the probability of a disease occurring and, if absent or removed reduces that probability".

A common finding in earlier experimental studies was that pathogenesis of peri-implant mucositis can primarily be attributed to plaque accumulation (Ericsson et al. 1992, Leonhardt et al. 1992, Abrahamsson et al. 1998, Zitzmann et al. 2002). Most of the studies mentioned

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2017 WORLD WORKSHOP

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Peri-implant mucositis

Lisa J.A. Heitz-Mayfield[1,2] | **Giovanni E. Salvi**[3]

[1]Department of Anatomy, Biology and Human Physiology, International Research Collaborative-Oral Health and Equity, University of Western Australia, IRCOHE, Crawley, WA, Australia

[2]Faculty of Dentistry, University of Sydney, Surry Hills, NSW, Australia

[3]Department of Periodontology, University of Bern, Bern, Switzerland

Correspondence
Dr. Lisa JA Heitz-Mayfield, 4 McCourt St, West Leederville, WA 6007-6009.
Email: heitz.mayfield@iinet.net.au

The proceedings of the workshop were jointly and simultaneously published in the *Journal of Periodontology* and *Journal of Clinical Periodontology*.

Abstract

Objectives: This narrative review was prepared for the 2017 World Workshop of the American Academy of Periodontology and European Federation of Periodontology to address key questions related to the clinical condition of peri-implant mucositis, including: 1) the definition of peri-implant mucositis, 2) conversion of peri-implant health to the biofilm-induced peri-implant mucositis lesion, 3) reversibility of peri-implant mucositis, 4) the long-standing peri-implant mucositis lesion, 5) similarities and differences between peri-implant mucositis at implants and gingivitis at teeth, and 6) risk indicators/factors for peri-implant mucositis.

Methods: A literature search of MEDLINE (PubMed) and The Cochrane Library up to and including July 31, 2016, was carried out using the search strategy (peri-implant[All Fields] AND ("mucositis"[MeSH Terms] OR "mucositis"[All Fields])) OR (periimplant[All Fields] AND mucosits[All Fields]). Prospective, retrospective, and cross-sectional studies and review papers that focused on risk factors/indicators for peri-implant mucositis as well as experimental peri-implant mucositis studies in animals and humans were included.

Findings: Peri-implant mucositis is an inflammatory lesion of the soft tissues surrounding an endosseous implant in the absence of loss of supporting bone or continuing marginal bone loss. A cause-and-effect relationship between experimental accumulation of bacterial biofilms around titanium dental implants and the development of an inflammatory response has been demonstrated. The experimental peri-implant mucositis lesion is characterized by an inflammatory cell infiltrate present within the connective tissue lateral to the barrier epithelium. In long-standing peri-implant mucositis, the inflammatory cell infiltrate is larger in size than in the early (3-week) experimental peri-implant mucositis lesion. Biofilm-induced peri-implant mucositis is reversible at the host biomarker level once biofilm control is reinstituted. Reversal of the clinical signs of inflammation may take longer than 3 weeks. Factors identified as risk indicators for peri-implant mucositis include biofilm accumulation, smoking, and radiation. Further evidence is required for potential risk factors, including diabetes, lack of keratinized mucosa, and presence of excess luting cement.

Conclusions: Peri-implant mucositis is caused by biofilm accumulation which disrupts the host–microbe homeostasis at the implant–mucosa interface, resulting in an inflammatory lesion. Peri-implant mucositis is a reversible condition at the host

Periimplantitis- A review

Aws Nabeel K, B.D.S. [1]
Saif Seeham Saliem, B.D.S., M.Sc. [2]

ABSTRACT

This review article concentrates the light about aetiology and treatment of the periimplantitis. **(J Bagh Coll Dentistry 2015; 27(2):101-104).**

INTRODUCTION

The goal of modern dentistry is to restore the patient to normal contour, function, comfort, esthetics, speech, and health, regardless of the atrophy, disease or injury of stomatognathic system. Teeth are integral part of the stomatognathic system. The primary function of teeth is to prepare food for swallowing as well as to initiate and facilitate digestion. Teeth are also necessary for the articulation of speech and proper looks. Implant-based dental rehabilitation techniques has come to offer highly predictable results, hence it has become one more element to be included in the wide range of therapeutic alternatives for totally or partially edentulous patients, albeit some complications have been described in relation with this type of treatment; of these complications, the progressive loss of alveolar bone surrounding the implant is perhaps the most salient. The name periimplant disease refers to the pathological inflammatory changes that take place in the tissue surrounding a loadbearing implant [1] for some authors it is the most common complication in oro-facial implantology [2].

Two entities are described within the concept of periimplant disease: - Mucositis: a clinical manifestation characterized by the appearance of inflammatory changes restricted to the periimplant mucosa. If treated properly, it is a reversible process [3]. Periimplantitis: a clinical manifestation where clinically and radiologically evident loss of the bony support for the implant occurs, together with an inflammatory reaction of the periimplant mucosa [4].

(1)High Diploma Student, Department of Periodontics, College of Dentistry, University of Baghdad.
(2)Assistant Professor, Department of Periodontics, College of Dentistry, University of Baghdad.

Etiopathogeny of periimplantitis

1- Periimplant tissue morphology: - Healthy periimplant tissue plays an important role as a biological barrier to some of the agents that cause periimplant disease. The epithelium and the interface between the supralveolar connective tissue and the titanium surface of an implant differ from the interface of the dental-gingival unit. Like the connective tissue attachment, the epithelium presents a hemidesmosomal attachment to the implant surface; the difference lies in the fact that the epithelial fibers are predominantly longitudinal to the surface of the implant and not perpendicular, as in the case of a natural tooth. In the most coronal region, they are circumferential, in addition to presenting a low degree of vascularization and a higher collagen fiber to fibroblast ratio in comparisonto the tooth (a ratio of 4 in a tooth to 109 in the implant) [5].
2- Implant structure: - The design of the implant is an important factor in the onset and development of periimplantitis. Poor alignment of the components that comprise an implant prosthesis system may foster the retention of bacterial plaque, as well as enabling microorganisms to pass inside the transepithelial abutment.
3- Microbial infection: - Another cause of periimplantitis, as previously mentioned, is the bacterial colonization of theperiimplant pocket. The association between different microorganisms and destructive periodontal or periimplant disease is governed by the same biological parameters. The microorganisms most commonly related to the failure of an implant are the Gram negative anaerobes, like *Prevotellaintermedia,Porphyromonasgingivalis, Actinobacillusactinomycetemcomitans, Bacterioidesforsythus, Treponemadenticola, Prevotellanigrescens, Peptostreptococcus micros and Fusobacteriumnucleatum* [6].
4- Excessive mechanical stress: - Another factor that intervenes in periimplantitisaetiopathogeny is excessive

Prevalence, Etiology and Treatment of Peri-Implant Mucositis and Peri-Implantitis: A Survey of Periodontists in the United States

Evangelos Papathanasiou,* Matthew Finkelman,† James Hanley,* and Andreas O. Parashis*‡

Background: Currently, information available on the exact prevalence and standard therapeutic protocol of peri-implant diseases is insufficient. The aim of this survey was to investigate the perceived prevalence, etiology, and management of peri-implant mucositis and peri-implantitis by periodontists in the United States.

Methods: A twenty-question survey was developed. Periodontists currently practicing in the United States were contacted by an e-mail that contained a link to access the survey.

Results: Two hundred eighty periodontists (79.3% males; 62.9% with >10 years in practice, 75.7% in private practice) completed the survey. Most (96.1%) of the participants were placing implants (58.3% for >10 years and 32.4% >150 implants/year). The majority reported that the prevalence of peri-implant mucositis and peri-implantitis in their practices is up to 25% but is higher in the general US population and that up to 10% of implants must be removed due to peri-implantitis. There was agreement among contributing etiologic factors such as: 1) plaque; 2) smoking; 3) adverse loading; 4) oral hygiene; 5) use of antimicrobial gel/mouthrinse; 6) non-surgical debridement; 7) use of systemic antibiotics; and 8) 3-month supportive care for treatment of peri-implantitis. Significant heterogeneity was recorded in relation to the instruments used for debridement, use and type of surgical treatment, and materials used for regeneration. Only 5.1% believed that treatment is very effective.

Conclusions: This survey indicates that peri-implant diseases are a frequently encountered problem in periodontal practices and that the absence of a standard therapeutic protocol results in significant empirical use of therapeutic modalities and a moderately effective treatment outcome. *J Periodontol 2016;87:493-501.*

KEY WORDS

Diagnosis; etiology; peri-implantitis; prevalence; surveys and questionnaires; therapeutics.

* Department of Periodontology, School of Dental Medicine, Tufts University, Boston, MA.
† Division of Biostatistics and Experimental Design, School of Dental Medicine, Tufts University.
‡ Private practice, Athens, Greece.

Dental implants have revolutionized the treatment of edentulous patients for the last two decades, demonstrating high success and survival rates.[1] However, clinicians are challenged with biologic complications of peri-implant tissues; namely, peri-implant mucositis and peri-implantitis.[1-5] Peri-implant mucositis is a reversible inflammatory process causing redness and swelling localized to the soft tissue around implants without signs of loss of supporting bone following initial bone remodeling during healing.[1-5] Peri-implantitis is an inflammatory process that includes both soft tissue inflammation and progressive loss of supporting bone beyond biologic bone remodeling of the functioning implant, possibly leading to implant loss.[1-5]

Limited information is currently available on the prevalence of peri-implant diseases in the United States. An accurate estimate of the true prevalence of peri-implant diseases in other countries also remains controversial with reported prevalence ranging from 11.2% to 47.1% of individuals.[1] A recent systematic review reported that the prevalence of peri-implant mucositis and peri-implantitis ranged from 19% to 65% and 1% to 47%, respectively. Meta-analyses estimated weighted mean prevalence of peri-implant mucositis and peri-implantitis of 43% (confidence interval [CI]: 32% to 54%) and 22% (CI: 14% to 30%), respectively.[6] Differences

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Peri implantitis: An overview

Benita Maria Regi[1*], S Savita[2], Gautami Kaimal[3]

[1,3]Postgraduate, [2]Professor and HOD, Dept. of Periodontology, Rajarajeswari Dental College and Hospital, Bangalore, Karnataka, India

***Correspondig Author: Benita Maria Regi[1]**
Email: benitaregi@gmail.com

Abstract
Biologic complications associated with dental implants primarily relate to infection in the soft and hard tissue around implants known as peri implant mucositis and peri implantitis respectively. Prevalence of peri implantitis rates upto 60% and lead to the loss of implants. Current evidence points to poor oral hygiene, history of periodontitis, and smoking as being the strongest risk indicators for peri implantitis along with the factors affecting plaque accumulation and removal like design of prosthesis and excess cement. Different methods are used to assess peri implant tissue health and to diagnose these entities. Various treatment modalities are available including conservative and surgical approaches for the treatment of peri implant diseases so as to achieve reosseointegration of the exposed implant surface, being the ultimate goal. The aim of this review is to provide an overview regarding etiology, diagnosis and treatment of peri implantitis.

Keywords: Mouthwash, Chlorhexidine, Stains, Bacteria.

Introduction
The introduction of dental implants has created a paradigm shift in the orodental rehabilitation of patients. They are proven and well-established treatment modality which helps to restore esthetics and compromised oral function resulted from tooth loss. Evidences proved the safe use of dental implants and has been presented since 1960s and 1970s. Despite the high success and survival rates of oral implants, failures do occur and implant-supported prosthesis may require a substantial periodontal and prosthodontic maintenance over time.[1] Peri-implant tissues are more liable to inflammatory disease than periodontal tissues due to diminished vascularization and parallel orientation of the collagen fibres. This phenomenon can be verified immunohistochemically through increased formation of inflammatory infiltrate, in comparison with the teeth.[2]

Definition
According to American Academy of Periodontology, peri-implantitis is defined as an inflammatory process around an implant, including both soft tissue inflammation and progressive loss of supporting bone beyond biological bone remodeling.

Epidemiology
Peri-implantitis has been known to affect 28–56% of the subjects and 12–43% of the implants, although epidemiological data are limited.[3] Based on the 6th European Workshop on Periodontology consensus report, Lindhe & Meyle, reported peri implantitis rate between 28% to 58%.[3]

Etiology
Subgingival microbiology and dental implants
In good oral health, microflora with streptococci and nonmobile rods predominate, in both teeth and implants. The same groups of periodontopathogens are recognized in periodontal diseases and peri implantitis. Commonly found microflora are A. actinomycetemcomitans, P. gingivalis, T. forsythia, P. intermedia, C. rectus. There are five lines of evidence that support the role of microorganisms in causing peri-implantitis.[4]

1. Human experiments, reveals plaque deposition on implants, that can induce peri-implant mucositis,
2. Distinct quantitative and qualitative differences are demonstrated in the microflora associated with successful and failing implants,
3. Shift in the composition of the microflora and peri-implantitis due to placement of plaque - retentive ligatures in animals,
4. Clinical status of peri-implantitis patients improved by antimicrobial therapy and,
5. Evidence indicates that oral hygiene level has an impact on the long-term success of implant therapy.

Biomechanical overload
Excessive biomechanical forces/ or overloading may lead to high stress or microfractures at the coronal aspect of implant bone interface, thereby causing bone loss. The apical downgrowth of epithelium and connective tissue result in loss of osseointegration around the implant region. The degree of loss of implant bone contact depends on the frequency and magnitude of the occlusal loading as well as superimposed bacterial invasion. Naert et al (1991), reported greater bone loss around the implant with respect to the magnitude of implant loading.[5]

Other etiologic factors
Patient related factors

1. Systemic diseases like diabetes
2. Smoking
3. Poor plaque control/irregular maintenance therapy
4. Para functional habits
5. Inadequate amount of bone resulting in an exposed implant surface at the time of placement

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PERI-IMPLANTITIS (I DARBY, SECTION EDITOR)

A Comprehensive Review of Peri-implantitis Risk Factors

Dena Hashim[1] · Norbert Cionca[1]

Published online: 27 July 2020

Abstract

Purpose of Review This is a comprehensive narrative review aimed at identifying relevant risk factors associated with peri-implantitis.

Recent Findings Recent studies suggest that water pipes and electronic cigarettes present potentially significant risk factors for peri-implantitis. In addition, we have recently appreciated that the release of titanium particles into the peri-implant tissues is associated with inflammation and disease progression. Yet the question remains as to whether these factors could be sole or major causes of peri-implantitis, or merely additional factors contributing to the aggravation of the disease. Furthermore, the use of zirconia implants does not prevent the development of peri-implantitis, but it has been associated with lower inflammation and marginal bone resorption.

Summary Established peri-implantitis risk factors include periodontal disease, lack of maintenance, cigarette and smokeless tobacco use, hyperglycaemia and obesity. Local risk factors include inadequate plaque control, mucositis, implant's malposition and poorly designed prostheses or presence of excess cement. Potential risk factors requiring additional research include genetic and systemic conditions, high doses of bisphosphonates and hormonal replacement therapy. Occlusal overload, lack of keratinised tissue and local presence of titanium particles seem to aggravate peri-implant disease, but studies are still required prior to drawing definitive conclusions.

Keywords Peri-implantitis · Risk factors · Risk predictors · Biological complications · Implants · Review

Introduction

Oral implants are currently an essential and routine part of any dental practice. Yet despite their formidable success, complications and failure rates have been progressively rising [1, 2]. Peri-implantitis is one of the most common biological complications affecting functional implants. It is a destructive inflammatory disease associated with pocket formation and peri-implant bone loss [3]. Marginal bone level changes after initial remodelling, accompanied by bleeding on peri-implant probing (BOP), are recommended for its diagnosis [3]. Peri-implantitis affects around 13% of implants and 18.5% of patients [4], with its incidence rising from 0.4 to 43.9% within 3–5 years [5•]. However, the disease affects different subjects and different implants at variable rates. Despite its predominantly bacterial aetiology [6, 7], various factors may increase the risk of developing peri-implantitis. Whether inherent or modifiable, the identification of these factors is crucial for both prevention and treatment of the disease.

Since peri-implantitis presents a public health issue [4, 8, 9], this review aims to describe all relevant risk factors in order to identify susceptible patients and implants. This will help the development of individualised maintenance programs, eventually contributing to the primary prevention of the disease.

This article is part of the Topical Collection on *Peri-implantitis*

✉ Dena Hashim
dena.hashim@unige.ch

Norbert Cionca
norbert.cionca@unige.ch

[1] Division of Regenerative Dental Medicine and Periodontology, University of Geneva, 1 Rue Michel-Servet, CH-1211 Genève 4, Switzerland

Peri-implantitis Risk Factors

Patient-Related Risk Factors

Periodontal Disease and Microbiological Aspects

The diagnosis, or history, of periodontal disease is the most researched factor associated with peri-implantitis. This is

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Peri-implantitis: Better understanding, better treatment!

Houda El Ghoulbzouri[1], Houda El Ayachi[2], OumKeltoum Ennibi[3], Amine Cherkaoui[4]

[1,2,3,4] *Department of Periodontology, Laboratory of Oral Biology and Biotechnology, Dental School, Mohammed V University, Rabat, Morocco*
Corresponding Author; Houda El Ghoulbzouri

Abstract: *Over the last decades, dental implants have been used as a standard treatment option to support dental restorations after tooth loss and the proportion of patients with dental implants is increasing. Despite these encouraging data for the use of dental implants in oral rehabilitation, clinicians consider Peri-implantitis as one of the most common biological complications that may be encountered. Peri-implantitis is defined as an inflammatory process affecting tissues around an osseointegrated implant in function. Peri-implantitis is considered the most challenging biological complication as, if untreated, it may progress and result in implant loss. In addition, treatment of peri-implantitis requires extensive resources in dentistry. Prevention of the disease is therefore a high priority in every-day clinical practice to minimize the occurrence and the severity of the problem. This overview provides a synopsis on the identification of etiology and risk factors of peri-implantitis using current data prevention and management of the disease are also described.*

Keywords:*Dental implant,osseointegration, peri-implantitis,debridement, surgical treatment, periodontal maintenance.*

Date of Submission: 26-04-2019 Date of acceptance: 11-05-2019

I. Introduction

Dental implants are a common treatment modality in the replacement of missing teeth in partially or fully edentulous patients.[1]Although data showing long-term success of using dental implants some complications may occur. Such problems mainly refer to inflammatory conditions associated with a bacterial challenge.[2]With an increasing number of implants placed, complications associated with implants such as peri-implant diseases have also increased, occurring with a frequency ranging from 1% to 47%.[3,4]Peri-implantitis is considered the most challenging complication, as untreated disease may progress and result in implant loss. In addition, treatment of peri-implantitis requires extensive resources in dentistry. Prevention of the disease is therefore a high priority in every-day clinical practice to minimize the occurrence and the severity of the problem.[5,6]

II. Definition of peri-implantitis

In 2017's World Workshop Classification of Periodontal and Peri-implant diseases and Conditions, characteristics together with disease definitions and case definitions were presented for peri-implant health, peri-implant mucositis and peri-implantitis. It stated thatosseointegrated peri-implantitis is a plaque-associated pathological condition occurring in tissues arounddental implants, characterized by inflammation in the peri-implant mucosa and subsequent progressive loss of supporting tissue.[8]

Peri-implant Heath

Teeth and dental implants are alike, as they constitute hard materials passing from alveolar bone through oral mucosa. While there are obvious differences between the enamel and dentin at teeth as opposed to implant materials, there are also important differences between teeth and implants regarding the interface towards the surrounding hard and soft tissues. [9,10]

The tooth is anchored to the alveolar bone and gingiva through a periodontal ligament and supra-crestal connective tissue fibers. The fibrous attachment between root cementum and alveolar bone proper is formed in conjunction with root formation. The interface between the gingiva and the tooth crown is composed of a thin junctional epithelium, which is continuous with a sulcular and oral epithelium (Fig. 1).[9,10]

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Microbial Community-Driven Etiopathogenesis of Peri-Implantitis

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G.N. Belibasakis[1] and D. Manoil[1]

Abstract

Osseointegrated dental implants are a revolutionary tool in the armament of reconstructive dentistry, employed to replace missing teeth and restore masticatory, occlusal, and esthetic functions. Like natural teeth, the orally exposed part of dental implants offers a pristine nonshedding surface for salivary pellicle-mediated microbial adhesion and biofilm formation. In early colonization stages, these bacterial communities closely resemble those of healthy periodontal sites, with lower diversity. Because the peri-implant tissues are more susceptible to endogenous oral infections, understanding of the ecological triggers that underpin the microbial pathogenesis of peri-implantitis is central to developing improved prevention, diagnosis, and therapeutic strategies. The advent of next-generation sequencing (NGS) technologies, notably applied to 16S ribosomal RNA gene amplicons, has enabled the comprehensive taxonomic characterization of peri-implant bacterial communities in health and disease, revealing a differentially abundant microbiota between these 2 states, or with periodontitis. With that, the peri-implant niche is highlighted as a distinct ecosystem that shapes its individual resident microbial community. Shifts from health to disease include an increase in diversity and a gradual depletion of commensals, along with an enrichment of classical and emerging periodontal pathogens. Metatranscriptomic profiling revealed similarities in the virulence characteristics of microbial communities from peri-implantitis and periodontitis, nonetheless with some distinctive pathways and interbacterial networks. Deeper functional assessment of the physiology and virulence of the well-characterized microbial communities of the peri-implant niche will elucidate further the etiopathogenic mechanisms and drivers of the disease.

