MEDDOCS Open Access Publisher

ISSN: 2639-9210

Annals of Dentistry and Oral Health

Open Access | Research Article

Can Preoperative Soft Tissue Evaluation Predict Postoperative Peri-Implant Health and Aesthetics?

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Received: Feb 23, 2021

Accepted: Mar 11, 2021

Published Online: Mar 13, 2021

Journal: Annals of Dentistry and Oral Health

Publisher: MedDocs Publishers LLC

Online edition: http://meddocsonline.org/

Keywords: Keratinized; Gingival biotype; Soft tissue; Dental implant.

Abstract

Purpose: To review existing classifications concerning soft tissue considerations around dental implants prior to dental implants insertion that may predict postoperative soft tissue outcomes.

Materials and Methods: We reviewed all studies concerning soft tissue considerations/classification around dental implants, prior to dental implants insertion, that may predict postoperative soft tissue outcomes.

Results: Two peri-implant classifications were found suitable. The Seibert classification, based on bone level and focusing on edentulous ridges, is appropriate to posterior regions, not site specific, and based on subjective clinical evaluation. The Palacci and Ericsson classification refers to the specific implant site based on adjacent papilla and is considered accurate. Nevertheless, it poses disadvantages, including the absent of reference to bone level and need for bone graft instead of, or in addition to soft tissue augmentation. Thin gingival biotype must be treated with cautious regarding desired quality and quantity of soft tissue around planned implants.

Conclusions: Peri-implant classifications referring to the pre-operative phase can help surgeons predict post-operative clinical outcomes. We present a novel classification system, Clinical Soft tissue Implant Related (CSIR), based on three main parameters: soft tissue level, mucosal keratinization band, and gingival biotype.

Introduction

Implant supported fixed prosthodontics is becoming the chosen treatment alternative in modern dentistry. Peri-implant mucosa, the soft tissue surrounding the dental implant, forms a barrier between peri-implant bone and the oral cavity [1-3]. Sufficient quantity and quality of peri-implant mucosa promotes healthy environment and stable osseointegration process, leading to long-term implant survival and aesthetics [3]. Variable soft tissue augmentation procedures may aid in formation, and especially long-term maintenance, of adequate soft tissue around dental implants [4].

Cite this article: Hamzani Y, Chaushu G, Yahya BH. Can Preoperative Soft Tissue Evaluation Predict Postoperative Peri-Implant Health and Aesthetics?. Ann Dent Oral Health. 2021; 4(1): 1031.

Most surgical procedures take place at one or more times: (a) before dental implants insertion, (b) simultaneously with dental implants insertion, or (c) at the second stage of surgery. The surgeon should identify soft tissue characteristics at the preoperative (before dental implant insertion) clinical evaluation, regardless of the scheduled time of soft tissue procedures. Practitioners attempt to predict soft tissue characteristics surrounding future implants sites, based on preoperative parameters. Preoperative classifications for predicting postoperative lining condition of soft tissue may be of great assistance.

This study aims to review existing classifications concerning soft tissue considerations around dental implants prior to dental implants insertion that may predict postoperative soft tissue outcomes.

Gingival characteristics and their clinical significance

Gingival biotype

Similar to natural tooth, the soft tissue surrounding implants must provide a seal around the neck of the implant and abutment [1]. However, attachments around dental implants have biological and histological differences; peri-implant tissues do not consist of cementum and periodontal ligament, the peri-implant epithelium is often longer, and the fibers orientation in the connective tissue is different. Regarding blood supply, peri-implant tissues are less vascularised in the zone between the bone crest and the junctional epithelium [5]. Thus, a precise assessment of peri-implant soft tissue characteristics is required.

Gingival biotype, first introduced by Seibert and Lindhe, may be defined as thin and scalloped (Biotype I) or thick and flat (Biotype II) [2,6-8]. Periodontal bio-typing is influenced by gingival thickness, gingiva morphology, interdental papilla, and underlying osseous architecture.

