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Implant Mucointegration, A Key to Enhance Osteointegration

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Abstract

After osseointegration, mucointegration becomes over the years the new paradigm in implantology. The mucosal biological seal is the only and most important protection barrier between the osteointegrated implant and the oral environment. For optimal mucointegration to take place, several conditions are required, including the presence of a vertical thickness of soft tissue greater than 2 mm. This value is all the more important today, especially with the rise in use of short implants. A thick phenotype is a trait to research or to recreate. If the vertical thickness soft tissue is insufficient, the optimal conditions for establishing biological space, several options will be presented to the practitioner: thickening of the mucosa, reduction of the bone ("reduce the bone to save the bone") or the choice of placing a "tissue
level "a little deeper knowing fully well that bone resorption will follow. The diagnosis of the fine phenotype must be made before surgery, as CBCT can then be an invaluable ally to adapt our implant therapy. Accordingly, mucointegration depends on other factors such as: implant materials and design, implant surface condition, type of implant / abutment connection, and occlusion, all of which have a lesser impact than the gingival phenotype.
The objective of this article is to focus on the particularities of the peri-implant attachment system and to show its place in the maintenance of osseointegration.

Keywords: Mucointegration;, biological width; soft tissue attachment

The biological space around implants or implant mucointegration is histological, clinical and radiological evidence

Dental implants are indicated to replace lost or missing teeth to provide for successful oral rehabilitation. However, the treatment has, in some cases, resulted in complications, and suboptimal peri-implant soft tissue health and/or bone loss. Such complications often start with inflammation of the soft tissue surrounding the abutment. (1)

It has been proposed that the risk for inflammation could be reduced by placing abutments in firm tissue with minimal mobility, and it is clinical practice to place abutments embedded in keratinized mucosa whenever possible. Keeping inflammation sufficiently low is necessary to allow for optimized integration of the abutments in soft tissue and to avoid perturbation of tissue structure recovery during the healing phase after abutment placement. Initial firm soft tissue integration may also increase the probability of maintaining soft tissue health in the long term. (2)

This principle has been well elucidated during the description of periodontal health around supra-dental prosthetic restorations by insisting on the notion of respect for the biological space. (3)

The peri-implant tissues consisted of a dense, collagenous lamina propria covered with a stratified, squamous, keratinizing oral epithelium. The latter was continuous with the Para keratinized sulcular epithelium that lined the lateral surface of the peri-implant sulcus

Apically, the sulcular epithelium overlapped the coronal border of the junctional epithelium. Between the apical termination of the junctional epithelium and the alveolar bone crest, connective tissue directly apposed the implant surface. (fig 1) (4)

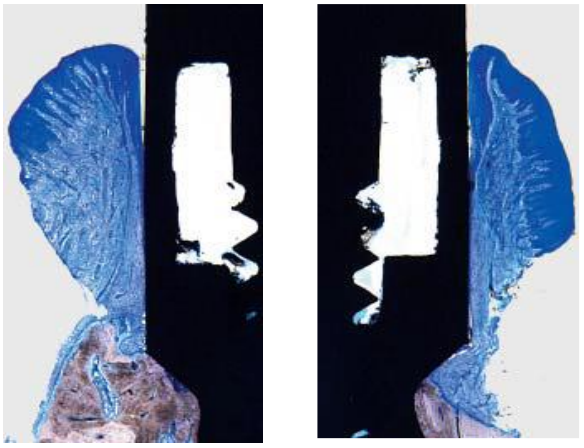


fig 1. The peri-implant tissues above the alveolar bone crest. Note the keratinized oral epithelium and the junctional epithelium tapering in the apical direction. The red arrows indicate the apical end of the junctional epithelium. The white gap between the junctional epithelium and the implant surface is an artifact created during histologic preparation. The implant surface between the apical extension of the functional epithelium and the alveolar bone is populated by a connective tissue attachment (4)