Keywords: peri-implant infection(s), microbiology, microbial ecology, implant dentistry/implantology, inflammation, periodontal disease(s)/periodontitis

Clinical Definition and Epidemiology of Peri-Implant Infections

Along with the advent of dental implants as a reconstructive treatment option in dentistry, peri-implant infections have emerged as a by-product of this advancement in bioengineering. Peri-implant infections are categorized as either peri-implant mucositis, if the induced inflammation is limited to peri-implant soft tissues, or peri-implantitis, if the inflammation extends to the underlying bone, further causing osteolysis. Diagnostic criteria for peri-implant infections primarily rely on clinical and radiographic examinations. Accordingly, the clinical sign of bleeding on probing (BOP) is central to detecting peri-implant inflammation in the form of mucositis. The diagnosis of peri-implantitis is commensurate with radiographic changes in crestal bone levels, particularly characterized by a symmetrical "saucer-shaped" bone defect around the implant. The latest case definitions for peri-implant mucositis include BOP or suppuration but no radiographic crestal bone loss beyond the initial remodeling. Peri-implantitis also includes further bone loss and increased probing pocket depth (PPD), compared to previous examinations (Berglundh et al. 2018). Overall, approximately one-third of all patients and one-fifth of all implants will experience peri-implantitis (Kordbacheh Changi et al. 2019). The primary risk factors coupled to these epidemiological observations are ill-fitting or ill-designed fixed and cement-retained restorations, as well as a history of periodontitis (Kordbacheh Changi et al. 2019). Smoking is also an important risk factor that is shared with periodontitis, particularly in combination with poor oral hygiene (Kumar 2019).

Histological Particularities of Peri-Implant Sites

Manufactured primarily out of titanium, dental implants consist of an endosseous rough-surfaced part that promotes osseointegration and a transmucosal smooth-surfaced part exposed to the intraoral environment. Since they are expected to compensate for the absence of natural teeth and their physiological functions, there is also a tendency to perceive peri-implant infections as pathologies analogous to gingivitis and periodontitis of

[1]Division of Oral Diseases, Department of Dental Medicine, Karolinska Institute, Huddinge, Sweden

Corresponding Author:
G.N. Belibasakis, Division of Oral Diseases, Department of Dental Medicine, Karolinska Institute, Alfred Nobels allé 8, 141 04 Huddinge, Stockholm County, Sweden.
Email: George.Belibasakis@ki.se

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NEW CLASSIFICATION OF PERIODONTAL AND PERI-IMPLANT DISEASES

Guest editors:
Mariano Sanz y Panos N. Papapanou

new classification of periodontal and peri-implant diseases

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JOURNAL OF Periodontology

2017 WORLD WORKSHOP

Peri-implantitis

Frank Schwarz[1]* | Jan Derks[2]* | Alberto Monje[3,4] | Hom-Lay Wang[4]

[1]Department of Oral Surgery and Implantology, Carolinum, Johann Wolfgang Goethe-University Frankfurt, Frankfurt, Germany

[2]Department of Periodontology, Institute of Odontology, The Sahlgrenska Academy at University of Gothenburg, Gothenburg, Sweden

[3]Department of Oral Surgery and Stomatology, ZMK School of Dentistry, University of Bern, Bern, Switzerland

[4]Department of Periodontics and Oral Medicine, University of Michigan School of Dentistry, Ann Arbor, MI, USA

Correspondence
Univ. Prof. Dr. Frank Schwarz, Department of Oral Surgery and Implantology, Carolinum, Johann Wolfgang Goethe-University Frankfurt, 60596 Frankfurt, Germany.
Email: f.schwarz@med.uni-frankfurt.de

*Frank Schwarz and Jan Derks equally contributed to the manuscript and are considered joint first authors.

The proceedings of the workshop were jointly and simultaneously published in the *Journal of Periodontology* and *Journal of Clinical Periodontology*.

Abstract

Objectives: This narrative review provides an evidence-based overview on peri-implantitis for the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions.

Methods: A literature review was conducted addressing the following topics: 1) definition of peri-implantitis; 2) conversion from peri-implant mucositis to peri-implantitis, 3) onset and pattern of disease progression, 4) characteristics of peri-implantitis, 5) risk factors/indicators for peri-implantitis, and 6) progressive crestal bone loss in the absence of soft tissue inflammation.

Conclusions:

1) Peri-implantitis is a pathological condition occurring in tissues around dental implants, characterized by inflammation in the peri-implant connective tissue and progressive loss of supporting bone.

2) The histopathologic and clinical conditions leading to the conversion from peri-implant mucositis to peri-implantitis are not completely understood.

3) The onset of peri-implantitis may occur early during follow-up and the disease progresses in a non-linear and accelerating pattern.

4a) Peri-implantitis sites exhibit clinical signs of inflammation and increased probing depths compared to baseline measurements.

4b) At the histologic level, compared to periodontitis sites, peri-implantitis sites often have larger inflammatory lesions.

4c) Surgical entry at peri-implantitis sites often reveals a circumferential pattern of bone loss.

5a) There is strong evidence that there is an increased risk of developing peri-implantitis in patients who have a history of chronic periodontitis, poor plaque control skills, and no regular maintenance care after implant therapy. Data identifying "smoking" and "diabetes" as potential risk factors/indicators for peri-implantitis are inconclusive.

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2017 WORLD WORKSHOP

Peri-implant health

Mauricio G. Araujo[1] | Jan Lindhe[2]

[1]Department of Dentistry, State University of Maringa, Maringa, Brazil

[2]Department of Periodontology, Sahlgrenska, Academy at University of Gothenburg, Gothenburg, Sweden

Correspondence
Dr. Mauricio Araujo, Department of Dentistry, State University of Maringa, Maringa, Brazil.
Email: odomar@hotmail.com

The proceedings of the workshop were jointly and simultaneously published in the *Journal of Periodontology* and *Journal of Clinical Periodontology*.

Abstract

Objective: The aim is to define clinical and histologic characteristics of peri-implant tissues in health and describe the mucosa–implant interface.

Importance: An understanding of the characteristics of healthy peri-implant tissues facilitates the recognition of disease (i.e., departure from health).

Findings: The healthy peri-implant mucosa is, at the microscopic level, comprised of a core of connective tissue covered by either a keratinized (masticatory mucosa) or non-keratinized epithelium (lining mucosa). The peri-implant mucosa averages about 3 to 4 mm high, and presents with an epithelium (about 2 mm long) facing the implant surface. Small clusters of inflammatory cells are usually present in the connective tissue lateral to the barrier epithelium. Most of the intrabony part of the implant appears to be in contact with mineralized bone (about 60%), while the remaining portion faces bone marrow, vascular structures, or fibrous tissue. During healing following implant installation, bone modeling occurs that may result in some reduction of the marginal bone level.

Conclusions: The characteristics of the peri-implant tissues in health are properly identified in the literature, including tissue dimensions and composition. Deviation from the features of health may be used by the clinician (and researcher) to identify disease, including peri-implant mucositis and peri-implantitis.

KEYWORDS

connective tissue biology, diagnosis, implantology, osseointegration

Peri-implant tissues are those that occur around osseointegrated dental implants. They are divided into soft and hard tissue compartments. The soft tissue compartment is denoted "peri-implant mucosa" and is formed during the wound healing process that follows implant/abutment placement.[1] The hard tissue compartment forms a contact relationship to the implant surface to secure implant stability.[2] Due to their histologic and anatomic features, peri-implant tissues carry out two basic functions: the mucosa protects the underlining bone, while the bone supports the implant. Indeed, the destruction of peri-implant tissues can jeopardize the implant success and survival,[3] and the understanding of the characteristics of healthy peri-implant tissues allows the recognition of disease. Thus, the aim of the present review was to define clinical and histologic characteristics of peri-implant tissues in health and describe the mucosa–implant interface.

A search in MEDLINE-PubMed was used to retrieve the evidence to support the present review. The following key words were used for the literature search: dental implants (Mesh) AND biological width OR mucosa OR soft tissue OR attachment OR keratinized mucosa OR peri-implant mucosa OR probing depth OR microbiota OR collagen fibers OR epithelium OR adhesion OR seal OR bone OR osseointegration AND humans OR animals. The two main reasons for exclusion of studies were: 1) not published in English, and 2) lack of detailed clinical, histologic, or microbiologic description of healthy peri-implant tissues.

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ORIGINAL ARTICLE

Peri-implant mucositis sites with suppuration have higher microbial risk than sites without suppuration

Qi Wang[1*] | Hongye Lu[1*] | Li Zhang[1] | Xia Yan[1] | Bin Zhu[2] | Huanxin Meng[1]

[1]Department of Periodontology, Peking University School and Hospital of Stomatology, National Engineering Laboratory for Digital and Material Technology of Stomatology, Beijing Key Laboratory of Digital Stomatology, Beijing, China

[2]Department of Periodontology, Stomatology Hospital, Zhejiang University School of Medicine, Hangzhou, China

Correspondence
Huanxin Meng, No.22, Zhongguancun South Avenue, Haidian District, Beijing, 100081, China.
Email: kqhxmeng@bjmu.edu.cn

[*]Qi Wang and Hongye Lu contributed equally to this work.

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Abstract

Background: The aims of the present study were to compare the microbial differences between peri-implant mucositis sites with or without suppuration, and to construct a classification model with microbiota.

Methods: Twenty-four implants with peri-implant mucositis were divided into suppuration (SUP) group and non-suppuration (Non-SUP) group. Clinical assessments of bleeding index, probing depth, suppuration following probing (SUP) were recorded. Submucosal samples were collected from mesiobuccal sites and distobuccal sites, and analyzed by 16S rRNA gene sequencing. Generalized linear mixed model was used to adjust age, gender, location of implants, and intraindividual correlation.

Results: It was demonstrated that the microbial richness was lower in SUP group. The relative abundance of some pathogenic taxa, such as genera of *Fusobacterium*, *Tannerella*, and *Peptostreptococcus*, were significantly higher in SUP group than Non-SUP group. In addition, SUP group had less Gram-positive bacteria, aerobic bacteria, and more metabolic pathway related to life activity. The classification model constructed with 12 genera got a 100% accuracy in identifying sites with or without suppuration.

Conclusions: The results from this study demonstrate a higher pathogenicity of microbiome at peri-implant mucositis sites with suppuration than without suppuration, which supports suppuration as a clinical indicator for higher microbial risk.

KEYWORDS
dental implants; microbiology; mucositis; RNA, ribosomal, 16S; suppuration

1 | INTRODUCTION

Osseo-integrated dental implants have become a favorable treatment option for partially or fully edentulous patients in the last three decades. Although a high long-term success rate ranging from 90% to 95% over 20 years has been reported,[1–3] pathological conditions may occur in hard and soft peri-implant tissues. Biological complications associated with dental implants are mostly inflammatory conditions which include peri-implant mucositis and peri-implantitis.[4–6] Peri-implant mucositis is the first clinical sign in response to plaque accumulation, which may develop into peri-implantitis if left untreated.[7]

The consensus report of the 2017 World Workshop on the Classification of Periodontal and Peri-implant Diseases and Conditions proposed that peri-implant mucositis is characterized by bleeding upon probing and visual signs of inflammation, which can be reversed with measures aimed

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Prevalence and Mechanisms of Peri-implant Diseases

G.E. Salvi[1], R. Cosgarea[2,3], and A. Sculean[1]

Abstract

The aim of the present critical review is to summarize recent evidence on the prevalence of peri-implant diseases and their similarities and differences with periodontal diseases with a focus on their pathogenetic mechanisms. Reports on the extent and severity of peri-implant diseases are influenced by different case definitions. The prevalence of peri-implant diseases is reported at the subject or implant level and affected by the type of population samples analyzed (e.g., randomly selected population samples or convenience samples). The outcomes of studies on animals and humans indicate that experimental biofilm accumulation leads to a higher frequency of bleeding sites around implants as compared with teeth. Despite the proof of principle that experimentally induced mucositis may be reversible, early diagnosis and management of naturally occurring peri-implant mucositis are clinically relevant. Tissue destruction at experimental peri-implantitis sites is faster and more extensive when compared with that at experimental periodontitis sites. Although human periodontitis and peri-implantitis lesions share similarities with respect to etiology and clinical features, they represent distinct entities from a histopathologic point of view. To avoid implant loss, patients diagnosed with peri-implantitis should be treated without delay.

Keywords: periodontal disease(s)/periodontitis, implant dentistry/implantology, inflammation, peri-implant infection(s), epidemiology, plaque/plaque biofilms

Introduction

Upon completion of hard and soft tissue integration following implant placement (Salvi et al. 2015), peri-implant diseases have been defined as 1) development of mucosal inflammation around implants without loss of supporting bone (i.e., peri-implant mucositis) and 2) presence of inflammation with additional loss of supporting bone (i.e., peri-implantitis; Lindhe and Meyle 2008). Peri-implant diseases are initiated by the presence of similar etiologic factors as those involved in the onset of periodontal diseases (Heitz-Mayfield and Lang 2010). In patients diagnosed with moderate/severe peri-implantitis, onset of disease occurred within 3 y of function and followed a nonlinear accelerating pattern over a 9-year period (Derks et al. 2016b).

For the purpose of the present critical review, recent evidence on the prevalence/incidence of peri-implant mucositis and peri-implantitis was summarized. In addition, peri-implant mucositis and peri-implantitis were compared with their counterparts around natural teeth (i.e., gingivitis and periodontitis), focusing on similarities and differences between the pathogeneses of periodontal and peri-implant diseases.

Prevalence of Peri-implant Diseases

Currently, the prevalence of peri-implant diseases represents a controversial issue (Tarnow 2016). Patient-based estimated weighted mean prevalences and ranges for peri-implant mucositis and peri-implantitis were reported in a systematic review with meta-analysis (Derks and Tomasi 2015). The prevalence for peri-implant mucositis was reported at 43% (range, 19% to 65%), whereas for peri-implantitis it amounted to 22% (range, 1% to 47%; Derks and Tomasi 2015). Moreover, results from recent cross-sectional studies not included in the systematic review mentioned above reported prevalences for peri-implantitis within ranges comparable to those reported by Derks and Tomasi (2015): 20% (Rokn et al. 2016), 15.1% (Aguirre-Zorzano et al. 2015), 13.9% (Schwarz et al. 2015), 26% (Daubert et al. 2015), 16.4% (Dalago et al. 2016), 12.9% (Konstantinidis et al. 2015), and 28% (Filho et al. 2014).

Clearly, these outcomes indicate a wide range in the prevalence of peri-implant diseases, making it difficult to globally estimate the magnitude of the disease. These inadequacies may rely on methodological inconsistencies and shortcomings of the reported studies (Sanz and Chapple 2012; Tomasi and Derks 2012). One of the major inconsistencies reflecting the lack of consensus in epidemiologic research is found in the differences applied for case definitions.

[1]Department of Periodontology, School of Dental Medicine, University of Bern, Bern, Switzerland
[2]Department of Periodontology, Philipps University Marburg, Marburg, Germany
[3]Department of Prosthetic Dentistry, University Iuliu Hatieganu, Cluj-Napoca, Romania

Corresponding Author:
A. Sculean, Department of Periodontology, School of Dental Medicine, University of Bern, Freiburgstrasse 7, CH-3010 Bern, Switzerland.
Email: anton.sculean@zmk.unibe.ch

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REVIEW ARTICLE

Periodontology 2000 WILEY

Patient compliance as a risk factor for the outcome of implant treatment

Simone Cortellini | Charlotte Favril | Mathieu De Nutte | Wim Teughels | Marc Quirynen

Section of Periodontology, Department of Oral Health Sciences, KU Leuven & Dentistry, University Hospitals, KU Leuven, Leuven, Belgium

Correspondence
Simone Cortellini, Department of Periodontology, Department of Oral Health Sciences, KU Leuven & Dentistry, University Hospitals, KU Leuven, Leuven, Belgium.
Email: simone.cortellini@kuleuven.be

KEYWORDS
dental implant, implant treatment, patient compliance, peri-implantitis

1 | INTRODUCTION

It is well-established that the maintenance of healthy tissues around implants is one of the key factors in the long-term success of implants. Plaque accumulation induces an inflammatory process that may lead to a progressive destruction of soft and hard tissues and, ultimately, to implant failure.[1-3] The inflammatory process, mucositis, is a marginal inflammation without attachment or bone loss,[4] similar to gingivitis around natural teeth. The inflammatory process associated with the loss of marginal supporting bone around an implant is defined as peri-implantitis.[5,6]

One problem with the diagnosis of peri-implant disease is that substantial variation in prevalence has been reported in the same patient population depending on which diagnostic criteria are used.[7] The current guidelines for the definition and diagnosis of peri-implant diseases were established in the sixth, seventh, and eighth European Workshops on Periodontology.[6,8,9] The prevalence of peri-implantitis seems to be of the order of 10% at implant level and 20% at patient level during 5-10 years of function.[10] A meta-analysis reported a weighted mean prevalence of peri-implant mucositis of 43% (1196 patients and 4209 implants) and a weighted mean prevalence of peri-implantitis of 22% (2131 patients and 8893 implants). However, the authors stated that the heterogeneity in definition criteria of peri-implantitis could be a confounder.