Gingival thickness

A gingival thickness of ≥2 mm is defined as thick biotype, and a gingival thickness of <1.5 mm as thin biotype [9]. The literature describes several methods for measuring tissue thickness: Direct probe measurement, probe transparency method, oral photography, ultrasonic devices, Cone-Beam Computed Tomography (CBCT) scan, Moire method, laser-aided design, computer-aided design, and computer-aided manufacturing [4,10-13].

Morphology

Palacci and Nowzari stated that tooth morphology relates to periodontal biotype, and this is most apparent in the anterior aesthetic zone [7]. Accordingly, a surgeon can characterise the future peri-implant soft tissue adaptation before extracting the tooth.

Biotype I pertain to triangular-shaped teeth. The interproximal contact area, centered in the coronal one-third of the crown, is associated with a long, thin papilla. The underlying bone is usually thin and scalloped, similar to the gingiva [14]. An implant placed in a site with thin periodontal biotype is more technique-sensitive, with a higher probability of gingival recession or black triangle formation [14,15]. In contrast, thick and flat periodontium (Biotype II) pertain to square-shaped teeth [14]. The interproximal contact area, located in the middle one-third of the crown, is associated with a short, wide papilla. Underneath is an unusually thick and flat alveolar bone that may provide a more comfortable environment for dental implant procedures [14].

Clinical significance (marginal bone loss, gingival recession)

Abraham et al. found that thin gingival tissue is associated with a narrow band of keratinised tissue and scalloped gingival contour, suggestive of thin bony architecture and higher sensitive to inflammation and trauma. They suggest that in cases where the lamina bone is limited or absent, the cortical bone is at risk of rapid resorption [6]. Moreover, in Biotype I patients, gingival recession occurs more frequently following implant restoration [16]. In contrast, Tarnow found that thick gingival tissues are easier to manipulate, maintain their vascularity, and promote wound healing during and after surgery [17]. An effective healing process enhances the revascularization of bone and soft tissue grafts, leading to graft incorporation, and thus clarifies the predictable results of immediate implant placement in thick gingival biotypes [6].

A recent meta-analysis examined the influence of thin and thick soft tissue on early Marginal Bone Loss (MBL) of dental implants. The study found a difference of -0.8 mm (P <0.0001) in MBL, favoring the thicker peri-implant soft tissue group [18]. The results confirmed previous observations, demonstrating that in the presence of thin tissue (<2 mm), higher values of MBL will occur [18-21].

Gingival keratinisation

The type of mucosa facing the implant surface is determined by the bucco-lingual extension of the masticatory mucosa, in the area of the alveolar process. This relates to the position of the mucogingival line, and degree of resorption of the alveolar process [22]. As reported by Mericske-Stern et al., crestal bone resorption, which leads to reduced height of the alveolar process, results in loss of keratinised mucosa [23].

The clinical significance of Keratinised Mucosa (KM) for the maintenance of peri-implant health and soft-tissue integration is a debated issue [5,24]. Most researchers agree that KM may have advantages regarding patient comfort, plaque score, and bleeding on probing [5,22,25]. The debated issues are the influence of KM on mucosal recession and periodontal attachment loss.

Chiu et al.'s review on the significance of KM in peri-implant health found that a keratinised mucosal band is not crucial for the maintenance of peri-implant tissue. They concluded there are conflicting results regarding the different clinical parameters, and recommended individual consideration of treatment strategies for patients with minimal keratinised mucosa [24]. Berglundh et al. also claimed that data on the effect of KM over long-term health of the peri-implant tissue is equivocal [5].

Wennström and Derks, in 8/10 human studies, found no differences in probing depths for "Inadequate" (<2 mm) and "Adequate" (≥2 mm) width of keratinised mucosa [22]. Regarding recessions, two-thirds of longitudinal studies found no long-term differences with regard to the amount of keratinised mucosa [22].

In contrast, Kim et al. conducted an average of 13 months' follow-up for 276 implants placed in 100 patients. Mucosal recession and MBL were found to be statistically significant higher in the group with deficient KM [26].

