Biological sealing aspects surrounding anterior crowns on dental implants: clinical and photographic cases report

Access this article online	
Quick Response Code:	Website: https://periodicos.uff.br/ijosd/article/view/57026
	DOI: 10.22409/ijosd.v2i61.57026

Autores:
Sergio Henrique Gonçalves Motta
Clivo-CIODONTO, Rio de Janeiro, Brazil

Cristiane Ferreira Pinto Paterline Vivacqua
Instituto Militar de Engenharia (IME), Rio de Janeiro, Brazil

Leonardo Emiliano dos Santos
Instituto Militar de Engenharia (IME), Rio de Janeiro, Brazil

Marco Aurélio Chaves da Silva
São Leopoldo Mandic, Rio de Janeiro, Brazil

Gustavo Boehmer Leite
Instituto Militar de Engenharia (IME), Rio de Janeiro, Brazil

Juliana Campos Hasse Fernandes
Private Practice – MI, U.S.A.

Gustavo Vicentis Oliveira Fernandes
Periodontics and Oral Medicine Department, University of Michigan School of Dentistry MI, North University Ave, Ann Arbor, MI, U.S.A., 48109

Correspondence adress:
Gustavo Fernandes, gustfernandes@gmail.com

ABSTRACT

The biological sealing (BS) around implants is a dominant factor to determine the long-term success of peri-implant health. There are several features of the BS around implants in common with the soft tissue attached to teeth, such as the presence of crevicular fluid, acquired pellicle, epithelium; otherwise, the quality of the BS around implants is weaker compared with the junctional epithelium of natural teeth. Then, this article aimed to describe three cases report showing the presence of a BS (cuticle-crevice fluid-acquired pellicle) around the fixed crowns on dental implants in the anterior zone, through photographic analysis. It was used a Nikon 8100 camera with a 105 mm macro lens and a Macro Ring circular flash. A photographic profile examination was made always showing the clinical case and, specifically, the focal point in the crown-gingival tissue (prosthesis boundary and peri-implant tissue), highlighting the anatomical gingiva on the ceramic prosthetic crown at an angle between 140 to 160 degrees. Although cases 1 and 2 had 1-year follow-up and case 3 around 4 years, the common findings for all treatments done were: (i) oral rehabilitation with crowns on dental implants; (ii) patients satisfied with the esthetic and functional result; (iii) stability of the soft tissue around the crowns; (iv) all the patients had a good oral hygiene; (v) presence of a thin membrane associated with the acquire pellicle, similar to an annular cuticle, which we named cuticle-acquired pellicle complex or tertiary cuticle or prosthetic-implant cuticle. This complex (cuticle-crevicular fluid-acquired pellicle) is suggested to be the responsible by the BS on dental implants. Moreover, the cuticle (epithelial part in the peri-implant sulcus), although similar to teeth, may be considered a tertiary pellicle due to be found on ceramic crowns on dental implants, differently of the primary and secondary pellicle. Whitin the limitation of these three cases reports, the BS was reported and can be introduced the new concept of the “cuticle-crevicular fluid-acquired pellicle complex” or “prosthetic-implant cuticle”.

Keywords: Dental implants; single crown; biological sealing; biofilms; pellicle; acquired pellicle; saliva; gingival crevicular fluid.

INTRODUCTION

Oral microbial biofilm is currently a major concern. It composes the dental plaque which exists on the surface of the solid structures. The bacteria in the plaque may produce acid that can cause disintegration of the tooth’s surface (dental caries) (MARSH, 2006) or not, becoming mineralized into calculus.

Continuous acquisition of calculus forms a thick deposit and has potential to cause inflammation or infection in the periodontal apparatus, leading to destructive periodontal disease (KOLENBRANDER et al., 2000).

Natural mechanisms of defense exist to avoid diseases (CEKICI et al., 2014; TAKAHASHI et al., 2019). One of the mechanisms, in the periodontal tissues, are the primary or developmental cuticle (JAGELAVICIENE, 2021) (Nasmyth's membrane) that was identified as a thin membrane of tissue (primarily basal lamina) with cellular origin; there is a cellular response; and other products coming from saliva. The primary cuticle is produced by the ameloblasts as their last action before the tooth crown erupts into the oral cavity. It is deposited on the enamel's surface and covers the tooth once it has erupted and is usually worn away by mastication and cleaning (NAIM, 2011). It has also association with reduced enamel epithelium (REE). Therefore, REE is lost during teeth eruption in the oral cavity, remaining only the developmental cuticle on the tooth surface. The cuticular protein, which initiates attachment of the junctional epithelium to enamel, has the most important function of the primary cuticle.