Peri-implantitis has been primarily described as a simple infectious pathologic condition of peri-implant tissues.[1,11] Many local factors, such as implant surface, topology, and bacterial contamination at the implant/abutment junction, and patient factors, such as smoking habit, poor oral hygiene, history or presence of periodontitis, genetics, and excessive alcohol consumption, have also been associated with an increased risk of developing peri-implant diseases.[12-16]

The etiology of alveolar bone loss around implants plays a crucial role in the classification of the disease. The most common theories to explain alveolar bone loss are the infection theory and the overload theory.[17] The infection theory states that implants are susceptible to similar types of disease as teeth, the major difference being that the term periodontitis is reserved for teeth and peri-implantitis is reserved for implants. The overload theory has not been clearly determined. Some studies have suggested that Occlusal overload may play a role when associated with plaque accumulation or pre-existing inflammation.[18] A third theory has also been developed, where alveolar bone loss is explained by the synergy of combined factors, such as surgical procedures, prosthodontics, and patient disorders.[17] The difference between primary and secondary peri-implantitis has also been presented. In primary peri-implantitis, bacterial infection is the primary cause of alveolar bone loss, whereas secondary peri-implantitis may originate from other factors.[19] In a recent review, the risk indicators that can lead to peri-implant infection and, consequently, to secondary peri-implantitis were described.[20] Hence, peri-implantitis can be explained using a multicausality model and the following factors must be considered:

1. Genetics/host predisposition to disease, specifically the immune response that determines the susceptibility of individuals. The patients who are more prone to developing peri-implant diseases are those with a history of periodontitis, especially aggressive periodontitis.
2. Lifestyle of the patient. Oral hygiene is the most crucial factor, but smoking habits, diet, and stress are also relevant. Specifically,

Haline Renata Dalago
Guenther Schuldt Filho
Mônica Abreu Pessoa Rodrigues
Stefan Renvert
Marco Aurélio Bianchini

Risk indicators for Peri-implantitis. A cross-sectional study with 916 implants

Authors' affiliations:
Haline Renata Dalago, Guenther Schuldt Filho, Implant Dentistry, Federal University of Santa Catarina (UFSC), Florianópolis, Brazil
Guenther Schuldt Filho, Universität Bern, Bern, Switzerland
Mônica Abreu Pessoa Rodrigues, Implant Dentistry, Paulista University (UNIP), Sao Paulo, Brazil
Stefan Renvert, Department of Health Sciences, Kristianstad University, Kristianstad, Sweden
*Stefan Renvert*Blekinge Institute of Technology, Karlskrona, Sweden
Stefan Renvert, School of Dental Sciences, Trinity College, Dublin, Ireland
Marco Aurélio Bianchini, Dentistry Department, Federal University of Santa Catarina (UFSC), Florianópolis, Brazil

Corresponding author:
Guenther Schuldt Filho
Av. Santa Catarina, 1130, ap. 1101, CEP 88070-740 – Bairro, Canto, Florianópolis, Santa Catarina, Brazil
Tel./fax: + 55 (48) 3733-8008
e-mail: guenthersf83@hotmail.com

Key words: clinical assessment, clinical research, clinical trials, diagnosis, epidemiology

Abstract

Objectives: The aim of this study was to identify systemic and local risk indicators associated with peri-implantitis.

Material and methods: One hundred eighty-three patients treated with 916 osseointegrated titanium implants, in function for at least 1 year, were included in the present study. The implants were installed at the Foundation for Scientific and Technological Development of Dentistry (FUNDECTO) - University of Sao Paulo (USP) - from 1998 to 2012. Factors related to patient's systemic conditions (heart disorders, hypertension, smoking habits, alcoholism, liver disorders, hepatitis, gastrointestinal disease, diabetes mellitus I and II, hyperthyroidism or hypothyroidism, radiation therapy, chemotherapy, menopause, osteoporosis, active periodontal disease, history of periodontal disease and bruxism), implant's characteristics (location, diameter, length, connection, shape, and antagonist), and clinical parameters (wear facets, periodontal status on the adjacent tooth, plaque accumulation on the adjacent tooth, modified plaque index, sulcus bleeding index, probing depth, bleeding on probing, width of keratinized tissue and marginal recession).

Results: An increased risk of 2.2 times for history of periodontal disease (PD), 3.6 times for cemented restorations compared to screw-retained prostheses, 2.4 times when wear facets were displayed on the prosthetic crown and 16.1 times for total rehabilitations when compared to single rehabilitations were found. Logistic regression analysis did not show any association between the implant's characteristics and peri-implantitis.

Conclusions: A history of periodontal disease, cemented prostheses, presences of wear facets on the prosthetic crown and full mouth rehabilitations were identified as risk indicators for peri-implantitis. Implants' characteristics were not related to the presence of peri-implantitis.

The word peri-implantitis is used to describe destructive infectious pathologies in the soft tissues around dental implants resulting in bone loss (Lindhe & Meyle 2008). Bone remodeling after implant placement should be distinguished from bone loss due to subsequent infection. The presence of bacteria at the implant-abutment interface and its proximity to the bone may result in bone loss (Berglundh et al. 1991; Quirynen & van Steenberghe 1993; Jansen et al. 1997). The microbiota adhering to the implant surface results in an inflammatory response. The marginal bone is affected, which may be due to the absence of a periodontal ligament and a reduced number of fibroblasts and blood vessels (Zeza & Pilloni 2012; Wilson 2013).

Current guidelines for the diagnosis of peri-implantitis were determined in the seventh (Lang & Berglundh 2011) and eighth (Sanz & Chapple 2012) European Workshop on Periodontology. Peri-implantitis is characterized by increased depth of the peri-implant sulcus >4 mm; bleeding and/or suppuration on probing and marginal bone loss ≥2 mm, very often detected accidentally in radiographs during professional maintenance care, since pain does not seem to be a common phenomenon (Mombelli 1999; Lindhe et al. 2008; Lang & Berglundh 2011). If the apical osseointegration is maintained, the disease can progress without any notable signs of implant mobility (Mombelli & Lang 1998).

It is assumed that risk indicators associated with periodontal disease actively contribute to peri-implantitis, thus patients with increased susceptibility to periodontal disease, poor oral hygiene and smoking habits

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NOVEL DEVELOPMENT

CLINICAL ORAL IMPLANTS RESEARCH WILEY

Implant Disease Risk Assessment IDRA–a tool for preventing peri-implant disease

Lisa J. A. Heitz-Mayfield[1,2,3] | Fritz Heitz[2] | Niklaus P. Lang[3]

[1]The University of Western Australia, Crawley, Western Australia, Australia
[2]Perth Periodontal Specialists, West Leederville, Western Australia, Australia
[3]University of Bern, Bern, Switzerland

Correspondence
Lisa J. A. Heitz-Mayfield, 4 Mc Court St, West Leederville, WA, Australia.
Email: heitz.mayfield@iinet.net.au

Abstract

Objective: This treatment concept paper introduces a risk assessment tool, the Implant Disease Risk Assessment, (IDRA) which estimates the risk for a patient to develop peri-implantitis.

Materials and methods: The functional risk assessment diagram was constructed incorporating eight parameters, each with documented evidence for an association with peri-implantitis.

Results: The eight vectors of the diagram include (1) assessment of a history of periodontitis (2) percentage of sites with bleeding on probing (BOP) (3) number of teeth/implants with probing depths (PD) ≥5 mm (4) the ratio of periodontal bone loss (evaluated from a radiograph) divided by the patient's age (5) periodontitis susceptibility as described by the staging and grading categories from the 2017 World Workshop on the Classification of Periodontal and Peri-implant Diseases (Journal of Periodontology, 89 Suppl 1, S159-S172, 2018) (6) the frequency/compliance with supportive periodontal therapy (7) the distance in mm from the restorative margin of the implant-supported prosthesis to the marginal bone crest and (8) prosthesis-related factors including cleanability and fit of the implant-supported prosthesis.

Conclusion: The combination of these factors in a risk assessment tool, IDRA, may be useful in identifying individuals at risk for development of peri-implantitis.

KEYWORDS

disease progression, disease susceptibility, patient compliance, peri-implant disease "peri-implant mucositis", peri-implantitis, periodontal diseases, periodontal pocket, risk assessment, risk factors, risk indicators

1 | INTRODUCTION

In the past decades, risk assessment has become a focus of attention in clinical research. Several periodontal risk assessment tools have been developed and validated to varying extents (Heitz-Mayfield, 2005; Lang, Suvan, & Tonetti, 2015). At the 11th European Workshop on Periodontology (2015), five risk assessment tools were addressed in a systematic review (Lang et al., 2015). Of the five, one risk assessment tool, the Periodontal Risk Assessment (PRA) (Lang & Tonetti, 2003) was highlighted as having been validated in nine international studies. All of these studies indicated that patients at high risk for periodontal re-infection and

REVIEW ANALYSIS & EVALUATION // DIAGNOSIS/TREATMENT/PROGNOSIS

SUPPORTIVE THERAPY (SPT) CAN POTENTIALLY IMPROVE IMPLANT SURVIVAL RATE (SR), PERI-IMPLANTITIS, AND PERI-IMPLANT MUCOSITIS

Check for updates

Do systematically healthy patients who receive SPT compared to patients who receive no SPT after implant placement have an improvement in implant SR and/or reduction in the incidence of peri-implant disease?

REVIEWER
PAUL S. FARSAI

ARTICLE TITLE AND BIBLIOGRAPHIC INFORMATION
The effect of supportive care in preventing peri-implant diseases and implant loss: A systematic review and meta-analysis. ***Lin C-Y, Chen Z, Pan W-L, Want H-L.*** *Clin Oral Implants Res 2019;30(8):714-24.*

SUMMARY

Selection Criteria

Three electronic databases (Pubmed/MEDLINE, Embase, and Cochrane Central) were searched for articles up to June 2018. Inclusion criteria included the following: 1) any clinical trials with SPT and non-SPT groups; 2) any SPT should be mentioned with details in articles for maintenance care; 3) studies with at least 1-year follow-up period after implant prosthesis loading; and 4) studies with data of peri-implant conditions (whether SR, bone level, plaque, and bleeding status, or prevalence of peri-mucositis and/or peri-implantitis).

Two independent reviewers performed data extraction from the eligible articles, and any inter-reviewer disagreements were resolved by discussion and consultation with another reviewer. The *k* values for inter-reviewer agreement for title/abstract and full-text screen were 0.87 and 0.91, respectively. The prevalence of peri-implant mucositis and peri-implantitis was analyzed at the patient level. Meta-regression analysis was performed to analyze the potential influence of confounding factors, including SPT interval and use of chemical agents.

Among the 9 clinical controlled trials fulfilling the inclusion criteria in this systematic review, 5 were retrospective studies and 4 were prospective studies. For the selected nonrandomized studies, the Newcastle–Ottawa Scale (NOS) was used to assess the risk of bias. One study was not eligible for meta-analysis but was included for the systematic review.

Key Study Factor

Unlike previous reviews, this systematic review divided the implant maintenance care into mechanical and chemical components and made a comparison between SPT and non-SPT groups based on outcomes in meta-analysis.

SORT SCORE

A	B	C	N/A

SORT, Strength of Recommendation Taxonomy.

LEVEL OF EVIDENCE

1	2	3

See article 101433 for complete details regarding SORT and LEVEL OF EVIDENCE grading system.

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TYPE OF STUDY/DESIGN
Systematic review with meta-analysis.

KEYWORDS
Maintenance, Peri-implantitis, Supportive treatment, Survival rate, Systematic review and meta-analysis

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Review

Smoking and dental implants: A systematic review and meta-analysis

Bruno Ramos Chrcanovic [a,*], Tomas Albrektsson [a,b], Ann Wennerberg [a]

[a] Department of Prosthodontics, Faculty of Odontology, Malmö University, Malmö, Sweden
[b] Department of Biomaterials, Göteborg University, Göteborg, Sweden

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ABSTRACT

Objective: Recent studies implicate smoking as a significant factor in the failure of dental implants. This review aims to test the null hypothesis of no difference in the implant failure rates, risk of postoperative infection, and marginal bone loss for smokers versus non-smokers, against the alternative hypothesis of a difference.
Data: Main search terms used in combination: dental implant, oral implant, smoking, tobacco, nicotine, smoker, and non-smoker.
Sources: An electronic search was undertaken in September/2014 in PubMed/Medline, Web of Science, Cochrane Oral Health Group Trials Register plus hand-searching.
Study selection: Eligibility criteria included clinical human studies, either randomized or not. The search strategy resulted in 1432 publications, of which 107 were eligible, with 19,836 implants placed in smokers, with 1259 failures (6.35%), and 60,464 implants placed in non-smokers, with 1923 failures (3.18%).
Conclusions: The insertion of implants in smokers significantly affected the failure rates, the risk of postoperative infections as well as the marginal bone loss. The results should be interpreted with caution due to the presence of uncontrolled confounding factors in the included studies.
Clinical significance: Smoking is a factor that has the potential to negatively affect healing and the outcome of implant treatment. It is important to perform an updated periodic review to synthesize the clinical research evidence relevant to the matter.

1. Introduction

Nicotine is the most important constituent among more than 4000 potentially toxic substances in tobacco products. It is the main chemical component responsible for tobacco addiction, appears to mediate the haemodynamic effects of smoking, and has been implicated in the pathogenesis of numerous diseases.[1] Studies have also demonstrated the detrimental effects of smoking on oral health. A clinical study[2] observed that smokers had a higher prevalence of moderate and severe periodontitis and higher prevalence and extent of attachment loss and gingival recession than non-smokers, suggesting poorer periodontal health in smokers. In addition, smokers had a higher number of missing teeth than non-smokers. Concerning the bone-implant interface, the deleterious effects

* *Corresponding author*. Tel.: +46 725 541 545; fax: +46 40 6658503.
E-mail addresses: bruno.chrcanovic@mah.se, brunochrcanovic@hotmail.com (B.R. Chrcanovic).
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Smoking as a Risk Factor for Peri-Implantitis and Dental Implant Failure - A Literature Review

Dr. Shabana Lone

MPDC RCSED (UK)

Abstract: ***Background: Despite the fact that dental implant therapy is a very successful treatment, various studies have suggested higher Implant failure rates in smokers. The aim of this study is to assess whether smokers are at an increased risk of implant failure and peri-implantitis, as compared to non-smokers. Methods: A comprehensive search on PubMed, Cochrane library and Web of Science was conducted to identify studies investigating the association between smoking and peri-implantitis and implant failure. Only studies published between 1990 and 2016 were considered in this review. Results: From the 920 search results initially retrieved, only 20 were selected after analysis of the abstracts and titles. The quality of the included papers was assessed using the Quality Assessment Tool for Quantitative Studies. It was found that the quality rating for most of the studies included was moderate or strong. The majority of the included studies showed a relationship between cigarette smoking and dental implant failure. Conclusion: The results from the included studies showed that smoking is an important risk factor for dental implant failure. However high quality studies with additional robust epidemiological and clinical investigations are required to confirm the association between the two.***

Keywords: Dental Implants, Peri implantitis, Smoking, Success, Tobacco

1. Introduction

Dental implants, with their high survival rates and predictability, have made a significant impact on dentistry. Their fixed nature and the lack of any need to involve adjacent teeth, has made them the option of choice for the restoration of most edentulous sites. The popularity of implants has increased over the past two decades, this has in part been due to studies showing their high survival rates. One such study (Jung et al., 2008)observed 96.8% survival after 5 years and similarly another more recent study, (Simonis et al., 2010) reported 89.23% and 82.94% survival rates after 10 and 16 years respectively.

In recent years the dental implant market has shown significant global growth. The rising ageing population as well as the increasing trend for general dentists to offer implants in their practice has played a role in the development of this growth. Data shows that there has been a 10 fold increase globally in the number of dental implants placed from 2002 to 2010 (Misch, 2014). According to the American Academy of Implant dentistry (AAID), the global market for dental Implants is anticipated to exceed $4.2 billion by 2022. All of these statistics show the growing significance of implant treatment in general practice and suggest trends which confirm their increased usage.

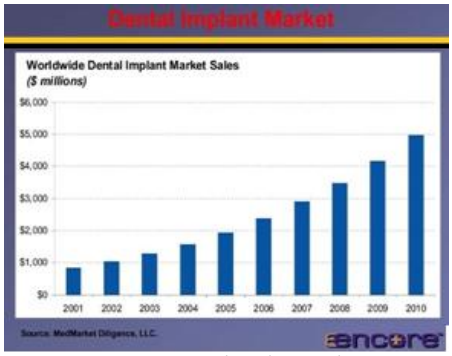

Figure 1: Dental Implant Market

Adapted from (Encore Medical Corporation.(ENMC) 2004

The success of implant treatment is important from the patient's perspective because firstly it is an expensive treatment and failure will represent a poor financial investment in their health and wellbeing and secondly because the placement of an implant involves an invasive, surgical procedure, subsequent failure of the implant would therefore have entailed the patient undergoing this traumatic procedure, and its associated surgical risks, without gaining the desired long term functional and/or aesthetic benefits.

Implant failure is important from the perspective of the clinician because they make the decision as to the suitability, for implant placement, of a case. An understanding of the factors that may compromise the success rate of implants is therefore crucial in this decision making process. Furthermore in gaining the patient's consent prior to embarking on implant placement, the clinician must be in a position to accurately inform the patient of any risk factors that might predispose the patient to a higher probability of implant failure.

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The Influence of Smoking on the Peri-Implant Microbiome

A.A. Tsigarida[1,2], S.M. Dabdoub[2], H.N. Nagaraja[3], and P.S. Kumar[2]

Abstract

Smokers are at high risk for 2 bacterially driven oral diseases: peri-implant mucositis and peri-implantitis. Therefore, the purpose of this investigation was to use a deep-sequencing approach to identify the effect of smoking on the peri-implant microbiome in states of health and disease. Peri-implant biofilm samples were collected from 80 partially edentulous subjects with peri-implant health, peri-implant mucositis, and peri-implantitis. Bacterial DNA was isolated and 16S ribsomal RNA gene libraries sequenced using 454-pyrosequencing targeting the V1 to V3 and V7 to V9 regions. In total, 790,692 classifiable sequences were compared against the HOMD database for bacterial identification. Community-level comparisons were carried out using UniFrac and nonparametric tests. Microbial signatures of health in smokers exhibited lower diversity compared to nonsmokers, with significant enrichment for disease-associated species. Shifts from health to mucositis were accompanied by loss of several health-associated species, leading to a further decrease in diversity. Peri-implantitis did not differ significantly from mucositis in species richness or evenness. In nonsmokers, by contrast, the shift from health to mucositis resembled primary ecological succession, with acquisition of several species without replacement of pioneer organisms, thereby creating a significant increase in diversity. Again, few differences were detected between peri-implantitis and mucositis. Thus, our data suggest that smoking shapes the peri-implant microbiomes even in states of clinical health, by supporting a pathogen-rich community. In both smokers and nonsmokers, peri-implant mucositis appears to be a pivotal event in disease progression, creating high-at-risk-for-harm communities. However, ecological succession follows distinctly divergent pathways in smokers and nonsmokers, indicating a need for personalized therapeutics for control and prevention of disease in these 2 cohorts.

Keywords: high-throughput nucleotide sequencing, peri-implantitis, 16S ribosomal RNA, tobacco, biofilms, microbiota

Introduction

According to the Centers for Disease Control and Prevention (2012), nearly 44 million people in the United States are current smokers. Considering that heavy smokers are nearly 7 times more prone to tooth loss (Mai et al. 2013), increasing numbers of this cohort are expected to require replacement of missing teeth.

Ever since Chercheve developed the first root-form or endosseous implants in 1966 (Chercheve 1966), they have become increasingly popular options for replacement of missing teeth. Dental implants have a 10-y survival rate of over 95% (Jung et al. 2012), but the past several years have seen an increase in 2 bacterially driven oral diseases: peri-implant mucositis and peri-implantitis (Mombelli et al. 2012). Studies have reported that peri-implant mucositis occurs in 50% to 90% of implants, while 20% of implants with an average function time of 5 to 11 y develop peri-implantitis (Roos-Jansaker et al. 2006; Zitzmann and Berglundh 2008; Mombelli et al. 2012).