Adibrad et al. studied 27 edentulous patients, with 66 restored and functioning dental implants supporting overdentures [25]. Mean gingival index score, plaque index score, and bleeding on probing were significantly higher for the implants

surrounded by narrow (<2 mm) keratinised zone. In addition, wider (≥2 mm) mucosal band was associated with less mucosal recession and periodontal attachment loss, compared with narrower mucosal band [25].

Wennström and Derks reported that in 5/12 human studies, an inadequate (<2 mm) width was associated with a significant higher plaque score [22]. Moreover, half of the studies showed significantly higher bleeding scores for implants surrounded by <2 mm of keratinised mucosa [22].

A 1965-2012 systematic review and meta-analysis on the effect of KM on various peri-implant health-related parameters, found lack of adequate KM around dental implants was associated with more plaque accumulation, tissue inflammation, recessions, and attachment loss [27].

A 2017 quality assessment of the above four systematic reviews on the significance of KM on implant health, reported a positive association between adequate KM width (≥2 mm) and peri-implant health [28].

Peri-implant health definition

Peri-implant health is characterised by the absence of erythema, Bleeding On Probing (BOP), gingival swelling, and suppuration. Peri-implant health can exist around implants with reduced bone support [5]. Accordingly, one can assume that soft tissue characteristics surrounding dental implants are key factors in determining peri-implant health.

Peri-implant mucositis has been defined as reversible inflammatory reaction of peri-implant soft tissues, with no radiographic evidence of bone loss [3]. Strong evidence from animal and human experimental studies suggest plaque is the etiological factor for peri-implant mucositis [7]. The clinical essential parameters for diagnosis are probing depth and BOP with gentle probing (<0.25 N) [5,29].

A more significant plaque-associated pathological condition occurring around peri-implant tissues is peri-implantitis [5]. Peri-implantitis has been identified as a progressive and irreversible infectious pathological condition associated with changes in the radiographic level of crestal bone, presence of BOP, and suppuration with or without concomitant deepening of the peri-implant pockets [5,29,30].

Peri-implant aesthetic definition

Recent studies assessing the aesthetic success of surgical and prosthodontics outcome use the White Esthetic Score (WES) and Pink Esthetic Score (PES) [31]. The WES focuses on the part of the implant crown that emerges from the peri-implant mucosa, based on general tooth form, clinical crown outline and volume, color, surface texture, translucency, and characterization [31].

The PES, developed by Fürhauser et al., [32] focuses on the soft tissue features associated with restoration of an anterior implant by evaluating seven distinct soft tissue parameters. These include presence or absence of mesial and distal papillae; level and curvature of the line of emergence of the implant restoration from the mucosa at the facial aspect; facial soft tissue convexity; and color and texture of the facial marginal peri-implant mucosa. The investigators assigned grades as follows for each parameter: absence/markedly different (Grade 0), incomplete presence/slightly different (grade 1), and complete presence/identical (grade 2); resulting in a maximum possible score of 14 [31].

Classifications

Peri-implant soft tissue classifications published in the literature aimed to predict clinical success of implants supported fixed prosthodontics based on clinical evaluation, [1] beginning with Seibert who suggested ridge defect classification depending on the amount and location of volume loss [8]. This classification gained support and is among the most cited, probably because of its ease of use. The main disadvantage is inaccuracy of ridge quantity measurements. Subsequently, Palacci and Ericsson [14] referred to the adjacent papilla on specific implant sites, based on the loss of hard and soft tissues. This system classifies peri-implant soft tissues into four classes in each of two categories, horizontal and vertical (Table 1). The Palacci and Ericsson classification enables the surgeon to evaluate future implant sites and compare them to adjacent papilla. Moreover, it is relevant for implant specific site and edentulous ridge [14].

Table 1: Published classification systems.