The formation of a soft tissue seal around implants has been shown to be a long and complex process. Implant mucointegration begins immediately after placement of the implant not buried at the time of the sutures. If the implant is buried, it begins during the connection of the healing abutment, during the second surgical stage. At this moment, the implant is exposed to
an unfavorable oral environment; therefore, a mechanism of special protection must be organized to avoid direct contact of the bone with other oral tissues.
Epithelial proliferation, followed by the organization of collagen fibers, results in establishing a stable dimension of approximately 4 mm of vertical extension, responsible for protection of the alveolar bone around osseointegrated

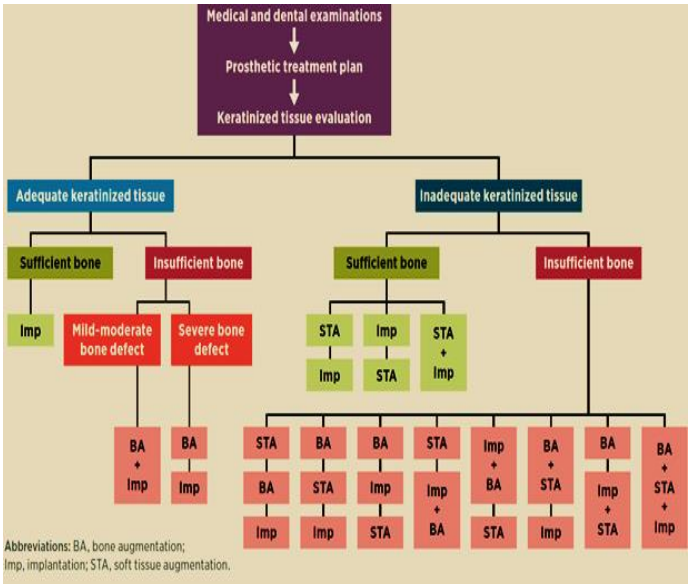
implants. (4,5)
In fact, in periodontal tissues, the collagen fibers are firmly inserted so obliquely and parallel to the root cement. The arrangement of fibers around the implant neck is different, and subject to some variations.(4,5)
The attachment mechanism of the gingival tissues to the implant has been explained as follows. After placing an implant abutment that emerges through the mucosa, the surface immediately becomes covered with a pellicle of ions and proteins derived mainly from serum and saliva, where the composition of the pellicle is determined by the presence of available adsorbents and surface properties such as topography, micro- and nanostructured morphology, chemistry and possible crystallinity. Adsorbed ions and proteins, combined with the underlying substrate surface, then provide the conditions (cell proliferation and migration, wound healing, collagen expression, keratinized tissue formation) that result in soft tissue integration. However, these ions and proteins also offer a range of binding sites for oral bacteria to attach and initiate the development of a microbial biofilm. (6)
The biological space play an important role as a defensive mechanism for osseointegration, preventing the penetration of microorganisms (Linkevicius and Apse 2008). Therefore, maintaining a healthy and undisturbed biological space around implants is considered a crucial component for the protection of the underlying bone tissue, and for the long-term success of implant treatment. (7)
Several parameters have been implicated in the alteration of the composition and conformation of this biological space. This disruption of the biological space will lead to a defect in mucointegration and the onset of early bone loss. (2, 8)
The incriminated factors are in particular occlusal overload, the presence of the microgap, the use of a smooth neck, and also, more recently, the vertical thickness of soft tissues and their influence on the re-establishment of the biological space (Oh et al. 2002). (9)

How to improve implant mucointegration?

To maintain and improve the gingival mucoingration around implants, researchers have tried to study the impact of the gingival biotype on the quality of mucointegration, while others have tried to improve the implant surface and the type of implant-abutement connection to seek maximum mucoimplant compatibility.