Although early evidence was equivocal on the effect of smoking on dental implants, burgeoning evidence within the past 2 y strongly suggests that smoking is a significant risk factor for implant failure following functional loading (Chen et al. 2013; Doan et al. 2014; French et al. 2014; Twito and Sade 2014). Taken together with the higher rates of tooth loss in smokers (Salvi et al. 2014), this suggests that these individuals represent a high-need, high-risk cohort for implant therapy. Since bacteria play an important etiological role in the pathogenesis of implantitis and mucositis, it is important to understand the impact of smoking on the peri-implant microbiome to improve therapeutic outcomes.

We have previously demonstrated that smoking negatively affects the subgingival microbiome in states of both periodontal health and disease, supporting the formation of pathogen-rich communities (Kumar et al. 2011b; Mason et al. 2014).

[1]Present address: Division of Periodontics, Eastman Institute for Oral Health, School of Medicine and Dentistry, University of Rochester, Rochester, NY, USA
[2]Division of Periodontology, College of Dentistry, The Ohio State University, Columbus, OH, USA
[3]Division of Biostatistics, College of Public Health, The Ohio State University, Columbus, OH, USA

A supplemental appendix to this article is published electronically only at http://jdr.sagepub.com/supplemental.

Corresponding Author:
P.S. Kumar, The Ohio State University, 4111 Postle Hall, 305 W 12th Avenue, Columbus, OH 43210, USA.
Email: kumar.83@osu.edu

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Risk Factors for Peri-Implantitis: Effect of History of Periodontal Disease and Smoking Habits. A Systematic Review and Meta-Analysis

Claudio Stacchi,[✉1] Federico Berton,[1] Giuseppe Perinetti,[1] Andrea Frassetto,[1] Teresa Lombardi,[2] Aiman Khoury,[1] Francesca Andolsek,[3] and Roberto Di Lenarda[1]

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ABSTRACT

Go to:

Objectives

The purpose of this review was to evaluate whether history of periodontitis and smoking habits could represent a risk factor for peri-implantitis and implant loss.

Material and Methods

This systematic review followed PRISMA guidelines and was registered at the PROSPERO database [registration numbers CRD42016034160 (effect of history of periodontitis) and CRD42016033676 (effect of smoking)]. Broad electronic (MEDLINE) and manual searches were conducted among articles published from January 1st 1990 up to December 31st 2015, resulting in 49332 records for history of periodontitis and 3199 for smoking habits. Selection criteria included prospective studies comparing two cohorts of patients, with and without the investigated risk factor, with a minimum follow-up period of three years, and reporting data on peri-implantitis and implant loss occurrence. Considering that only prospective studies were included, dichotomous data were expressed as risk ratios and 95% confidence intervals.

Results

Three studies evaluating history of periodontitis (on which quantitative analysis was performed) and one study on smoking effect were included. Both implant and patient-based meta-analyses revealed a significantly higher risk of developing peri-implantitis in patients with a history of periodontitis compared with periodontally healthy subjects, but not a statistically significant increased risk for implant loss.

Conclusions

The outcomes of this systematic review indicate history of periodontitis as a possible risk factor for peri-implantitis, while insufficient data are present in literature to evaluate the role of smoking. However, available evidence is still weak and immature, and sound epidemiological studies are needed to analyse the specific contribution of these potential risk factors.

Keywords: dental implants, peri-implantitis, periodontitis, risk factors, smoking, systematic review

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REVIEW Open Access

Dental implants and diabetes mellitus—a systematic review

Hendrik Naujokat*, Burkhard Kunzendorf and Jörg Wiltfang

Abstract

Dental implant surgery has developed to a widely used procedure for dental rehabilitation and is a secure and predictable procedure. Local and systemic risk factors can result in higher failure rates. Diabetes mellitus is a chronic disease that goes in with hyperglycemia and causes multifarious side effects. Diabetes as a relative contraindication for implant surgery is controversially discussed. Because the number of patients suffering from diabetes increases, there are more diabetic patients demanding implant procedures. We aimed to answer the PICO question "Do diabetic patients with dental implants have a higher complication rate in comparison to healthy controls?" by a systematic literature search based on the PRISMA statement. We identified 22 clinical studies and 20 publications of aggregated literature, which were quite heterogeneous concerning methods and results. We conclude that patients with poorly controlled diabetes suffer from impaired osseointegration, elevated risk of peri-implantitis, and higher level of implant failure. The influence of duration of the disease is not fully clear. The supportive administration of antibiotics and chlorhexidine seems to improve implant success. When diabetes is under well control, implant procedures are safe and predictable with a complication rate similar to that of healthy patients.

Keywords: Dental implants, Implant survival, Diabetes mellitus, Glycemic control, Peri-implantitis, Systemic disease, Risk factor

Review

Introduction

Today, dental implants are one of the restorative methods to replace missing teeth. Improvements in implant design, surface characteristics, and surgical protocols made implants a secure and highly predictable procedure with a mean survival rate of 94.6 % and a mean success rate of 89.7 % after more than 10 years [1]. Implant survival is initially dependent on successful osseointegration following placement. Any alteration of this biological process may adversely affect treatment outcome. Subsequently, as an implant is restored and placed into function, bone remodeling becomes a critical aspect of implant survival in responding to the functional demands placed on the implant restoration and supporting bone. The critical dependence on bone metabolism for implant survival leads us to evaluation of certain risk factors. One of the controversial discussed diseases is diabetes mellitus. Diabetes mellitus is a chronic metabolic disorder that leads to hyperglycemia, which raises multiple complications caused by micro- and macroangiopathy. Diabetic patients have increased frequency of periodontitis and tooth loss [2], delayed wound healing [3], and impaired response to infection. In 1980, more than 150 million people worldwide were affected and that number had grown to 350 million by 2008 [4]. This trend highlights the need for better understanding of diabetes and its therapy and its impact on dental implant rehabilitation. In the past, diabetes was long time seen as a relative risk factor to dental implants. In contrast, today, there is a change in paradigm. Recent studies offer indirect evidence for diabetes patients benefiting from oral rehabilitation based on dental implant therapy. After tooth loss, patients avoid food which needs more effort to masticate which can lead to an adverse nutrition with poor metabolic control. A sufficient dental rehabilitation allows the patient to improve nutrition and the metabolic control. On the other hand, it is still unclear how quality of diabetes therapy and duration of disease influence the

* Correspondence: naujokat@mkg.uni-kiel.de
Klinik für Mund- Kiefer- und Gesichtschirurgie, Universitätsklinikum Schleswig-Holstein, Campus Kiel, Arnold-Heller-Straße 3, 24105 Kiel, Germany

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SYSTEMATIC REVIEW

WILEY Journal of Clinical Periodontology

Association between diabetes mellitus/hyperglycaemia and peri-implant diseases: Systematic review and meta-analysis

Alberto Monje[1,2] | Andres Catena[3] | Wenche S. Borgnakke[1]

[1]Department of Periodontics and Oral Medicine, School of Dentistry, University of Michigan, Ann Arbor, MI, USA

[2]Department of Oral Surgery and Stomatology, ZMK School of Dental Medicine, University of Bern, Bern, Switzerland

[3]Department of Experimental Psychology, University of Granada, Granada, Spain

Correspondence
Alberto Monje, Department of Periodontics and Oral Medicine, School of Dentistry, University of Michigan, Ann Arbor, MI, USA.
Email: amonjec@umich.edu
and
Wenche S. Borgnakke, Department of Periodontics and Oral Medicine, School of Dentistry, University of Michigan, Ann Arbor, MI, USA.
Email: wsb@umich.edu

Abstract

Aim: This systematic review investigates whether hyperglycaemia/diabetes mellitus is associated with peri-implant diseases (peri-implant mucositis and peri-implantitis).

Materials and Methods: Electronic and manual literature searching was conducted. An a priori case definition for peri-implantitis was used as an inclusion criterion to minimize risk of bias. The Newcastle-Ottawa Scale was used for quality assessment; random effect models were applied; and results were reported according to the PRISMA Statement.

Results: Twelve studies were eligible for qualitative and seven of them for quantitative analyses. Meta-analyses detected the risk of peri-implantitis was about 50% higher in diabetes than in non-diabetes (RR = 1.46; 95% CI: 1.21–1.77 and OR = 1.89; 95% CI: 1.31–2.46; $z = 5.98$; $p < .001$). Importantly, among non-smokers, those with hyperglycaemia had 3.39-fold higher risk for peri-implantitis compared with normoglycaemia (95% CI: 1.06–10.81). Conversely, the association between diabetes and peri-implant mucositis was not statistically significant (RR = 0.92; 95% CI: 0.72–1.16 and OR = 1.06; 95% CI: 0.84–1.27; $z = 1.06$, $p = .29$).

Conclusions: Within its limits that demand great caution when interpreting its findings, this systematic review suggests that diabetes mellitus/hyperglycaemia is associated with greater risk of peri-implantitis, independently of smoking, but not with peri-implant mucositis.

KEYWORDS
dental implants, diabetes complications, epidemiology, gestational diabetes, glycosylated, haemoglobin A, humans, review, systematic

1 | INTRODUCTION

Peri-implant diseases—that reportedly affect around half the individuals with dental implants (Derks & Tomasi, 2015)—constitute one of the major challenges in contemporary implant dentistry and hence require primary prevention and early diagnosis (Sanz, Chapple, & Working Group 4 of the VIII European Workshop on Periodontology 2012; Tonetti, Chapple, Jepsen, & Sanz, 2015; Tonetti, Eickholz et al., 2015). One of the main obstacles to early diagnosis is the lack of standard case definitions for peri-implant diseases (Sanz & Chapple, 2012). Moreover, local and systemic factors have been shown to substantially and negatively impact the peri-implant tissues, leading to increased susceptibility, which—in the presence of biofilm on the fixture surface—may trigger an inflammatory response that ultimately will lead to tissue breakdown in especially susceptible persons (Renvert & Polyzois, 2015). Therefore, identification of risk indicators based on patients' risk profiles is essential to prognosticate disease occurrence and provide individually tailored preventive intervention (Jepsen et al., 2015; Tonetti, Eickholz et al., 2015; Tonetti, Chapple, Jepsen, & Sanz, 2015).

With the realization that the individual host inflammatory response is the main promoter of several chronic diseases and conditions,

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REVIEW ARTICLE

WILEY CLINICAL ORAL IMPLANTS RESEARCH

Effects of modified abutment characteristics on peri-implant soft tissue health: A systematic review and meta-analysis

Ignacio Sanz-Martín[1] | Ignacio Sanz-Sánchez[1,2] | Ana Carrillo de Albornoz[1] | Elena Figuero[1,2] | Mariano Sanz[1,2]

[1]Section of Graduate Periodontology, University Complutense, Madrid, Spain

[2]ETEP (Etiology and Therapy of Periodontal Diseases) Research Group, University Complutense, Madrid, Spain

Correspondence
Mariano Sanz, Facultad de Odontología, Universidad Complutense de Madrid, Madrid, Spain.
Email: marsan@ucm.es

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Abstract

Objectives: The purpose of this systematic review was to evaluate the impact of the abutment characteristics on peri-implant tissue health and to identify the most suitable material and surface characteristics.

Methods: A protocol was developed aimed to answer the following focused question: "Which is the effect of the modification of the abutment design in regard to the maintenance of the peri-implant soft tissue health?" Further subanalysis aimed to investigate the impact of the abutment material, macroscopic design, surface topography and surface manipulation. Randomised controlled trials (RCTs) with a follow-up of at least 6 months after implant loading were considered as inclusion criteria. Meta-analyses were performed whenever possible.

Results: Nineteen final publications from thirteen investigations were included. The results from the meta-analysis indicated that zirconia abutments (Zi) experienced less increase in BOP values over time [n = 3; WMD = −26.96; 95% CI (−45.00; −8.92); p = .003] and less plaque accumulation [n = 1; MD = −20.00; 95% CI (−41.47; 1.47); p = .068] when compared with titanium abutments (Ti). Bone loss was influenced by the method of abutment decontamination [n = 1; MD = −0.44; 95% CI (−0.65; −0.23); p < .001]. The rest of the studied outcomes did not show statistically significant differences.

Conclusions: The macroscopic design, the surface topography and the manipulation of the implant abutment did not have a significant influence on peri-implant inflammation. In contrast, the abutment material demonstrated increased BOP values over time for Ti when compared to Zi abutments.

KEYWORDS
dental abutment, dental implants, dental-implant abutment surface, mucositis, systematic review

1 | INTRODUCTION

Dental implants are the preferred treatment to restore partially and completely edentulous patients due to their reported long-term success (Buser et al., 2012; Gotfredsen, 2012). Dental implants anchored in the jaw bones are connected to the prosthetic construction through a transmucosal component, the abutment, which allows the transmission of functional masticatory forces and at the same time protects the implants from the highly contaminated oral environment. This is accomplished by the formation of a biological seal where the soft tissues

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Journal of Clinical Periodontology

Primary and secondary prevention of periodontal and peri-implant diseases

Introduction to, and objectives of the 11th European Workshop on Periodontology consensus conference

Maurizio S. Tonetti[1], Iain L. C. Chapple[2], Søren Jepsen[3] and Mariano Sanz[4]

[1]European Research Group on Periodontology, Genova, Italy; [2]Periodontal Research Group & MRC Centre for Immune Regulation Birmingham Dental School, Birmingham, UK; [3]Department of Periodontology, Operative and Preventive Dentistry, University of Bonn, Germany; [4]Faculty of Odontology, University Complutense of Madrid, Spain

Tonetti MS, Chapple ILC, Jepsen S, Sanz M. Primary and secondary prevention of periodontal and peri-implant diseases–Introduction to, and objectives of the 11th European workshop on periodontology consensus conference. J Clin Periodontol 2015; 42 (Suppl. 16): S1–S4. doi: 10.1111/jcpe.12382.

Abstract

Background: Periodontitis prevalence remains high. Peri-implantitis is an emerging public health issue. Such a high burden of disease and its social, oral and systemic consequences are compelling reasons for increased attention towards prevention for individuals, professionals and public health officials.

Methods: Sixteen systematic reviews and meta-reviews formed the basis for workshop discussions. Deliberations resulted in four consensus reports.

Results: This workshop calls for renewed emphasis on the prevention of periodontitis and peri-implantitis. A critical element is the recognition that prevention needs to be tailored to the individual's needs through diagnosis and risk profiling. Discussions identified critical aspects that may help in the large-scale implementation of preventive programs: (i) a need to communicate to the public the critical importance of gingival bleeding as an early sign of disease, (ii) the need for universal implementation of periodontal screening by the oral health care team, (iii) the role of the oral health team in health promotion and primary

Key words: clinical recommendations; consensus conference; evidence based medicine; gingival bleeding; gingivitis; health policy; peri-implant mucositis; peri-implantitis; periodontitis; prevention; public health

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Conflict of interest and source of funding statement

Workshop participants filed detailed disclosure of potential conflict of interest relevant to the workshop topics and these are kept on file. Declared potential dual commitments included having received research funding, consultant fees and speakers fee from: Colgate-Palmolive, Procter & Gamble, Johnson & Johnson, Sunstar, Unilever, Philips, Dentaid, Ivoclar-Vivadent, Heraeus-Kulzer, Straumann.

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PERSPECTIVE

WILEY CLINICAL ORAL IMPLANTS RESEARCH

Peri-implantitis and its prevention

Abstract

This perspective article on peri-implantitis and its prevention was produced as a supplement to a 3-D, computer-animated film aiming at presenting key characteristics of peri-implant health, the build-up of a biofilm and the ensuing host-response resulting in peri-implant mucositis and, subsequently, peri-implantitis. Treatment concepts for peri-implantitis were briefly reviewed, and prevention of the condition was brought to attention as a priority in implant dentistry. The overview also highlighted the 2017 World Workshop on Classification of Periodontal and Peri-implant diseases and Conditions, in which new disease definitions and case definitions were presented for peri-implant health, peri-implant mucositis, and peri-implantitis.

1 | INTRODUCTION

Dental implants are used to support dental restorations after tooth loss and the proportion of patients with dental implants is increasing. Data presented from a Swedish quality registry (SKaPa, 2017) revealed that the percentage of patients with ≥1 dental implants in a registry population consisting of >4 million patients increased from 1.7% to 2.8% over the last 5 years. Although data showing long-term success of using dental implants to replace missing teeth have been presented, biological and technical complications do occur (Derks & Tomasi, 2015). Peri-implantitis is considered the most challenging biological complication, as untreated disease may progress and result in implant loss. In addition, treatment of peri-implantitis requires extensive resources in dentistry. Prevention of the disease is therefore a high priority in everyday clinical practice to minimize the occurrence and the severity of the problem (Jepsen et al., 2015; Tonetti, Chapple, Jepsen, & Sanz, 2015; Tonetti, Jepsen, Jin, & Otomo-Corgel, 2017). In this overview, the etiology and pathogenesis of peri-implantitis are presented using data obtained from preclinical and clinical trials. Prevention and management of the disease are also described.

According to recently established disease definitions, peri-implantitis is a plaque-associated pathological condition occurring in tissues around dental implants. It is characterized by inflammation in the peri-implant mucosa and loss of supporting bone (Berglundh, Armitage, et al., 2018; Schwarz, Derks, Monje, & Wang, 2018). It is important to understand the difference between the terms disease definitions and case definitions. While disease definitions are descriptive and aim at presenting the typical features of a disease, case definitions are designed to guide clinicians how to establish a clinical diagnosis. In the 2017 World Workshop on Classification of Periodontal and Peri-implant diseases and Conditions, characteristics together with disease definitions and case definitions were presented for peri-implant health, peri-implant mucositis, and peri-implantitis (Berglundh, Armitage, et al., 2018).

2 | PERI-IMPLANT HEALTH

Teeth and dental implants are unique, as they constitute hard materials passing from alveolar bone through oral mucosa. While there are obvious differences between the enamel and dentin at teeth as opposed to implant materials, there are also important differences between teeth and implants regarding the interface toward the surrounding hard and soft tissues. The tooth is anchored to the alveolar bone and gingiva through a periodontal ligament and supra-crestal connective tissue fibers. The fibrous attachment between root cementum and alveolar bone proper is formed in conjunction with root formation. The interface between the gingiva and the tooth crown is composed of a thin junctional epithelium, which is continuous with a sulcular and oral epithelium.

The peri-implant hard and soft tissues, on the other hand, are formed as a result of a wound-healing process. The tissue injury elicited during the osteotomy procedure during implant installation, leads to a series of reactions in bone, including degradation of the bone compartment immediately lateral to the implant after implant placement. The modeling and remodeling processes of the hard tissue interface to implants take several weeks and result in the formation of new bone in contact with the implant, that is, osseointegration (Berglundh, Abrahamsson, Lang, & Lindhe, 2003; Bosshardt et al., 2011; Terheyden, Lang, Bierbaum, & Stadlinger, 2012). Similarly, and irrespective if a one-stage or a two-stage implant installation technique is used, the healing of the peri-implant mucosa takes several weeks and includes the formation of a junctional epithelium and an adaptation of the connective tissue toward the implant material in the compartment between the epithelium and the bone (Berglundh, Abrahamsson, Welander, Lang, & Lindhe, 2007; Tomasi et al., 2016). While the connective tissue-implant interface lacks a fibrous attachment, collagen fibers in this zone of the peri-implant mucosa are aligned parallel to the long axis of the implant. Furthermore, the density of blood vessels in the supra-crestal connective tissue of the peri-implant mucosa is lower than in the corresponding tissue compartment at teeth (Berglundh, Lindhe, Jonsson, & Ericsson, 1994).