Classification Systems	Classes			
Seibert [8] (1983)	**I**	**II**	**III**	
	Buccolingual loss of tissue with normal ridge height in an apico-coronal dimension	Apico-coronal loss of tissue with normal ridge width in a buccolingual dimension	Combination buccolingual & apico-coronal loss of tissue, resulting in loss of normal height and width	
Palacci & Ericsson [14] Vertical (2001)	**I**	**II**	**III**	**IV**
	Intact or slightly reduced papillae	Limited loss of papillae (< 50%)	Severe loss of papillae	Absence of papillae (edentulous ridge)
Palacci & Ericsson [14] Horizontal (2001)	**A**	**B**	**C**	**D**
	Intact or slightly reduced buccal tissues	Limited loss of buccal tissues	Severe loss of buccal tissues	Extreme loss of buccal tissue

Table 2: Clinical Soft tissue Implant Related (CSIR) Classification System

CSIR Classification System				
	K>2 mm	K>2 mm	K<2 mm	K<2 mm
	Biotype 1	Biotype 2	Biotype 1	Biotype 2
P1/A	No intervention	Soft tissue graft		
P2/B	Soft tissue graft	Bone graft /Soft tissue graft		
P3/C, P4/D	Bone graft	Bone graft + Soft tissue graft/ Multiple soft tissue grafts		

K: Keratinised Band Width; P: Palacci & Ericsson Class: Biotype 1: Thick And Flat; Biotype 2: Thin And Scalloped.

Discussion

In general, the final position of the soft and hard tissues following periodontal surgical procedures is difficult to predict, as each time a flap is reflected, there is at least 0.5-0.8 mm of bone loss [33,34]. Moreover, there might be gingival recessions following flap reflection [6]. Accordingly, especially with thin gingival biotype, surgeons must be over cautious regarding desired quality and quantity of soft tissue around future implants.

Two peri-implant classifications were presented for the preoperative phase, which we assume is the most critical for soft tissue evaluation. The Seibert [8] classification is cited and popular, based on bone level and focusing on edentulous ridges. Seibert classification is appropriate to posterior regions, not site specific, and based on subjective clinical evaluation. Palacci and Ericsson [14] referred to specific implant site and based their classification on adjacent papilla. Their classification is semi-quantitative in the vertical dimension, less subjective, and site specific. It is also suitable for the anterior aesthetic zone. Nevertheless, it does not consider bone level, which has a direct influence on soft tissue level, and is a major criterion the surgeon must assess when conducting soft tissue augmentation procedures.

The dental surgeon should consider several clinical issues or leading questions when determining treatment plans for patients seeking implant supported fixed prosthodontics, such as which jaw and location, and if this is an aesthetic zone? Afterwards, they must evaluate bone level and determine if bone augmentation is needed, then evaluate quantity and quality of future peri-implant soft tissue desired. Finally, they should decide when to conduct each procedure, and the type of soft and/or hard tissue augmentations required.

We could not find a decision tree or classification regarding hard and soft tissue concerns around dental implants. A novel classification based on three main parameters: Soft tissue level, mucosal keratinization band, and gingival biotype is introduced to assist in the decision-making process (Table 2). The suggested CSIR classification system is based on Palacci and Ericsson's [14] classes, and also considers keratinised band width and gingival biotype, which may influence health and aesthetics of soft tissue around dental implants.

Table 2 describes severe or extreme loss of buccal tissues in the horizontal (PC and PD), and P3 and P4 severe loss or absence of papillae in the vertical dimension. Underlying bone is the main reason for severe loss of soft tissue, hence soft tissue augmentation alone will not restore the existing tissue; bone graft is mandatory.

According to Palacci and Nowzari [7], when a total of 4-5 mm gain in soft tissue needed (P3 and P4 in Table 2), it might be obtained through a series of surgical steps by combining bone and soft tissue augmentations or multiple soft tissue augmentations [26]. Regarding P2, 2-3 mm defect that might be filled by bone augmentation procedure, which can provide a height gain of 2–3 mm, or by using soft tissue augmentation to provide 2 mm in soft tissue height [7].

Further research is recommended in order to determine best bone and soft tissue specific procedures for each CSIR class.

Conclusion

Best clinical outcome is achieved by good prediction and pre-treatment planning. The need for a soft tissue classification system prior to implant insertion is critical, to help practitioners achieve best clinical outcome. CSIR classification is a clinically oriented classification that can help in procedure decision making. Further clinical research is needed to test this novel classification system.

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