The effect of Gingival biotype on mucointegration quality

In a sytematic review conducted by Lukas Poškevičius and coll, the clinical relevance of keratinized mucosa around dental implants in preventing periimplant disease was examined . (8) All studies concluded that the width of keratinized mucosa around dental implants was related with less mucosal inflammation, less plaque accumulation, increased stability of the peri-implant area, and prevention of mucosal recession leading to loss of implant. (10)
Within the limitations of the current review, the following conclusions may be drawn:
1. The absence of adequate keratinized mucosa around implants supporting overdentures was associated with higher plaque accumulation, gingival inflammation and bleeding on probing.
2. Only one study reported that in cases with insufficient keratinized gingiva in the vicinity of implants, the insufficiency does not necessarily mediate adverse effects on the hygiene management and soft tissue health condition. (8)
The influence of the thickness of soft tissue on bone stability and mucosal integration are factors that have not been taken into account only recently, and which have received little attention in comparison to the others.
The hypothesis that some size of the peri-implant mucosa was required for the optimal establishment of an epithelio-conjunctival attachment was shown in the results of research from a study by Abrahamsson et al. in 1996. At implant sites with uniform alveolar characteristics, without angular defect, a prevalence of thick phenotype was noted. They then expressed their concern about the ability implant sites with thin soft tissue to develop angular bone defects around implants after healing. (11)
In fact, despite the presence of a thin mucous membrane in some sites, an epithelio- conjunctive attachment formed with dimensions similar to that in sites with thick mucosa. If the dimension of soft tissue was not satisfied, therefore bone resorption inevitably took place to ensure the formation of an adequate biological space (I. Abrahamsson et al. 1996). (1, 11)
Recent clinical research by Linkevicius et al. has shown that the soft tissue thickness is an important factor in maintaining the stability of the peri-implant bone.
From another point of view, the aesthetic results of an implant-supported prosthesis depend on the shape and texture of the soft tissues. Soft tissue recession is among the most common problems encountered in anterior implants. (12)
According to Evans & Chen and Berglundh & Lindhe, gingival recession and marginal bone loss increase in patients with thin biotypes, while
thick gingival tissue (more than 2.5 mm) can significantly prevent crestal bone loss around implants. (Berglundh & Lindhe1996) (13,14,15,16)
Soft tissue management around dental implants may be accomplished prior to the surgical phase, after the surgical phase, before loading, or even after loading (2, 17, 18). Previous studies have discussed some techniques of ST management around dental implants, but the most suitable timing for this process has not been studied precisely .
Mahdi Kadkhodazadeh and coll. tried to assess the decision-making criteria for peri-implant tissue planning according to the implant protocol, they concluded the following decision tree, (Fig 2) (19, 20)



Improving implant connection, materials and implant surfaces to improve implant mucointegration

The extent of tissue integration and attachment to the implant and abutment is largely dependent on implant design and material surfaces that contact the surrounding tissues. Surface chemistry, surface topography, surface charge, oxidelayer thickness, and wettability are key parameters that modulate the body's response and subsequent tissue integration. (21)
An ideal implant system needs optimal surfaces that balance biological, clinical, and aesthetical design requirements at every level: abutment, implant collar, and implant apex. (22)
in a recent systematic review, in 2020, studying the impact of gingival thickness on periimplant bone loss, we concluded that Soft tissue thickness was found to be correlated with marginal bone loss except in cases of platform switching connections used on implants with thin tissues and screw-retained prostheses. In this study, mucosal thickness did not affect implant survival or the occurrence of biological or aesthetic complications (23)
in other side, a pilot study (on a very small sample) looked at the effect that a thin phenotype can have on the Peri-implant bone stability in the presence of implants with platform-switching. The results of this study showed that changing the position of the microgap does not preserve bone loss if the initial vertical thickness of the mucosa at the top of the edentulous ridge is ≤ 2mm.
A mean bone loss of 1.76mm was demonstrated in the presence of thin tissue. This conclusion is therefore in opposition to the prevailing opinion that platform-switching is effective to limit bone remodeling (Linkevicius et al. 2010). (24)
This pilot study was then confirmed in 2015 by the same team of researchers.

This inability of implants with platform-switching to better preserve the bone level than traditional implants in the case of a thin phenotype may explain the disparity in measurements from some studies and clinical trials. (25)
A comparative study by Vervaeke et al. also showed more bone loss when the soft tissues are purposes, confirming the data from this study (Vervaeke et al. 2014). (26)

A similar conclusion was reached by Vandeweghe and DeBruyn, having carried out an assessment of the concept of platform-switching, and stating that platform-switching is effective only in the presence of a thick peri-implant mucosa (Vandeweghe and De Bruyn 2012). (27)

In a dogs study, Abrahamsson et al. (1998) demonstrated that the material used for the abutment has a major impact on the location of soft connective tissue. The ceramic abutment has a comparable binding peri-implant mucosa to the titanium abutments.