Healthy peri-implant mucosa is clinically characterized by absence of visible signs of inflammation, for example, swelling and

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Periodontology 2000

Implant surface roughness and patient factors on long-term peri-implant bone loss

Hugo De Bruyn, Véronique Christiaens, Ron Doornewaard, Magnus Jacobsson, Jan Cosyn, Wolfgang Jacquet & Stijn Vervaeke

Evolution in implant dentistry

Dental implants are widely used to restore function, aesthetic appearance and quality of life in partially and fully edentulous patients. Over 50 years of clinical scientific research have led to continuous improvement of dental implant designs, implant surface topography and a better understanding of bone and soft tissue biology. Compared with the era of the introduction of dental implants in clinical practice half a century ago, implant survival is today predictable, regardless of implant length, implant diameter, bone quality, available bone volume, surgical or prosthetic treatment protocol. The overwhelming positive acceptance of dental implants during the past decade has been lowered by suggestions of large incidences of biological complications that may only be clinically detected or become relevant after a sufficiently long time of follow-up. Suggestions have been made that implant surface topography may well have an impact on changes in peri-implant bone levels and consequently may affect the incidence of biological complications such as peri-implantitis.

Peri-implant bone level and peri-implant health

During the first European Workshop on Periodontology, opinion leaders from both academic and clinical backgrounds described the healing of dental implants and the diagnostic criteria for success, failure, health and disease. This included the classification of biological complications occurring in the tissues surrounding dental implants. They defined mucositis as a local, plaque-related inflammation of the surrounding supracrestal mucosa and peri-implantitis as a localized inflammation that also yields irreversible crestal bone loss beyond the normal bone remodeling related to the initial healing process. It was well understood that the long term and predictable success of an implant was largely dependent on the crestal bone level preservation over time, logically assessed through radiographic assessment at regular time intervals. With the available implant surfaces at that time, this was described as not exceeding on average 0.2 mm yearly after the first year of function. De Bruyn and co-workers (22) reviewed the aspect of radiographic assessment of dental implants and suggested that mean bone loss may be useful in clinical research for comparison of implant systems or protocols, but yields very limited information on the condition of individual implants. Given the fact that a majority of implants yield very stable crestal bone levels over time with no bone loss at all, the statistical interpretation of mean values often hides the condition of implants positioned in the upper quartile of the bone level spectrum.

This was demonstrated by Pettersson & Sennerby (43) in a 5-year follow-up study including 88 patients treated with an anodized moderately rough surface implant. The cumulative survival was 99.6% and the average crestal bone loss from the day of implant placement to 5 years of function was 0.1 mm. However, widely spread and extreme values were reported and 15% of the implants showed more than 2 mm bone loss. Based on the cross-sectional evaluation at 5 years, it is tempting to suggest that these are at risk for peri-implantitis when applying, for

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Dr. Hema Kanathila
Reader, Department of Prosthodontics, KLE VK Institute of Dental Sciences Kahe Belgaum, Karnataka, India

Dr. Ashwin Pangi
Prosthodontist, Clinical Practitioner, Aesthetix Dental Clinic, Belgaum, Karnataka, India

Dr. Veena Benakatti
Senior Lecturer, Department of Prosthodontics, KLE VK Institute of Dental Sciences Kahe Belgaum, Karnataka, India

Dr. Suvidha Patil
Senior Lecturer, Department of Prosthodontics, KLE VK Institute of Dental Sciences Kahe Belgaum, Karnataka, India

Correspondence
Dr. Hema Kanathila
Reader, Department of Prosthodontics, KLE VK Institute of Dental Sciences Kahe Belgaum, Karnataka, India

Maintenance of dental implants: A way to long term success: A review

Dr. Hema Kanathila, Dr. Ashwin Pangi, Dr. Veena Benakatti and Dr. Suvidha Patil

Abstract
Apart from the professional care taken during surgical phase, professional implant maintenance and patient home care play very important role in deciding the long term success of osseointegrated implants. The patients are to be educated about the importance of proper oral hygiene maintenance and its effect on the dental implant prosthesis. This article reviews about the evaluation of implants and various professional and home care methods of dental implant prosthesis.

Keywords: dental implants, periimplantitis, oral hygiene, maintenance, long term success

1. Introduction
Oral implants have become an integral part of reconstructive dentistry. Implant devices, prosthetic devices and superstructures are different from the normal gingival/ tooth contours and relationships. They create a situation that demands special, detailed instruction and attention in terms of home care procedures. Patients presenting themselves as possible candidates for implant placement are patients with a history of less than optimum home care in the past. In partially dentate patients, both dental and implant abutments are used to reconstruct the compromised dentition. This blend of teeth and implants is critical in the periodontally susceptible patient in whom the sub marginal biofilms may harbor periodontal pathogens which may be involved in the processes associated with the resorption of the bony support for the implant.
Permucosal seal of the soft tissue to the implant surface is important for the success of implants. Failure to maintain this seal, will cause bacteria and their by-products have a direct entry to the bone surrounding the implant. Poor oral hygiene is a documented risk factor associated with implant failures.

2. Implant and Natural Teeth
Implants are basically different from natural teeth starting from composition to the vascularity. The implant behaves as an ankylosed unit, whereas the natural teeth show physiologic mobility by the viscoelastic properties of periodontal ligament. There is no proprioception with respect to implants due to the absence of ligament receptors. Adaptive capacity in case of implants is less compared to natural tooth where the width of the ligament helps in mobility with increased occlusal forces [1]
Gingival fibres are inserted into the cementum above the crestal bone, whereas there is no collagen fibre attachment in case of implants. There is less vasculature in the gingival tissue surrounding the dental implants compared to natural teeth. This reduced vascularity together with parallel oriented collagen fibres adjacent to the body of any dental implant makes implants more vulnerable to bacterial insult [2, 3].
Oral implants when evaluated after 10 years of service do not surpass the longevity of natural teeth even of those that are compromised, for either periodontal or endodontic reason. Proper evaluation, monitoring and maintenance is essential to ensure the longevity of the dental implant and its restoration by combining regular check up, professional care and effective home care.


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Danielle Clark

Dental implant management and maintenance: How to improve long-term implant success?

Danielle Clark, RDH[1]/Liran Levin, DMD[2]

Although dental implants are proven to be a predictable long-term treatment for patients, it is important to realize that not all implants that survive are necessarily successful. Successful implants are those that remain fully functional and healthy within the oral cavity. Peri-implantitis is a disease that is associated with implant failure, and is becoming rather prevalent. Assessing risk factors and stabilizing existing oral disease prior to the placement of implants will aid in preventing implant disease and failure. After implant placement, a strict follow-up regime with a dental professional should be implemented in order to monitor the implant and surrounding teeth for disease. The dental professional should continually encourage the patient to adhere to consistent homecare to prevent peri-implantitis from occurring, and in turn increase the success of their implants. Early diagnosis and elimination of inflammatory processes around the implants will improve the long-term prognosis as well. *(Quintessence Int 2016;47:417–423; doi: 10.3290/j.qi.a35870)*

Key words: bone, bone loss, gingival health, implant, plaque, survival

Dental implants are a popular treatment option for today's dental patient. Survival rates for implants in the mandible, for example, are as high as 92.6%.[1] With high survival rates, dental implants are seemingly an obvious answer to restore a fully or partially edentulous dentition. However, we should recognize the difference between implant failure or survival, and actual implant success.[2] Implants that have remained in the oral cavity are considered to be survived implants. This means that diseased implants that may not be functioning or surrounded by healthy tissues are considered survived implants for many of the published evaluations.[3] Determining the success of a dental implant is more complicated. Successful implants are defined based on criteria; however, there is not one universal set of criteria being used.[4] Due to the variability in defining a successful implant, it is difficult to accurately assess the number and rates of successful implants.

DIFFERENCES IN ANATOMY BETWEEN TEETH AND IMPLANTS

A natural tooth is encircled by mucosa with keratinized tissue surrounding the crown of the tooth.[5] When bacteria accumulates, this tissue becomes inflamed and gingivitis develops.[5] When an implant is placed, these tissues are now considered peri-implant tissues.[5] When these tissues become inflamed and bone loss occurs in the natural dentition, it is known as periodontal disease. When bone loss is experienced around a dental implant, the disease is known as peri-implantitis. Natu-

[1]Dental Hygienist, Division of Dental Hygiene, Faculty of Medicine and Dentistry, University of Alberta, Canada.

[2]Professor and Head, Division of Periodontology, Faculty of Medicine and Dentistry, University of Alberta, Canada.

Correspondence: Professor Liran Levin, University of Alberta, School of Dentistry, Faculty of Medicine & Dentistry, 5-468 Edmonton Clinic Health Academy, 11405 - 87 Avenue NW, 5th Floor, Edmonton, AB, Canada. Email: liran@ualberta.ca

REVIEW ARTICLE

Dental-Implant Maintenance: A Critical Factor in Long-Term Treatment Success

Nami Sheth[1]*, Rubina Tabassum[2], Gaurang Mistry[3], Omkar Shetty[4]
[1]Post Graduate, Dept. of Prosthodontics, School of Dentistry, D. Y. Patil University, Navi Mumbai, India
[2]Professor, Dept. of Prosthodontics, School of Dentistry, D. Y. Patil University, Navi Mumbai, India
[3]Professor & HOD, Dept. of Prosthodontics, School of Dentistry, D. Y. Patil University, Navi Mumbai, India
[4]Professor and Dean, School of Dentistry, D. Y. Patil University, Navi Mumbai, India

*Address for Correspondence: Dr. Nami Sheth, Post Graduate, Dept. of Prosthodontics, School of Dentistry, D. Y. Patil University, Navi Mumbai, India
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ABSTRACT- Initially when dental implants were first introduced their success was assumed to be dependent mostly on the surgical technique and later their placement. However, without a regular program of clinical reevaluation, plaque control, oral hygiene instruction, and reassessment of biomechanical factors, the benefits of treatment often are lost and inflammatory disease in the form of recurrent periodontitis or peri-implantitis may result. Maintenance of periodontal health is a critical factor in the long-term success of dental implant therapy. This article reviewed the goals, types, and appropriate frequency of periodontal maintenance in dental implant therapy as well as the incidence and etiology of peri-implant disease and strategies for management when the recurrent disease develops during the maintenance phase of treatment.
Key-words- Chemotherapeutic Aids, Dental Implants, Hygiene, Interdental Aids, Maintenance, Peri-implantitis, Peri-implant mucocitis

INTRODUCTION

In the recent past Implant supported restorations have become the more common treatment and a viable option for replacement of teeth in both complete and partially edentulous cases. Clinical findings in healthy dental implants include firm, pink peri-implant mucosa, shallow probing depths (3mm or less); absence of bleeding on gentle probing, absence of purulence or suppuration, and lack of response to percussion [1]. implant-supported restorations should provide comfortable function and appropriate esthetics.

Replacement of the missing teeth with implants provides us with the solution of not utilizing healthy natural teeth as abutments for a fixed prosthesis. After the treatment phase of implant restoration is over it is equally important for the dentist and the patient to strictly abide by the maintenance phase. Many principles and features of maintenance therapy apply to both the natural dentition and to dental implants. As the number of dental implants continues to increase, understanding the importance of maintenance as it relates to long-term implant success becomes more crucial. [2] The dental professional's role is to determine the patient's individual and specific home care needs.

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Literature Review

Professional Hygiene Maintenance- Frequent recall visits during the first year after implant placement and restoration are necessary for evaluation and establishment of good oral hygiene routines. In patients who are partially edentulous with implant-supported restorations maintenance visits combine traditional periodontal maintenance for the remaining natural teeth and dental implant maintenance. In fully edentulous patients with implant-supported restorations, the focus is on prevention or treatment of peri-implant mucositis or peri-implantitis, because dental caries and endodontic pathologic conditions are not possible [1,2]. Data collection includes measurement of probing depths, bleeding upon probing, suppuration, recession, mobility, response to percussion, and clinical appearance of peri-implant mucosa.

Probing- The generalized belief is that a baseline probing depth needs to be established and any signs of change, including bleeding, redness, edema, exudate, pain, or radiographic bone loss, warrant probing. Probing should be done with very gentle force (not to exceed 0.15 N) because excessive force may disrupt the soft tissue attachment and has been shown to overestimate probing depths and the incidence of bleeding upon probing [3]. As with natural teeth, inflammation of peri-implant soft tissue results in greater apical penetration of the periodontal probe. Hence, gentle probing has been shown to be an effective means to evaluate the stability of the peri-implant attachment and to detect peri-implantitis.

Nonsurgical Management of Peri-implant Bone Loss Induced by Residual Cement: Retrospective Analysis of Six Cases

Emanuele De Martinis Terra, DDS[1]
Marco Berardini, DDS[2]
Paolo Trisi, PhD, DDS[3]

This report presents six consecutive cases of peri-implantitis associated with residual methacrylate cement. The cases responded to cement removal and disinfection procedures. Six patients, each presenting one methacrylate cement-retained implant restoration and showing peri-implant inflammation and bone loss, were treated. All the cases were negative for bleeding on probing after 6 weeks, and this was maintained at 1 year of follow-up from nonsurgical therapy and crown refixation with alternative and resorbable cement. The treatment effectively solved the inflammation and led to complete restoration ad integrum, as evaluated clinically and radiographically, after 1 year. Int J Periodontics Restorative Dent 2018 (6 pages). doi: 10.11607/prd.3075

[1]Private Practice, Pescara, Italy.
[2]Researcher, Biomaterial Clinical and Histological Research Association, Pescara, Italy.
[3]Scientific Director, Biomaterial Clinical and Histological Research Association, Pescara, Italy.

Correspondence to: Dr Marco Berardini, Via Galilei 8, 65122 Pescara, Italy.
Fax: +39 085 7933050. Email: dottmarcoberardini@gmail.com

Peri-implant diseases are infective complications of tissues surrounding dental implants that often occur years after the final prosthetic restoration placement.[1] A variable percentage, ranging from 8.6% to 14.4%, of restored implants are easily affected by peri-implantitis within 5 years after functional loading.[2] Peri-implant diseases were described as two distinct entities by the Sixth European Workshop on Periodontology: peri-implant mucositis, in which the inflammation is confined to soft tissue without any peri-implant bone injury, and peri-implantitis, which involves peri-implant bone loss in addition to inflammation of the mucosa.[3] The peri-implantitis diagnostic criteria were specified by the Seventh European Workshop on Periodontology[4]: bleeding on probing (BoP) was established as the primary diagnostic criterion for peri-implant mucositis, while crestal bone changes in association with bleeding on probing presence were the primary criteria for a peri-implantitis diagnosis. Some studies demonstrated that the presence of severe chronic periodontitis,[5] smoking,[6] insufficient oral hygiene,[7] and some systemic diseases (eg, diabetes or cardiovascular diseases[8]) are factors related to peri-implant disease development. These cited factors were extensively discussed by international literature but authors do not agree

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THE JOURNAL OF PROSTHETIC DENTISTRY

SYSTEMATIC REVIEW

Systematic review of some prosthetic risk factors for periimplantitis

Paolo Pesce, DDS, PhD,[a] Luigi Canullo, DDS, PhD,[b] Maria Gabriella Grusovin, DDS,[c] Hugo de Bruyn, DDS, MSc, PhD,[d] Jan Cosyn, DDS, MSc, PhD,[e] and Paolo Pera, MD, PhD[f]

ABSTRACT

Statement of problem. The recent literature underlines a correlation between plaque and the development of periimplantitis but neglects the importance of the prosthetic factors.

Purpose. The purpose of this systematic review was to appraise the available literature to evaluate the role played by cement excess and misfitting components on the development of periimplantitis.

Material and methods. An electronic search restricted to the English language was performed in PubMed, Embase, and the Cochrane Register up to September 1, 2014, based on a selected search algorithm. Only cohort studies and case-control studies were included without additional restrictions. The presence of periimplantitis and implant failure were considered primary and secondary outcome variables.

Results. The search produced 275 potentially relevant titles, of which only 2 were found eligible. They showed a correlation in cemented implant prostheses between cement excess and the presence of periimplant disease, especially in patients with a history of periodontal disease. After cement excess removal by means of debridement, disease symptoms disappeared around most of the implants.

Conclusions. Scientific articles on prosthetic risk factors for periimplantitis are scarce. Although the studies found on cement remnants have a high risk for bias, cement excess seems to be associated with mucositis and possibly with periimplantitis, especially in patients with a history of periodontal disease. (J Prosthet Dent 2015;■:■-■)

Periimplantitis was defined during the first European Workshop on Periodontology in 1994 as inflammatory reactions associated with the loss of supporting bone around an implant in function.[1] This definition has been refined in various consensus meetings (Table 1), supporting a progressive bone loss pattern after initial bone remodeling as a clear characteristic of the condition.

Different hypotheses on its etiology have been proposed. Periimplant diseases have been reported to be infectious in nature.[2] Therefore, the correlation of pathogenic bacteria to the initiation and/or progression of the condition is important. However, while a relationship between plaque deposits and periimplant mucositis has been reported, a clear link to periimplantitis has yet to be demonstrated.[3]

In recent consensus meetings, periimplantitis has been described as a periimplant pathology with multifactorial etiology, including implant related factors (material, surface properties, design), clinician factors (surgical and prosthodontic experience, skill), and patient factors (systemic disease, medication, oral disease, oral hygiene, smoking, bone quality).[4] However, it is striking that prosthetic factors such as cement excess and ill-fitting components have only more recently been considered in the etiology of periimplantitis.

The purpose of the present study was to systematically review the available literature to evaluate the role

[a]Lecturer, Department of surgical and diagnostic sciences, University of Genova, Genova, Italy.
[b]Lecturer, Dental Institute Toscano, Viareggio, Italy.
[c]Professor, Periodontology Department, Vita-Salute University Milano, Milan, Italy.
[d]Professor, Department of Periodontology and Oral Implantology, Faculty of Medicine and Health Sciences, Dental School, Ghent University, Ghent, Belgium.
[e]Professor, Department of Periodontology and Oral Implantology, Faculty of Medicine and Health Sciences, Dental School, Ghent University, Ghent, Belgium; and Professor, Department of Periodontology and Oral Implantology, Vrije Universiteit Brussel (VUB) Belgium, Brussels, Belgium.
[f]Professor, Department of surgical and diagnostic sciences, Division of Prosthodontics, University of Genova, Genova, Italy.

Association of Preventive Maintenance Therapy Compliance and Peri-Implant Diseases: A Cross-Sectional Study

Alberto Monje,*†‡ Hom-Lay Wang,* and José Nart‡

Background: This study aims to investigate association between peri-implant maintenance therapy (PIMT) and the frequency of peri-implant diseases and to further identify factors that contribute to failure of PIMT compliance.

Methods: A cross-sectional study on patients who were healthy and partially edentulous was conducted. They were grouped in the following categories according to PIMT compliance: 1) regular compliers (RC) (≥2 PIMT/year); 2) erratic compliers (EC) (<2 PIMT/year); and 3) non-compliers (NC) (no PIMT). Radiographic and clinical analyses were carried out including probing depth (PD), plaque index (PI), bleeding on probing (BOP), mucosal redness (MR), suppuration (SUP), keratinized mucosa dimension, and marginal bone loss. A multiple logistic regression model was estimated at implant and patient level to obtain adjusted odds ratios (ORs) and to control possible confounding effects among variables.

Results: Overall, 206 implants in 115 patients fulfilled inclusion criteria. At patient level, it was shown that association between compliance and peri-implant condition was statistically significant (P = 0.04). Compliance was associated with 86% fewer conditions of peri-implantitis. The probability of PIMT compliance was substantially associated with frequency of peri-implantitis (OR = 0.13, P = 0.01). Patients with a history of periodontal disease multiplied their probability of being EC (versus NC) 4.23 times with respect to not having a history of periodontal disease (P = 0.02). Moreover, light smokers significantly resulted to be NC compared with RC (P = 0.04) and EC (P = 0.02). Nevertheless, mucositis was not found to be statistically associated with level of compliance. In addition, PD, PI, BOP, MR, and SUP varied significantly according to PIMT compliance and peri-implant condition.

Conclusions: Peri-implant maintenance compliance ≥2 PIMT/year seems to be crucial to prevent peri-implantitis in healthy patients. Furthermore, history of periodontal disease and disease severity, as well as its extent and a smoking habit, appear to be factors that influence the compliance risk profile (NCT02789306). *J Periodontol 2017;88:1030-1041.*

KEY WORDS

Dental implants; maintenance; mucositis; peri-implantitis; periodontitis; risk factors.

* Department of Periodontics and Oral Medicine, University of Michigan School of Dentistry, Ann Arbor, MI.
† Department of Oral Surgery and Stomatology, Zahnmedizinische Kliniken (ZMK) University of Bern, Bern, Switzerland.
‡ Department of Periodontology, International University of Catalunya, Barcelona, Spain.

Lack of supportive periodontal maintenance therapy has been demonstrated to be strongly associated with tooth mortality.[1-4] Hence, it has been suggested that a professional mechanical plaque removal treatment must be programmed to prevent periodontal tissue breakdown.[5] Nevertheless, early studies in the field of periodontology pointed out that ≈80% of patients do not adhere to a regular schedule, with only 16% being compliers after active periodontal therapy.[1,2] It was further shown that implementing efforts in identifying and targeting erratic and non-complying individuals with more information could increase compliance to 32%.[6] Biologic plausibility remains due to three dominant facts: 1) in susceptible hosts, plaque and its byproducts represent the primary etiology of periodontal disease;[7] 2) after episodes of inflammation, periodontal tissues are moderately more susceptible due to changes in gene expression that are not encoded by DNA itself;[8] and 3) recolonization of putative bacteria such as spirochetes and motile rods occurs as soon as 4 to 8 weeks after active periodontal treatment.[9]

Likewise, peri-implant diseases are defined as plaque-induced chronic inflammatory conditions.[10] Peri-implant maintenance therapy (PIMT) has been strongly encouraged according to patient risk profiling, with 5- to 6-month recall intervals being suggested for non-susceptible individuals.[11] In this context, it was reported that peri-implantitis

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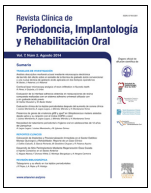

REVISIÓN BIBLIOGRÁFICA

Láser Er:YAG en el tratamiento de la periimplantitis: revisión de la literatura

Bárbara Feldman* **y Andrés Contreras**

Facultad de Medicina, Escuela de Odontología, Clínica Alemana-Universidad del Desarrollo, Santiago, Chile

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PALABRAS CLAVE
Periimplantitis;
Láser;
Láser Er:YAG;
Implante dental

Resumen La presente revisión bibliográfica describe la efectividad del uso del láser Er:YAG en los últimos 10 años, con el objetivo de esclarecer cuáles han sido sus efectos clínicos, sus efectos microbiológicos, sus efectos físicos y térmicos en la superficie del implante, su efecto en la biocompatibilidad y el tiempo de trabajo requerido.

Se efectuó la búsqueda en la base de datos PubMed, seleccionando investigaciones publicadas entre los años 2005 y 2015. Se seleccionaron 14 investigaciones *in vitro*, un estudio en animales, un reporte de casos, 6 series de casos, 2 estudios clínicos controlados, 4 estudios clínicos controlados aleatorizados y 5 revisiones bibliográficas.

La literatura disponible señala que el uso del láser Er:YAG en el tratamiento de la periimplantitis produce una mejoría clínica, expresada en una disminución del sangrado al sondaje, una disminución en la profundidad de sondaje y una ganancia de inserción que se limita a los primeros 6 meses luego del tratamiento. En relación con la descontaminación de la superficie del implante, la mayoría de los estudios reporta una disminución en el número de bacterias adheridas. Para no causar daños físicos y térmicos es necesario utilizar el láser Er:YAG en distintos niveles de energía, de frecuencia y de tiempo de exposición según el tipo de superficie del implante afectado. Respecto a la biocompatibilidad de la superfice existen aún resultados contradictorios. Las investigaciones coinciden en que el tratamiento con láser Er:YAG supone un menor tiempo de trabajo en comparación con terapias convencionales.

* Autor para correspondencia.
Correo electrónico: barbara.feldmanf@gmail.com (B. Feldman).

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CLINICAL ORAL IMPLANTS RESEARCH

Review

Excess cement and the risk of peri-implant disease – a systematic review

Noémie Staubli
Clemens Walter
Julia C. Schmidt
Roland Weiger
Nicola U. Zitzmann

Authors' affiliations:
Noémie Staubli, Clemens Walter, Julia C. Schmidt, Roland Weiger, Nicola U. Zitzmann, Department of Periodontology, Endodontology and Cariology, University Centre for Dental Medicine, University of Basel, Basel, Switzerland

Corresponding author:
Nicola U. Zitzmann
Department of Periodontology, Endodontology and Cariology, University Centre for Dental Medicine University of Basel, Hebelstrasse 3, CH-4056 Basel, Switzerland
Tel.: +41 61 2672625
Fax: +41 61 2672659
e-mail: n.zitzmann@unibas.ch

Key words: cement excess, implant restoration, peri-implant diseases, peri-implant mucositis, peri-implantitis, review

Abstract

Objective: The aim of this systematic review was to assess the role of excess cement as risk indicator for peri-implant diseases.

Material and methods: A systematic literature search with the keywords peri-implant disease, peri-implant mucositis, peri-implantitis, excess cement, cemented, and screw-retained restorations was performed for articles published by June 2016 using MEDLINE and EMBASE electronic databases, complemented by hand searching.

Results: The included 26 publications referring to 21 study groups were published between 1999 and 2016 and comprised 945 subjects with 1010 cemented implant restorations in 10 prospective and eight retrospective studies and eight case reports/series with pronounced heterogeneity of the study designs. Prevalence of peri-implant diseases varied between 1.9% and 75% of the implants with cemented restorations, with proportions of 33–100% associated with excess cement. In publications including early follow-ups and regular recall intervals, peri-implant disease was mostly detected at an early stage. Cofactors, such as type of abutment (standardized or individualized) and cementum medium used, did not have a significant influence, while higher prevalence of peri-implant diseases was found with immediate loading or cementation subsequent to reentry, and with cemented vs. screw-retained restorations.

Conclusions: Excess cement was identified as a possible risk indicator for peri-implant diseases and was more frequently observed with soft tissue healing periods shorter than 4 weeks. To reduce the risk of peri-implant disease associated with excess cement, a crown margin at the level of the mucosal margin providing sufficient access is recommendable, and soft tissue maturation and early follow-ups after restoration placement should be assured.

Fixed implant restorations including single crowns on implants and implant-fixed dental prostheses are either retained by temporary or permanent cement, or screwed directly to the enossal implant portion or onto individual abutments. While screw retention provides the option for retrievability in case of complications or need for intervention, cementation offers greater latitude to individualize the abutment and to compensate for some implant angulations. According to recent reviews comparing cemented and screw-retained restorations (Sailer et al. 2012; Wittneben et al. 2014), the dominating technical complications were abutment screw fractures and loss of retention with cemented restorations, while screw loosening or porcelain chipping was predominant with screw-retained restorations. Among biological complications, the presence of fistula and suppuration was found more often at cemented restorations (Wittneben et al. 2014), and bone loss exceeding 2 mm indicating peri-implantitis was also more frequently observed around cemented than at screw-retained implant restorations (Sailer et al. 2012). In contrast, the comparison by de Brandao et al. (2013) did not show differences in marginal bone loss at cemented or screw-retained restorations. Although plaque accumulation has been addressed as the major etiologic factor for peri-implant diseases, excess cement was discussed as local risk indicator based on the assumption that biofilm adherence is enhanced on the rough cement surface and cleaning impeded due to poor access to the submucosal peri-implant region (Jepsen et al. 2015).

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ORIGINAL ARTICLE

WILEY

Cement-associated peri-implant mucositis. A 1-year follow-up after excess cement removal on the peri-implant tissue of dental implants

Michael Korsch[1,2,3] | Winfried Walther[1] | Andreas Bartols[1,4]

[1]Dental Academy for Continuing Professional Development, Karlsruhe, Germany

[2]Clinic of Operative Dentistry, Periodontology and Preventive Dentistry, University Hospital, Saarland University, Homburg, Germany

[3]Private practice, Center for Implantology and Oral Surgery, Heidelberg, Germany

[4]Clinic for Conservative Dentistry and Periodontology, School for Dental Medicine, Christian-Albrechts-University Kiel, Kiel, Germany

Correspondence
Michael Korsch, Dental Academy for Continuing Professional Development, Lorenzstrasse 7, Karlsruhe 76135, Germany.
Email: michael-korsch@za-karlsruhe.de

Abstract

Background: Methacrylate-based cements seem to promote peri-implant tissue inflammation even in the absence of excess cement.

Purpose: The present study deals with the question of whether the removal of methacrylate cement from the peri-implant sulcus will lead to peri-implant tissues free of inflammation on a 1-year follow-up basis.

Material and Methods: Implant supported suprastructures that had been in the mouth for at least 3.5 years either cemented with methacrylate (premier implant cement [PIC]) or zinc eugenol (temp bond [TB]) cement were compared. All superstructures in 33 patients with a total of 61 implants (35 with PIC and 26 with TB) were removed and excess cement, bleeding on probing (BOP), suppurationen and probing depth were documented. Excess cement found was removed, and in all cases the suprastructure was recemented with TB. Patients were followed up after 4 weeks (F1) and 1 year (F2).

Results: Excess cement was found around 60% of the implants with PIC. No excess cement was found around implants with TB. At the time of revision therapy, BOP was found around 100% of the implants with PIC and excess cement (PIC+), 93% around implants with PIC but no excess cement (PIC−), and around 42% of the TB-cemented implants (Chi-squared $P < .01$). Suppuration was observed in 86% of the PIC+ implants, in 14% of the PIC− implants and in 0% of the TB implants (Chi-squared $P < .01$). At the time of both F1 and F2, the inflammation parameters, that is BOP and suppuration, on implant level were significantly reduced in the PIC+ cases (McNemar's test $P < .01$). For PIC−, BOP was significantly reduced at both points in time ($P < .05$). For TB no differences were found. Probing depth at F2 had significantly decreased in all groups (*t* test $P < .05$).

Conclusion: The removal of excess cement and recementation with TB had an anti-inflammatory effect on the peri-implant tissues after 1 year.

KEYWORDS
cement-retained reconstructions, excess cement, implants, inflammation

1 | INTRODUCTION

The long-term success of implants is defined as the preservation of the peri-implant structures, that is, the soft and hard tissues.[1,2] Infections will jeopardize the integrity of these tissues and may cause peri-implant mucositis and, with progressing inflammation, peri-implantitis.

Basically fixed implant-supported reconstructions are either screw-retained or cement-retained. Both methods of retention have been clinically tried and tested for decades and have different mechanical and biological risks.[3] In terms of survival rate of implant and restoration, the two methods of retention do not seem to differ significantly.[3–5]

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ORIGINAL RESEARCH

CLINICAL ORAL IMPLANTS RESEARCH WILEY

Keratinized mucosa width is associated with severity of peri-implant mucositis. A cross-sectional study

Jasmin Grischke[1] | Annika Karch[2] | Andreas Wenzlaff[1] | Magdalena Marta Foitzik[1] | Meike Stiesch[1] | Jörg Eberhard[3]

[1]Department of Prosthetic Dentistry and Biomedical Materials Science, Hannover Medical School, Hannover, Germany

[2]Institute for Biostatistics, Hannover Medical School, Hannover, Germany

[3]The School of Dentistry, Charles Perkins Centre, Westmead Centre for Oral Health, The University of Sydney, Sydney, New South Wales, Australia

Correspondence
Jasmin Grischke, Department of Prosthetic Dentistry and Biomedical Materials Science, Hannover Medical School, Carl-Neuberg-Str.1, 30625 Hannover, Germany.
Email: grischke.jasmin@mh-hannover.de

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Abstract

Objectives: This is a cross-sectional study designed with the aim to assess associations between the width of keratinized tissue and peri-implant mucositis.

Materials and methods: Two hundred and thirty one dental implants in 52 patients were evaluated. The width of keratinized mucosa (KM), plaque index (mPI), gingival index (mGI), bleeding on probing index (BoP), and the probing depth (PD) were measured clinically. Reduced KM was defined as a width of KM below 2 mm and 1 mm, respectively. In the primary analysis, data were analyzed on the implant level with the help of a generalized estimating equations (GEE) model. In sensitivity analyses, an adjusted linear mixed model was performed.

Results: Forty four implants in 12 patients had less than 2 mm KM, and 187 implants in 40 patients had ≥ 2 mm KM. In the non-adjusted analysis on the implant level, reduced keratinized tissue width was significantly associated with peri-implant mucositis (OR 3.3, 95%-CI (1.3–8.0), $p = 0.009$) and severity of disease (mean difference 2.5, 95%-CI (0.8–4.2) $p = 0.004$). In sensitivity analyses, reduced keratinized tissue showed a significant association with severity of disease (OR 1.7, 95%-confidence interval = 0.1–34, $p = 0.040$).

Conclusion: A reduced width of keratinized tissue around dental implants is a risk indicator for severity of peri-implant mucositis. The overall tendency of the results indicates that a sufficient amount of KM may contribute to reduce risk for and severity of peri-implant mucositis.

KEYWORDS
cross-sectional, peri-implant mucositis, peri-implant health, dental implant, keratinized mucosa, peri-implantitis, preventive maintenance

1 | INTRODUCTION

Soft tissue healing following dental implant placement and abutment connection surgery results in the establishment of a transmucosal region composed of either masticatory (keratinized) or lining (non-keratinized) mucosa (Wennström & Derks, 2012). Keratinized mucosa (KM) includes both free and attached mucosa and extends from the peri-implant mucosal margin to the mucogingival junction.

Based on the assumption that a specific amount of KM is necessary to maintain peri-implant health, the transmucosal region of dental implants is either designated as adequate or insufficient (Boynuegri, Nemli, & Kasko, 2013; Brito, Tenenbaum, Wong, Schmitt, & Nogueira-Filho, 2014; Ueno et al., 2016; Wennström &

CLINICAL ORAL IMPLANTS RESEARCH

André B. Souza
Mariana Tormena
Flávia Matarazzo
Maurício G. Araújo

The influence of peri-implant keratinized mucosa on brushing discomfort and peri-implant tissue health

Authors' affiliations:
André B. Souza, Mariana Tormena, Flávia Matarazzo, Maurício G. Araújo, Department of Dentistry, State University of Maringá, Maringá, Paraná, Brazil

Corresponding author:
Mauricio G. Araújo
Av Mandacaru 1550, 87080-000 Maringá, Paraná, Brazil
Tel./Fax: +55 44 3011 9052
e-mail: odomar@hotmail.com

Key words: brushing, discomfort, implants, keratinized mucosa

Abstract

Objective: The aim of this study was to compare the level of brushing discomfort (BD) during oral hygiene and peri-implant clinical variables between patients presenting implant sites with a band ≥2 mm and <2 mm of keratinized mucosa (KM).

Materials and Methods: Participating patients were recruited during routine maintenance follow-up visits from January to October 2013. Based on the presence of KM, patients were allocated into two groups: implant sites with ≥2 mm of KM (Wide Group); and implant sites with <2 mm of KM (Narrow Group). Patients were clinically assessed, and plaque index (PI), probing pocket depth (PPD), clinical attachment level (CAL), and bleeding on probing (BoP) data were collected from three sites at the buccal aspect of each implant. Subsequently, patients received standardized oral hygiene instructions and cleaning devices and were asked to clean around the experimental implant sites. All patients reported on the level of BD using the visual analog scale (VAS). Non-paired Student's *t*-test, Wilcoxon's signed-rank test, and chi-square tests were performed to analyze the outcome variables ($P < 0.05$).

Results: Eighty patients with a total of 270 implant sites were included. Implant sites in the Narrow Group exhibited higher levels of BD ($P < 0.001$), PI ($P = 0.0021$), and BoP ($P = 0.017$) than implant sites in the Wide Group.

Conclusion: Implant sites with a band of <2 mm of KM were shown to be more prone to brushing discomfort, plaque accumulation, and peri-implant soft tissue inflammation when compared to implant sites with ≥2 mm of KM.

Several clinical studies have demonstrated that the use of dental implants to support prosthetic rehabilitations is a very predictable treatment option (for a complete review, see Fiorellini et al. 1998). Nonetheless, mechanical/biological complications such as peri-implant diseases, soft tissue complications, implant fracture, paresthesia, and loss of osseointegration have all been reported (Berglundh et al. 2002; Heitz-Mayfield 2008). Peri-implant diseases are divided into two different conditions: mucositis and peri-implantitis (Schou 2008; Heitz-Mayfield et al. 2014). Mucositis is defined as an inflammatory reaction of peri-implant soft tissues, while peri-implantitis, in addition to soft tissue inflammation, also exhibits progressive marginal bone loss (Lang & Berglundh 2011).

Bacterial biofilm has been reported as the most important factor in the etiology of peri-implant diseases (Heitz-Mayfield 2008; Zitzmann & Berglundh 2008; Tomasi & Derks 2012). Plaque accumulation around implant may induce an inflammatory response (Nomura et al. 2000) characterized by the presence of increasing numbers of inflammatory cells and vascular structures, epithelial barrier ulceration and apical migration, and occasional crestal bone resorption (Zitzmann et al. 2001). Such tissue alterations result in clinical signs such as bleeding on probing, suppuration, increasing pocket probing depth, and marginal bone loss (Heitz-Mayfield et al. 2014).