However, Alloys gold or dental porcelain have shown less dimension of soft peri-implant tissue. (22)

Abrahamsson et al. (2001, 2002) have compared the quality of tissue attached to two different implant surface; rough titanium (acid etched) and a smooth titanium surface (machined). The biological space is higher on the rough surface, however, without any statistically significant difference compared to a smooth surface. (28)

Accoding to a systematic review and meta analysis, 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. (29)

In a dogs study, Schwarz et al. (2007) studied the effects of hydrophilia and microtopography of the surface on the soft and hard tissue healing at 1, 4, 7, 14 and 28 days. The authors conclude that the integration of soft tissues is influenced by hydrophilia rather than by microtopography. (30-31)

Other authors have showed in human study that there is no difference between surfaces (different microtopograhphies and different hydrphiliaies).

Comparing machined titanium implants in a single piece with smooth zirconia implants one piece also showed no difference in the orientation of collagen fibers. Otherwise said, the majority of collagen fibers were oriented parallel or parallel-oblique to the implant surface (Tete et al. 2009). (32)

The uniform and parallel way orientation of the collagen fibers have also been described around smooth titanium grade 4 implants in rats during the early healing phase. While, in the rough surface , the orientation of collagen fibers seems more irregular (Yamano et al. 2011). (33)

In conclusion, despite some scattered writings in the literature that evoke the observation of perpendicular connective fibers on the implant surface, we conclude that due to the absence of a cement-like layer on the implant surface, we cannot observe perpendicular fibers on the implant surface. So, the attachment of soft connective tissue to the transmucosal part of an implant is considered to be lower than the attachment of soft connective tissue to the surface of a tooth root. Therefore, improving the quality of the interface soft tissue-implant is considered of paramount importance.

To enhance the implant surface to attach more muosa, Vincent Milleret and his team tried to create a new design and new surface for implant and abutment. They established a check list for details requirement in each part in the implant , and they proposed a new design for implant to enhance osteointegration and cervical mucointegration (34)

They proposed an abutement fabricated with Oxidized nanostructured titanium surfaces to stimulate adhesion, proliférations and extracellular matrix secretion of human gingival fibroblasts, this is very important to support epithelial and connective tissue attachment for roughness we don't exceed an Ra value of 0,2 µm

At the implant collar, exactly at the platform and for the inial part of the implant (2mm), they require a turned surface to facilitate hygiene and by the way to minimise marginal bone loss.

At the implant apex, they adviced using titanium oxyde Moderately rough surfaces (Sa of approximately 1.5 µm surfaces) incroporated with phosphorous, calcium, magnesium, and fluoride to enhance osteointegration. The Micropores in the titanium oxide layer provide important retention features on the implant surface that promote bone-implant interactions and ensure a strong interlock, which are beneficial for osseointegration

Conclusion:

Despite the architectural and organizational difference that exists between the epithelio-conjunctive periodontal and periimplant attachment, the biological space around the implants plays an essential role in maintaining osseointegration by playing the role of a defense barrier preserving bone integrity. Mucointegration is very dependent on the presence of sufficient height and thickness of keratinized gingiva. In addition to its role as a barrier, mucointegration improves the aesthetic appearance of the prosthetic rehabilitation. Muco-integration must be sought from the design of the implant project; and in the case of gingival deficiency, a tissue planning procedure must be initiated according to the decision tree cited in this article.

Conflict of interest

None declared.

References

1. Christoph H.F. Hämmerle, Dennis Tarnow. The etiology of hard- and soft-tissue deficiencies at dentalimplants: A narrative review, *J Periodontol.* 2018;89(Suppl 1):S291–S303.
2. Yulan Wang,; Yufeng Zhang; Richard J. Miron,Health,Maintenance, and Recovery of Soft Tissues around Implants, Clinical Implant Dentistry and Related Research, Volume *, Number *, 2015
3. S.M. Dridi, J. Meyer La gencive saine : la référence ; Images en Dermatologie • Vol. IX - n° 2 • mars-avril 2016
4. Myron Nevins, Marc L. Nevins. Human Histologic Evidence of a Connective Tissue Attachment to a Dental Implant ; The International Journal of Periodontics & Restorative Dentistry Volume 28, Number 2, 2008
5. Ikiru Atsuta DDS, PhD*, Yasunori Ayukawa DDS, PhD, Ryosuke Kondo Soft tissue sealing around dental implants based on histological interpretation ; j o u r n a l o f p r o s t h o d o n t i c r e s e a r c h 6 0 (2 0 1 6) 3 – 1 14
6. Sculean A, Gruber R, Bosshardt DD. Soft tissue wound healing around teeth and dental implants. J Clin Periodontol 2014 ; 41: S6–S22.
7. Tomas Linkevicius, Peteris Apse. Biologic Width Around Implants. An Evidence-Based Review, Stomatologija, Baltic Dental and Maxillofacial Journal, 2008, Vol. 10, No. 1
8. Lukas Poskevicius, Gintaras Juodzbalys. Influence of Peri-Implant Soft Tissue Condition and Plaque Accumulation on Peri-Implantitis: a Systematic Review ; J Oral Maxillofac Res 2016 (Jul-Sep) | vol. 7 | No 3 | e2 | p.1
9. Oh, Tae-Ju, Joongkyo Yoon, Carl E. Misch, et Hom-Lay Wang. 2002.The Causes of Early Implant Bone Loss: Myth or Science? » Journal of Periodontology 73 (3): 32233.
10. Mauricio G. Araujo, Jan Lindhe. Peri-implant health ; J Periodontol. 2018;89(Suppl 1):S249–S256.
11. Abrahamsson, I., T. Berglundh, J. Wennström, et J. Lindhe. 1996.The Peri-Implant Hard and Soft Tissues at Different Implant Systems. A Comparative Study in the Dog. Clinical Oral Implants Research 7 (3): 21219.
12. Catharina Ladwein, Rainer Schmelzeisen, Katja Nelson,Is the presence of keratinized mucosa associated with periimplant tissue health? A clinical cross-sectional analysis ; l. International Journal of Implant Dentistry (2015) 1:11
13. Berglundh, T., I. Abrahamsson, et J. Lindhe. 2005. Bone Reactions to Longstanding Functional Load at Implants: An Experimental Study in Dogs . Journal of Clinical Periodontology 32 (9):
14. Berglundh, T., et J. Lindhe. 1996. Dimension of the Periimplant Mucosa: Biological Width Revisited. Journal of Clinical Periodontology 23 (10)
15. Berglundh, T., J. Lindhe, I. Ericsson, C. P. Marinello, B. Liljenberg, et P. Thomsen. 1991. The Soft Tissue Barrier at Implants and Teeth ». Clinical Oral Implants Research 2 (2): 8190.
16. Berglundh, T., J. Lindhe, C. Marinello, I. Ericsson, et B. Liljenberg. 1992. Soft Tissue Reaction to de Novo Plaque Formation on Implants and Teeth. An Experimental Study in the Dog . Clinical Oral Implants Research 3 (1): 18.
17. Robert A. Levine, FCPP/Guy Huynh-Ba, Dr Med Dent. Soft Tissue Augmentation Procedures for Mucogingival Defects in Esthetic Sites ; Int J Oral maxillofac Implants 2014;29(Suppl):155–185.
18. T. DEGORCE, Esthétique péri-implantaire : quelles stratégies muco-gingivales ? ; Stratégie prothétique septembre 2003 • vol 3, n° 4
19. Mahdi Kadkhodazadeh, Reza Amid, Mehdi Ekhlasmand Kermani. Timing of soft tissue managementar ound dental implants: a suggested protocol, GENERAL DENTISTRY May/June 2017
20. Regula Kaufmann , Renzo Bassetti, Regina Mericske-Stern Norbert Enkling. Elargissement de la muqueuse péri- implantaire kératinisée lors de la réouverture de l'implant
21. Jan Hall | Jessica Neilands | Julia R. Davies, A randomized, controlled, clinical study on a new titanium oxide abutment surface for improved healing and soft tissue health , Clin Implant Dent Relat Res. 2019;21:55–68.