Different local and systemic risk factors, for example, poor oral hygiene, untreated periodontal disease, absence of keratinized mucosa (KM), diabetes, and smoking habit, have all been suggested to be associated with peri-implant diseases (Bornstein et al. 2009; Pjetursson et al. 2012). Among these factors, the most controversial one is the absence of

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SUPPLEMENT ARTICLE

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Diagnosis and non-surgical treatment of peri-implant diseases and maintenance care of patients with dental implants – Consensus report of working group 3

Stefan Renvert[1,2,3,4], Hideaki Hirooka[5,6], Ioannis Polyzois[7], Anastasia Kelekis-Cholakis[8], Hom-Lay Wang[9] and Working Group 3

[1]*Oral Health Sciences, Kristianstad University, Kristianstad, Sweden;* [2]*School of Dental Science, Trinity College, Dublin, Ireland;* [3]*Blekinge Institute of Technology, Karlskrona, Sweden;* [4]*Faculty of Dentistry, The University of Hong Kong, Hong Kong City, Hong Kong;* [5]*Division of Advanced Prosthetic Dentistry, Tohoku University Graduate School of Dentistry, Sendai, Miyagi, Japan;* [6]*Sweden Dental Center, Tokyo, Japan;* [7]*Department of Restorative Dentistry and Periodontology, Trinity College, Dublin Dental University Hospital, Dublin, Ireland;* [8]*Division of Periodontics, Dr Gerald Niznick College of Dentistry, University of Manitoba, Winnipeg, MB, Canada;* [9]*Department of Periodontics and Oral Medicine, University of Michigan School of Dentistry, Ann Arbor, MI, USA.*

Abstract: The following consensus report is based on four background reviews. The frequency of maintenance visits is based on patient risk indicators, homecare compliance and prosthetic design. Generally, a 6-month visit interval or shorter is preferred. At these visits, peri-implant probing, assessment of bleeding on probing and, if warranted, a radiographic examination is performed. Diagnosis of peri-implant mucositis requires: (i) bleeding or suppuration on gentle probing with or without increased probing depth compared with previous examinations; and (ii) no bone loss beyond crestal bone level changes resulting from initial bone remodelling. Diagnosis of peri-implantitis requires: (i) bleeding and/or suppuration on gentle probing; (ii) an increased probing depth compared with previous examinations; and (iii) bone loss beyond crestal bone level changes resulting from initial bone remodelling. If diagnosis of disease is established, the inflammation should be resolved. Non-surgical therapy is always the first choice. Access and motivation for optimal oral hygiene are key. The patient should have a course of mechanical therapy and, if a smoker, be encouraged not to smoke. Non-surgical mechanical therapy and oral hygiene reinforcement are useful in treating peri-implant mucositis. Power-driven subgingival air-polishing devices, Er: YAG lasers, metal curettes or ultrasonic curettes with or without plastic sleeves can be used to treat peri-implantitis. Such treatment usually provides clinical improvements such as reduced bleeding tendency, and in some cases a pocket-depth reduction of ≤ 1 mm. In advanced cases, however, complete resolution of the disease is unlikely.

Key words: *Peri-implant diseases, peri-implantitis, peri-implant mucositis, non-surgical therapy, maintenance, supportive care*

INTRODUCTION

Dental implants have long been used to replace missing teeth. Initially, it was believed that the possible drawbacks of dental implant treatment were minimal if the implants were fully integrated into the bone. Over the years, however, it has become clear that biological complications frequently occur. Biological complications associated with dental implants are mostly infections induced by a bacterial biofilm, resulting in an inflammatory response in the soft tissues and bone surrounding implants. The inflammatory lesions located in the soft tissues have been referred to as peri-implant mucositis. If the inflammatory response progresses further and results in a loss of the bone beyond the initial bone remodelling, it is referred to as peri-implantitis[1,2].

The prevalence of peri-implant mucositis has, in a recent systematic review, been reported in the range of 19%–65% and the prevalence of peri-implantitis in the range of 1%–47%[3]. The wide range may be dependent on the different patient populations investigated in the studies included in the review, but it may also reflect differences in diagnostic criteria. In a paper using different levels of severity, a substantial variance in disease prevalence was highlighted[4]. The differences in criteria used to characterise peri-implant

FEATURE

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The management of periodontal and peri implant disease

Dental hygienist and reader panel member **Justine Nicholls** explains periodontal and peri implant disease and its management for the dental care professional (DCP).

Introduction

Periodontal disease is the most prevalent preventable disease globally and can have serious health consequences and impact on quality of life and productivity.

In recent years dental implant placement has become more frequent in order to treat aesthetic and functional problems due to natural tooth loss.

When considering restoration of the dentition, minimally invasive dentistry favours the adjacent teeth remaining intact for functionality and aesthetics.

I have endeavoured to provide an informative and interesting, thought provoking article which is limited to the non-surgical treatment of peri implant disease, its presentation and clinical and oral hygiene protocols.

Peri implant disease

Peri implant disease is a collective term for reversible peri implant mucositis and the irreversible peri implantitis.

Peri implant mucositis involves inflammatory changes within the peri implant soft tissues without bone loss.

Peri implantitis involves inflammatory changes affecting the soft tissues surrounding the implant resulting in loss of the supporting bone surrounding the implant.

As dental care professionals (DCPs) we are used to periodontitis around natural teeth where plaque biofilm induced inflammatory changes of the gingivae are followed by the loss of clinical attachment due to breakdown of the periodontal ligament and loss of the adjacent supporting bone.

Peri implantitis follows similar clinical

Two Keys to Periodontal and Peri-Implant Treatment Success

by Susan S. Wingrove, RDH, BS

Susan Wingrove, RDH, BS, is an international speaker, author, instrument designer, and 2016 SunstarRDH Award of Distinction recipient. Wingrove is a member of the American Dental Hygienist's Association, International Federation of Dental Hygienists, Academy of Osseointegration/ Educational Committee, and mentor for O'Hehir University. She is also the author for multiple journals and textbooks including Peri-Implant Therapy for the Dental Hygienist: Clinical Guide to Maintenance & Disease Complications

Dental professionals play a key role in identifying periodontal and peri-implant infections in the oral cavity. Biofilm and calculus act as a trigger for pro-inflammatory response to induce a systemic effect that can result in infection and affect the overall health of the patient.[1]

Fortunately, new research, technology and products have emerged for biofilm and calculus removal—the keys to successful periodontal and peri-implant treatment—to answer this challenge.

Studies show a link to biofilm and oral systemic diseases.[1,2] Too often as dental professionals we view only identifying and removing calculus as our main goal for maintenance procedures. Instead, we need to think in terms of biofilm and calculus removal—two very different procedures—on every periodontal and peri-implant maintenance appointment.

Periodontal and peri-implant disease are defined as inflammatory reactions to a chronic bacterial infection that affects the tissue and bone on teeth and implants. The immune inflammatory process associated with periodontal disease leads to apical migration of the epithelial attachment and, ultimately, to loss of periodontal soft and hard tissue.

Implants have rough and porous surfaces that hold more biofilm and microbes than smooth surfaces, making removal of biofilm and calculus critical elements in peri-implantitis prevention.[2]


Fig. 1a


Fig. 1b


Fig. 1c

Efficacy of 0.12% Chlorhexidine Gluconate for Non-Surgical Treatment of Peri-Implant Mucositis

Karyna M. Menezes,* Anderson N. Fernandes-Costa,* Reinaldo D. Silva-Neto,† Patrícia S. Calderon,* and Bruno C.V. Gurgel*

Background: Because peri-implant mucositis may progress to peri-implantitis, effective treatment resulting in resolution of inflammation could prevent peri-implantitis. Current treatment protocols for this condition are still unpredictable. The purpose of this study is to analyze efficacy of non-surgical treatment for patients with peri-implant mucositis during a 6-month follow-up period.

Methods: This controlled, randomized, double-masked clinical trial included 37 patients diagnosed with peri-implant mucositis, randomly assigned into test group (basic periodontal therapy + 0.12% chlorhexidine) with 61 implants; and control group (basic periodontal therapy + placebo) with 58 implants. Therapy consisted of adaptation of the full-mouth scaling and root planing protocol. Clinical parameters of visible plaque index (VPI), gingival bleeding index (GBI), probing depth (PD), and bleeding on probing (BOP) were measured in implants and were evaluated at baseline and at 1, 3, and 6 months post-therapy. Data were analyzed using the split-plot analysis of variance and χ^2 tests with a significance level of 5%.

Results: Intragroup analysis showed that VPI, GBI, PD, and BOP presented statistically significant improvements compared with baseline. No statistically significant differences were found between the test and control groups at any time.

Conclusions: Both isolated mechanical therapy and its association with 0.12% chlorhexidine mouthwash reduced peri-implant mucositis. Therefore, 0.12% of chlorhexidine was not more effective than placebo. *J Periodontol 2016;87:1305-1313.*

KEY WORDS

Chlorhexidine; clinical trials; dental implants; dental plaque; mucositis; oral hygiene.

* Department of Dentistry, Federal University of Rio Grande do Norte, Natal, Brazil.
† Department of Restorative Dentistry, School of Dentistry of Ribeirão Preto, University of São Paulo, São Paulo, Brazil.

Long-term studies with 15 and 20 years of follow-up have shown that rehabilitation with implant-supported prostheses is considered a viable treatment option for both the maxilla and mandible with partially or totally edentulous areas.[1-3] However, success of rehabilitation may be compromised by implant failure.

Oral health can be affected by failures; these failures can occur early, when they are associated with surgical procedures,[4,5] or later on when associated with occlusal overload[6,7] or peri-implant infections caused by biofilm accumulation.[4] In these cases, pathologic conditions may develop in peri-implant tissues.[8,9] Previous studies have shown that bacterial infection plays a central role in cases of dental implant failure.[5,8] Dental implants rehabilitated by prostheses are also susceptible to biofilm colonization, which constitutes the main etiologic factor of periodontal diseases.[10-12] Peri-implant diseases that occur around dental implants consist of peri-implant mucositis and peri-implantitis.[13]

Peri-implant mucositis is characterized by inflammation in the mucosa around the implant without signs of bone loss.[4] If bone loss also occurs, the condition is designated peri-implantitis.[4] Derks and Tomasi[14] reported 43% and 22% prevalence of peri-implant mucositis and peri-implantitis, respectively. Peri-implant mucositis is a reversible

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ENFERMEDADES PERIIMPLANTARIAS III: TRATAMIENTO

Cecilia Murga, R., González Serrano, J., Paredes Rodríguez, V. M., López-Quiles Martínez, J., Hernández Vallejo, G. Enfermedades periimplantarias III: tratamiento. Cient. Dent. 2016; 13; 3: 177-181.

Cecilia Murga, Roberto
Licenciado en Odontología. Universidad Rey Juan Carlos. Especialista Universitario en Medicina Oral. Alumno del Máster en Cirugía Bucal e Implantología. Facultad de Odontología. UCM.

González Serrano, José
Licenciado en Odontología. Universidad Rey Juan Carlos. Especialista Universitario en Medicina Oral. Alumno del Máster en Cirugía Bucal e Implantología. Facultad de Odontología. UCM.

Paredes Rodríguez, Víctor Manuel
Máster en Cirugía Bucal e Implantología. Profesor Colaborador Honorífico. Departamento de Estomatología III. Facultad de Odontología. UCM.

López-Quiles Martínez, Juan
Profesor Contratado Doctor. Departamento de Estomatología III. Facultad de Odontología. UCM.

Hernández Vallejo, Gonzalo
Profesor Titular. Departamento de Estomatología III. Director del Postgrado de Especialista en Medicina Oral. Facultad de Odontología. UCM.

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CORRESPONDENCIA:
Departamento de Estomatología III
Facultad de Odontología. UCM
Plaza Ramón y Cajal s/n
28040 Madrid

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RESUMEN

La rehabilitación oral mediante implantes dentales es una opción altamente predecible con una alta tasa de éxito. Sin embargo, las enfermedades que afectan a los tejidos que rodean al implante, como la mucositis periimplantaria y la periimplantitis pueden dar lugar a la pérdida del mismo. Por esta razón es de especial importancia la organización de un programa de citas en los que se debe analizar los signos indicativos de enfermedad periimplantaria, además de realizar técnicas de prevención y eliminación de los factores de riesgo.

Existen numerosas estrategias de tratamiento frente a las enfermedades periimplantarias. La mucositis periimplantaria puede ser manejada de forma conservadora, similar al tratamiento de la gingivitis. El tratamiento de la periimplantitis puede ser conservador, mediante terapia mecánica apoyada por terapia química o laser. En casos avanzados, la terapia debe ser quirúrgica. Dependiendo de diversos factores como la configuración del defecto óseo, puede seleccionarse técnicas quirúrgicas resectivas, para la eliminación del tejido enfermo y favorecer la higiene oral o pueden realizarse técnicas de regeneración ósea.

PALABRAS CLAVE

Periimplantitis; Mucositis periimplantarias; Tratamiento de periimplantitis.

PERI-IMPLANT DISEASES III: TREATMENT

ABSTRACT

Dental implants are a predictable treatment option with high success rate in oral rehabilitation. However, those diseases affecting tissues around the implants, like periimplant mucositis or peri-implantitis, could cause their loss. Therefore, it is esential to establish scheduled check-ups, in order to analyse any signs related to preiimplant disease and to carry out risk factor elimination and prevention techniques.

There are several treatment strategies for periimplant diseases. Periimplant mucositis may be treated in a conservative way, similar to gingivitis treatment. Periimplantitis treatment can also be conservative, using a mechanic therapy based on chemical or laser therapy. In advanced cases, therapy must be surgical. Depending on several factors, such as bone defect configuration, resective surgical techniques may be used to eliminate the granulation tissue and to favour oral hygine. Bone regeneration techniques may also be used

KEY WORDS

Peri-implantitis; Peri-implant mucositis; Peri-implant therapy.

TRATAMIENTO QUIRÚRGICO COMBINADO DE CIRUGÍA RESECTIVA Y REGENERATIVA EN EL TRATAMIENTO DE PERI-IMPLANTITIS

FRANK SCHWARZ, IGNACIO SANZ SÁNCHEZ.

Frank Schwarz[1], Ignacio Sanz Sánchez[2]

1. Docente privado del departamento de cirugía oral de la universidad de Heinrich Heine, Düsseldorf, Alemania.

2. Profesor Colaborador en Práctica Externa en la UCM.

Correspondencia a:

Dr. Ignacio Sanz Sánchez
ignaciosanz@mac.com

INTRODUCCIÓN

LAS ENFERMEDADES PERIIMPLANTARIAS SON PATOLOGÍAS INFLAMATORIAS de origen infeccioso que afectan a los tejidos que rodean el implante. Tienen una alta prevalencia y, actualmente, los tratamientos disponibles han mostrado poca eficacia en la resolución de la periimplantitis. Por eso, se ha propuesto una terapia quirúrgica combinada que contempla la regeneración ósea y la cirugía resectiva con implantoplastia en función de la anatomía del defecto. El objetivo, por tanto, de este informe de un caso, es explicar el protocolo quirúrgico y lo pasos clínicos de esta terapia combinada para el tratamiento de una lesión periimplantaria avanzada.

Presentación del caso
Paciente que presenta periimplantitis en los implantes en posición de 33 y 34 y que requerían un tratamiento quirúrgico combinado debido a las características del defecto. Se realizó implantoplastia en la porción supracrestal del defecto (>1 mm) y en las dehiscencias, y la regeneración de los componentes intraóseos del defecto.

Discusión
El tratamiento de la periimplantitis requiere un abordaje quirúrgico para tratar de detener la progresión de la pérdida ósea. A la hora de evaluar los factores a tener en cuenta para la selección del tipo de tratamiento caben destacar la cantidad de pérdida ósea, la anatomía intra-quirúrgica del defecto óseo, el material de injerto y la superficie del implante. La terapia combinada ha mostrado buenos resultados clínicos, radiográficos e histológicos a corto y medio plazo.

Conclusión:
El enfoque quirúrgico combinado puede ofrecer un tratamiento predecible en términos de restauración de la salud periimplantaria.


Frank Schwarz


Ignacio Sanz Sánchez

J Clin Periodontol 2015; 42 (Suppl. 16): S187–S201 doi: 10.1111/jcpe.12321

Journal of Clinical Periodontology

Efficacy of patient-administered mechanical and/or chemical plaque control protocols in the management of peri-implant mucositis. A systematic review

Giovanni E. Salvi and Christoph A. Ramseier

Department of Periodontology, School of Dental Medicine, University of Bern, Bern, Switzerland

Salvi GE, Ramseier CA. Efficacy of patient-administered mechanical and/or chemical plaque control protocols in the management of peri-implant mucositis. A systematic review. J Clin Periodontol 2015; 42 (Suppl. 16): S187–S201. doi: 10.1111/jcpe.12321.

Abstract

Aim: To systematically assess the efficacy of patient-administered mechanical and/or chemical plaque control protocols in the management of peri-implant mucositis (PM).

Material and Methods: Randomized (RCTs) and Controlled Clinical Trials (CCTs) were identified through an electronic search of three databases complemented by manual search. Identification, screening, eligibility and inclusion of studies was performed independently by two reviewers. Studies without professional intervention or with only mechanical debridement professionally administered were included. Quality assessment was performed by means of the Cochrane Collaboration's tool for assessing risk of bias.

Results: Eleven RCTs with a follow-up from 3 to 24 months were included. Definition of PM was lacking or heterogeneously reported. Complete resolution of PM was not achieved in any study. One study reported 38% of patients with complete resolution of PM. Surrogate end-point outcomes of PM therapy were often reported. The choice of control interventions showed great variability. The efficacy of powered toothbrushes, a triclosan-containing toothpaste and adjunctive antiseptics remains to be established. High quality of methods and reporting was found in four studies.

Conclusions: Professionally- and patient-administered mechanical plaque control alone should be considered the standard of care in the management of PM. Therapy of PM is a prerequisite for the prevention of peri-implantitis.

Key words: chemical plaque control; dental implants; mechanical plaque control; peri-implant diseases; peri-implant mucositis; prevention

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Conflict of interest and source of funding statement

The authors do not report any conflict of interest related to this study. The study was self-supported by the author's institution.

While peri-implant mucositis (PM) is defined as a reversible inflammatory process in the soft tissues surrounding an osseointegrated dental implant, peri-implantitis is characterized by additional loss of supporting bone (Lang & Berglundh 2011). Outcomes from animal (Berglundh et al.1992, Ericsson et al. 1992) and human studies (Pontoriero et al. 1994, Zitzmann et al. 2001) indicated that both clinically and histologically an inflammatory reaction to experimental plaque accumulation could

J Clin Periodontol 2015; 42: 462–469 doi: 10.1111/jcpe.12395

Journal of Clinical Periodontology

Treatment of peri-implant mucositis using a glycine powder air-polishing or ultrasonic device: a randomized clinical trial

Caroline Riben-Grundstrom[1], Ola Norderyd[1,2], Ulrika André[1] and Stefan Renvert[3,4,5]

[1]Department of Periodontology/Endodontics and Oral Prosthodontics, Institute for Postgrad Dental Education, Jönköping, Sweden, [2]Faculty of Odontology, Malmö University, Malmö, Sweden, [3]Department of Oral Sciences, Kristianstad University, Kristianstad, Sweden, [4]Blekinge Institute of Technology, Karlskrona, Sweden, [5]School of Dental Sciences, Trinity College, Dublin, Ireland

Riben-Grundstrom C, Norderyd O, André U, Renvert S. Treatment of peri-implant mucositis using a glycine powder air-polishing or ultrasonic device: a randomized clinical trial. J Clin Periodontol 2015; 42: 462–469. doi: 10.1111/jcpe.12395.

Abstract

Aim: To evaluate the clinical treatment effects of a glycine powder air-polishing or ultrasonic device on peri-implant mucositis.

Materials and methods: Thirty-seven patients with one implant diagnosed with peri-implant mucositis (probing depth ≥4 mm (0.2N) and bleeding on probing (BOP) (primary outcome)) were randomly assigned to treatment with either glycine powder air-polishing (GPAP) or ultrasonic (US) debridement. Treatment was performed at baseline and at 3 and 6 months. Professional supra gingival cleaning was performed at 9 and 12 months. Oral hygiene instructions were reinforced at each visit.

Results: At 12 months there was a statistically significant reduction in mean plaque score, bleeding on probing and number of periodontal pockets ≥4 mm within the treatment groups compared to baseline. The percentages of diseased sites were significantly reduced for both groups.

Conclusions: Treatment with a glycine powder air-polishing or an ultrasonic device is effective in non-surgical treatment of peri-implant mucositis.

Key words: air-abrasive device; mechanical therapy; non-surgical treatment; peri-implant mucositis

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Dental implants are often used to replace lost teeth and present a high level of predictability, patient satisfaction and long-term success (Schnitman et al. 1997, Romeo et al. 2004, Pjetursson et al. 2005, 2012, Jung et al. 2012). Biological complications such as peri-implant mucositis and peri-implantitis have, however, become major challenges to the profession (Mombelli et al. 2012).

Conflict of interest and source of funding statement

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The definition of peri-implant mucositis is an inflammation of the soft tissues adjacent to a dental implant diagnosed with bleeding on gentle probing (<0.25N) (Jepsen et al. 2015). If the clinical signs are combined with bone loss the condition is referred to as peri-implantitis (Lindhe & Meyle 2008, Lang et al. 2011).

When exposed in the oral cavity, the implant surface is rapidly colonized by microorganisms (Quirynen et al. 2006, Fürst et al. 2007, Salvi et al. 2007) .

The formation of a complex biofilm on the implant surface, which does not differ from that on tooth surfaces, triggers the host response and initiates an inflammatory reaction that may result in peri-implant tissue destruction. Risk including factors, for example an infected recipient site, inaccessibility to oral hygiene measures, smoking and susceptibility to periodontitis (Renvert & Polyzois 2014), (Quirynen & Vogels 2002) as well as remnants of cement (Linkevicius et al. 2012) have

Alex Daly
Giles McCracken

Peri-Implant Disease Part 2: Management of Peri-Implant Disease

Abstract: Unfortunately, peri-implant disease is a common clinical finding in patients with dental implants. Whilst preventive and supportive regimens are best practice, many patients still present with signs of peri-implant disease. Treatment options include non-surgical or surgical approaches but there does not appear to be a consensus for management of these challenging conditions. This paper discusses the current management options of peri-implant mucositis and peri-implantitis.
CPD/Clinical Relevance: This paper discusses the management of peri-implant diseases placing emphasis on regular supportive care and follow up.
Dent Update 2019; 46: 986–992

Peri-implant diseases are recognized as being polymicrobial, biofilm-associated inflammatory lesions.[1] Peri-implant mucositis is inflammation of peri-implant tissues without associated bone loss, whereas in peri-implantitis there is also loss of supporting clinical attachment and bone. The prevalence of peri-implantitis is reported to affect 10% of implants and 20% of patients over a minimum of 5 years,[2] but might range from 6.6%–36.6% of implants and 11.2%–47.1% of patients.[3] The prevalence of peri-implant mucositis is higher than that of peri-implantitis, occurring in about 50% of implants and just under 80% of patients.[4] Despite this, there does not appear to be any consensus in the treatment approaches for peri-implant diseases.[5] This article discusses management options for peri-implant diseases.

Alex Daly, BDS, FHEA, MClinDent, Specialty Registrar in Restorative Dentistry and **Giles McCracken**, BDS, PhD, FDS(Rest Dent) RCPS, FHEA, Professor of Restorative Dentistry, School of Dental Sciences Newcastle University, Newcastle, UK.

Supportive therapy

Following placement and restoration of any implant-supported prosthesis, patients should be enrolled on a supportive maintenance programme of regular reviews. The aim of this programme is to prevent and allow early detection and management of inflammatory lesions occurring in the peri-implant tissues.[5,6]

Peri-implant mucositis has been a common finding in patients not adhering to regular supportive care[6–8] in comparison to those attending,[9] and regular supportive care appears to be essential in identifying destructive peri-implant disease at an early stage, when treatment is potentially easier and outcomes more predictable.[10] Over 5 years, the incidence of peri-implantitis has been shown to be lower in subjects who are enrolled on a regular maintenance programme (18%) compared to those patients without regular maintenance care (43.9%).[3,7,11]

Signs and symptoms of peri-implant inflammation/disease should be recorded as well as plaque scores, pocket depths, bleeding indices, mobility, presence or absence of suppuration and assessment of crestal bone levels through radiographs, when appropriate. Risk assessment of factors, including poor plaque control, history or activity of periodontal or previous peri-implant disease, uncontrolled diabetes, and smoking status should be recorded and recommendations given. This patient contact, furthermore, provides the opportunity for professional prophylaxis through the removal of plaque and calculus by supra and submucosal instrumentation.

There continues to be no consensus on the frequency of recall visits for patients who have implants; typically patients will be placed on recall intervals of 3, 6 or 12 months subject to their perceived risk of developing peri-implant disease by their dentist. It has also been suggested that the more complex the implant prosthesis, the greater the risk from systemic, personal or genetic factors, and therefore the more frequent the recall rate should be.[9,12]

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Primary prevention of peri-implantitis: Managing peri-implant mucositis

Søren Jepsen[1], Tord Berglundh[2], Robert Genco[3], Anne Merete Aass[4], Korkud Demirel[5], Jan Derks[2], Elena Figuero[6], Jean Louis Giovannoli[7], Moshe Goldstein[8], France Lambert[9], Alberto Ortiz-Vigon[6], Ioannis Polyzois[10], Giovanni E. Salvi[11], Frank Schwarz[12], Giovanni Serino[13], Cristiano Tomasi[2] and Nicola U. Zitzmann[14]

[1]University of Bonn, Bonn, Germany; [2]University of Gothenburg, Gothenburg, Sweden; [3]University at Buffalo, Buffalo, NY, USA; [4]University of Oslo, Oslo, Norway; [5]Istanbul University, Istanbul, Turkey; [6]University of Complutense, Madrid, Spain; [7]Private Practice, Paris, France; [8]Hadassah-Hebrew University Medical Center, Jerusalem, Israel; [9]University of Liege, Liege, Belgium; [10]Trinity College Dublin, Dublin, Ireland; [11]University of Bern, Bern, Switzerland; [12]Heinrich Heine University, Düsseldorf, Germany; [13]Public Dental Service Borås, Borås, Sweden; [14]University of Basel, Basel, Switzerland

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Abstract

Aims: Over the past decades, the placement of dental implants has become a routine procedure in the oral rehabilitation of fully and partially edentulous patients. However, the number of patients/implants affected by peri-implant diseases is increasing. As there are – in contrast to periodontitis – at present no established and predictable concepts for the treatment of peri-implantitis, primary prevention is of key importance. The management of peri-implant mucositis is considered as a preventive measure for the onset of peri-implantitis. Therefore, the remit of this working group was to assess the prevalence of peri-implant diseases, as well as risks for peri-implant mucositis and to evaluate measures for the management of peri-implant mucositis.

Methods: Discussions were informed by four systematic reviews on the current epidemiology of peri-implant diseases, on potential risks contributing to the development of peri-implant mucositis, and on the effect of patient and of professionally administered measures to manage peri-implant mucositis. This consensus report is based on the outcomes of these systematic reviews and on the expert opinion of the participants.

Results: Key findings included: (i) meta-analysis estimated a weighted mean prevalence for peri-implant mucositis of 43% (CI: 32–54%) and for peri-implantitis of 22% (CI: 14–30%); (ii) bleeding on probing is considered as key clinical measure to distinguish between peri-implant health and disease; (iii) lack of regular supportive therapy in patients with peri-implant mucositis was associated with increased risk for onset of peri-implantitis; (iv) whereas plaque accumulation has been established as aetiological factor, smoking was identified as modifiable patient-related and excess cement as local risk indicator for the development of peri-implant mucositis; (v) patient-administered mechanical plaque control (with manual or powered toothbrushes) has been shown to be an effective preventive measure; (vi) professional intervention comprising oral hygiene instructions and mechanical debridement revealed a reduction in clinical signs of inflammation; (vii) adjunctive measures (antiseptics, local and systemic antibiotics, air-abrasive

Key words: chemical plaque control; mechanical plaque control; meta-analysis; peri-implant mucositis; peri-implantitis; primary prevention; secondary prevention; systematic review

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Peri-implantitis Update: Risk Indicators, Diagnosis, and Treatment

Dinesh Rokaya[1,2] Viritpon Srimaneepong[3] Wichaya Wisitrasameewon[4] Manoj Humagain[5] Pasutha Thunyakitpisal[2,6]

[1]International College of Dentistry, Walailak University, Bangkok, Thailand
[2]Research Unit of Herbal Medicine, Biomaterials and Materials for Dental Treatment, Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand
[3]Department of Prosthodontics, Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand
[4]Department of Periodontology, Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand
[5]Department of Periodontics, Kathmandu University School of Medical Sciences, Dhulikhel, Kavre, Nepal
[6]Department of Anatomy, Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand

Address for correspondence Viritpon Srimaneepong, DDS, MDSc, PhD, Department of Prosthodontics, Faculty of Dentistry, Chulalongkorn University, Bangkok 10330, Thailand (e-mail: viritpon.s@chula.ac.th).

Eur J Dent

Abstract

Despite the success rates of dental implants, peri-implantitis presents as the most common complication in implant dentistry. This review discusses various factors associated with peri-implantitis and various available treatments, highlighting their advantages and disadvantages. Relevant articles on peri-implantitis published in English were reviewed from August 2010 to April 2020 in MEDLINE/PubMed, Scopus, and ScienceDirect. The identified risk indicators of peri-implant diseases are plaque, smoking, history of periodontitis, surface roughness, residual cement, emergence angle >30 degrees, radiation therapy, keratinized tissue width, and function time of the implant, sex, and diabetes. Peri-implantitis treatments can be divided into non-surgical (mechanical, antiseptic, and antibiotics), surface decontamination (chemical and laser), and surgical (air powder abrasive, resective, and regenerative). However, mechanical debridement alone may fail to eliminate the causative bacteria, and this treatment should be combined with other treatments (antiseptics and surgical treatment). Surface decontamination using chemical agents may be used as an adjuvant treatment; however, the definitive clinical benefit is yet not proven. Laser treatment may result in a short-term decrease in periodontal pocket depth, while air powder abrasive is effective in cleaning a previously contaminated implant surface. Surgical elimination of a pocket, bone recontouring and plaque control are also effective for treating peri-implantitis. The current evidence indicates that regenerative approaches to treat peri-implant defects are unpredictable.

Keywords
- dental implants
- peri-implantitis
- implant complications
- decontamination
- anti-infective agents
- periodontal debridement
- bone regeneration

Introduction

The dental implant has revolutionized oral rehabilitation and become a part of routine treatment in prosthetic rehabilitation.[1] There has been marked advancement in implant design, materials used, and surgical protocols. A high implant survival rate (94.6%) has been reported over a 13.4-year follow-up.[2] Approximately 90% of patients who received an implant were satisfied with their chewing ability and

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PERIIMPLANTITIS: ¿CONFLICTO ACADÉMICO O PROBLEMA CLÍNICO? BASES Y PAUTAS EN EL TRATAMIENTO QUIRÚRGICO DE LA PERIIMPLANTITIS

Dr. Björn Klinge; Dr. Frank Schwarz

Resumen elaborado por:

Leticia Caneiro
Lourdes Novoa
Alexandre Pico

Universidad de Santiago
Máster en Periodoncia

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Increased Levels of Dissolved Titanium are Associated With Peri-Implantitis – A Case-Control Study

Luciana M. Safioti, DDS, MS*, Georgios A. Kotsakis, DDS, MS*, Alex E. Pozhitkov, PhD†, Whasun O. Chung, PhD†, Diane M. Daubert, MS*

*Department of Periodontics, University of Washington, Seattle, WA.

†Department of Oral Health Sciences, University of Washington, Seattle, WA.

Background. Peri-implantitis represents a disruption of the biocompatible interface between the titanium (Ti) dioxide layer of the implant surface and the peri-implant tissues. Increasing preclinical data suggest that the peri-implantitis microbiota not only triggers an inflammatory immune response but also causes electrochemical alterations of the Ti surfaces, i.e. corrosion, that aggravate this inflammatory response. Thus, we hypothesized that there is an association between the dissolution of titanium from dental implants, which suggests corrosion, and peri-implantitis in humans. The objective of this study was to compare the levels of dissoluted titanium in submucosal plaque collected from healthy implants and implants with peri-implantitis.

Methods. Submucosal plaque from N=20 implants with peri-implantitis and N=20 healthy implants was collected with sterile curettes (N=30 participants). Levels of titanium were quantified using inductively coupled plasma mass spectrometry (ICP-MS) and normalized for mass of bacterial DNA per sample to exclude confounding by varying amounts of plaque per site. Statistical analysis was performed utilizing Generalized Estimated Equations (GEE) to adjust for clustering of implants per subject.

Results. Implants with peri-implantitis harbored significantly higher mean levels of titanium (0.85 ± 2.47) versus healthy implants (0.07 ± 0.19) after adjusting for amount of plaque collected per site (p-value=0.033).

Conclusions. Greater levels of dissoluted titanium were detected in submucosal plaque around implants with peri-implantitis when compared to healthy implants, indicating an association between Ti dissolution and peri-implantitis. Factors triggering titanium dissolution as well as the role of titanium corrosion in the peri-implant inflammatory process warrant further investigation.

KEY WORDS:

biofilms, corrosion, dental implants, peri-implantitis, titanium.

Titanium dental implants are widely utilized to replace missing teeth owing to their ability to form a direct structural and functional connection with host bone.[1,2] Branemark coined the term "Osseointegration" in 1977 to describe this biologic phenomenon and paved the way for contemporary implant practice.[3] Titanium, a metal with excellent biocompatibility, is the most frequently utilized biomaterial for the construction of dental implants primarily because of the formation of a titanium dioxide (TiO_2) layer that yields high resistance to corrosion.[4,5] Nonetheless, despite the high resistance to corrosion and biocompatibility properties attributable to titanium, corrosion of dental implants can still happen under certain circumstances in the oral environment.

Corrosion processes lead to physicochemical alterations on the implant surface that include disruption of the TiO_2 layer and facilitate titanium dissolution.[6] A multitude of factors may lead to corrosion. Corrosion-triggering factors include local acidification due to inflammation of the peri-implant tissues which may modify the corrosion resistance of titanium, [7] or promotion of an acidic environment by bacteria such as *Streptococcus mutans*, due to the release of lactic acid, which promotes a decreased corrosion resistance of titanium in vitro.[8] Interestingly, *S. mutans* has been found in higher levels around implants with peri-implantitis when compared to healthy

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Clinical approaches to treat peri-implant mucositis and peri-implantitis

STEFAN RENVERT & IOANNIS N. POLYZOIS

In 1994, Albrektsson & Isidor (1) defined peri-implant mucositis as 'a reversible inflammatory change of the peri-implant soft tissue without bone loss (Fig. 1a,b). They further described peri-implantitis as 'an inflammatory process resulting in loss of supporting bone' (Fig. 2) (1). A few years later, at the 6th European Workshop on Periodontology (in 2008), the new term 'peri-implant disease' was introduced as a 'collective term for inflammatory reactions in the tissues surrounding the implants' (78). The description of inflammation around implants is congruent with inflammation around natural teeth and this may explain why all therapies proposed for the management of peri-implant disease are primarily based on the treatments available for targeting periodontitis.

Just as the subgingival microflora associated with periodontitis becomes established around the exposed surface of natural teeth, dental implants become contaminated soon after installation into the oral cavity. The development of this adherent biofilm on the implant surface seems to play a significant role in the initiation and progression of peri-implant diseases. This process mimics the establishment of subgingival microflora around the exposed surface of natural teeth, a process that has been associated with periodontitis (36, 74). Furthermore, the peri-implant diseases have been associated with predominantly gram-negative anaerobic bacteria, similar to those found around natural teeth in patients with advanced periodontitis (27, 31, 34). As a result, elimination of the established biofilm from the implant surface is the main objective in the treatment of peri-implant mucositis and peri-implantitis.

Implant surface debridement is still a common way of treating peri-implant diseases. However, implant design, implant surface characteristics and the design of the superstructure may hamper mechanical nonsurgical therapy, resulting in an ineffective treatment (Fig. 3). Adjunctive therapies for additional surface decontamination include the use of antibiotics, antiseptics, lasers and air-abrasive devices (40). In some cases, following successful decontamination, the bone that was lost as a result of infection may be regenerated using surgical approaches. The ultimate goal is re-osseointegration of the exposed implant surface. For this purpose a number of resective and regenerative surgical techniques have been introduced. In a recent review of the literature it was concluded, based on animal studies, that re-osseointegration is possible at a previously infected implant surface (41).

Clinical approach to treatment of peri-implant mucositis

It is generally believed that peri-implant mucositis is the precursor of peri-implantitis, in the same way that gingivitis is the precursor of periodontitis. In the consensus report of the 7th European Workshop on Periodontology it was concluded that the 'epithelial sealing' around implants is similar to that of teeth and that evidence leading us to believe that the existing structural differences can significantly affect the host response to the bacterial challenge were lacking (26, 34, 76, 77). Furthermore, we currently have enough evidence to suggest that peri-implant mucositis, like gingivitis, is reversible when effectively treated with the indicated therapeutic regimens (26, 34).

When signs of inflammation are identified around the implant head, mechanical therapy (with or without adjunctive use of antiseptic rinses) is usually the initial treatment of choice. However, in two studies, professional irrigation of the sulci with chlorhexidine,

Ligature-Induced Peri-implant Bone Loss Around Loaded Zirconia and Titanium implants

Stefan Roehling, DDS[1,2,3]/Michael Gahlert, DDS, PhD[2,4]/Simone Janner, DDS[1,5]/ Bo Meng, DDS[1]/Henriette Woelfler, PhD[6]/David L. Cochran, BA, MS, DDS, PhD, MMS[1]

[1)] Department of Periodontics, University of Texas Health Science Center at San Antonio, TX, USA
[2)] Clinic for Oral and Cranio-Maxillofacial Surgery, Hightech Research Center, University Hospital Basel, University of Basel, Basel, Switzerland
[3)] Clinic for Oral and Cranio-Maxillofacial Surgery, Kantonsspital Aarau, Aarau, Switzerland
[4)] Private Dental Clinic PD Dr. Gahlert, Munich, Germany
[5)] Department of Oral Surgery and Stomatology, School of Dental Medicine, University of Bern, Switzerland
[6)] Professor for Demography, University of Bamberg, Bamberg, Germany

Authors:
Dr. Stefan Roehling, DDS, Research Fellow, Department of Periodontics, University of Texas Health Science Center at San Antonio, 7703 Floyd Curl Drive, San Antonio, TX 78229-3900, USA and Associate Professor, Clinic for Oral and Cranio-Maxillofacial Surgery, Hightech Research Center, University Hospital Basel, University of Basel, Spitalstr. 21, 4031 Basel, Switzerland and Clinic for Oral and Cranio-Maxillofacial Surgery, Kantonsspital Aarau, Tellstr. 5001 Aarau, Switzerland

PD Dr. Michael Gahlert, DDS, PhD, Private Dental Clinic, Theatinerstr. 1, D-80333 Munich, Germany and Senior Surgeon, Staff Scientist Clinic for Oral and Cranio-Maxillofacial Surgery, Hightech Research Center, University Hospital Basel, University of Basel, Spitalstr. 21, 4031 Basel, Switzerland

Dr. Simone Janner, DDS, Research Fellow, Department of Periodontics, University of Texas Health Science Center at San Antonio, 7703 Floyd Curl Drive, San Antonio, TX 78229-3900, USA and Associate Professor, Department of Oral Surgery and Stomatology, School of Dental Medicine, University of Bern, Freiburgstr. 7, 3008 Bern, Switzerland

Dr. Bo Meng, DDS, Research Fellow, Department of Periodontics, University of Texas Health Science Center at San Antonio, 7703 Floyd Curl Drive, San Antonio, TX 78229-3900, USA

Prof. Dr. Henriette Woelfler, PhD, Professor for Demography, University of Bamberg, Feldkirchenstraße 21, 96045 Bamberg, Germany