The saliva contains salivary proteins and glycoproteins that attach to enamel and exposed cementum or dentin (TAVARES et al., 2022). It deposits a thin protein coat or membrane on the surface of the tooth, named pellicle or acquired pellicle (CHAWHUAVEANG et al., 2021). The pellicle, although protective to the tooth, allows plaque to form on the tooth surface, which is composed of bacteria and salivary proteins, becoming a dense layer that gradually accumulates on that surface if not removed.

There is also a "secondary enamel cuticle" which was observed on the enamel of an embedded tooth. It is not a secretion product of epithelial cells but a "horny epithelial hyaline-like membrane", because it continues into horny hyaline-like bodies within densely proliferated epithelial strands, which were a product of chronic inflammation. Then, its formation seems to be a casual relation to chronic inflammation, demonstrating, thereby, fundamental difference existing between this membrane and the primary enamel cuticle (BAUER, 1943).

The cuticle membrane serves as an attachment of the gingival junctional epithelial cells to the tooth (SAWADA et al., 2001). Moreover, it is known that the sulcular epithelium is continually forming proteins, which renews the gingival attachment throughout its life. Nevertheless, the cuticle is not present long on the enamel, as above mentioned, mainly due to the contact of the opposing teeth, causing wear away. It remains only in the spot where the soft tissue covers the enamel in the gingival crevice, keeping a biological sealing (BS). In addition, there are many questions for the existence of this biological

component (cuticle) after tooth extraction, and lack of scientific evidence showing its presence associated with crowns on dental implants. This fact, the intimate prosthetic-biologic connection, must be carefully observed in order to promote an environment for long-term peri-implant stability and health (KAWAHARA et al. 1998; YEUNG, 2008).

The BS around implants is a dominant factor to determine the long-term success of peri-implant health [11,12]. There are several features of the BS around implants in common with the soft tissue attached to teeth (BERGLUNDH et al., 1991; FUJISEKI et al., 2003), such as the presence of crevicular fluid, acquired pellicle, epithelium; otherwise, the quality of the BS around implants is weaker compared with the junctional epithelium of natural teeth (BERGLUNDH et al., 1991; IKEDA et al., 2002; ATSUTA et al., 2005), forming a poorer barrier compared with the Sharphey's fibers attached perpendicularly to the tooth surface (SCHUPBACH et al., 2007). This fact could be due to the attachment of the non-keratinized peri-implant epithelium (PIE) onto the implant surface via the internal basal lamina and hemidesmosomes (ATSUTA et al., 2005; CHAI et al., 2012), being limited to the apical region of the PIE (ATSUTA et al., 2005), and the orientation of the peri-implant connective tissue collagen fibers, which are mainly in a circular or oblique direction to the implant surface (RUGGERI et al., 1992; TETÈ et al., 2009).

Thus, this article aimed to describe three cases report showing the presence of a BS (cuticle-crevice fluid-acquired pellicle) around the fixed crowns on dental implants in the anterior zone, through photographic analysis.

CASES REPORTS

Technical details

The equipment used to take pictures (always by the same operator) was a Nikon 8100 camera with a 105 mm macro lens and a Meike Macro Ring Lite MK-14 circular flash. A photographic profile examination was made always showing the clinical case and, specifically, the focal point in the crown-gingival tissue (prosthesis boundary and peri-implant tissue), highlighting the anatomical gingiva on the ceramic prosthetic crown at an angle between 140 to 160 degrees (Fig. 1).

Figure 1. – Technical detail of the pictures taken to show the BS (cuticle-crevice fluid-acquired pellicle).

Cases description

Three cases were included after filled out the informed consent and had the following parameters for inclusion: (i) anterior rehabilitation with implants after CBCT analysis, (ii) always observed and followed by the same professional (MHGM), (iii) metal-ceramic crown installed, (iv) ≥ 18 years old, and (v) pictures showing the treatment and angled pictures with the cuticle-acquired pellicle around crown on implants.

Case report 1 (Figs. 2-4)

Patient 1 (E.A.G.F.), female, middle age, arrived for the first consult requesting implant placement for #11 and #21 (July 2014). After planned the treatment, the implants were placed in October 2014 and a provisional removable denture was delivered which was used for 5 months. In March 2015, a provisional fixed crown was installed (Fig. 2). After soft tissue preparation with provisional crown, the final crowns were placed with 20N.mm of torque and periapical x-ray was taken (Fig. 3), after around 6 months. Angled photos were taken showing the biological sealing in the buccal face (Fig. 4) were taken when the patient was recalled to follow-up after 1 year.

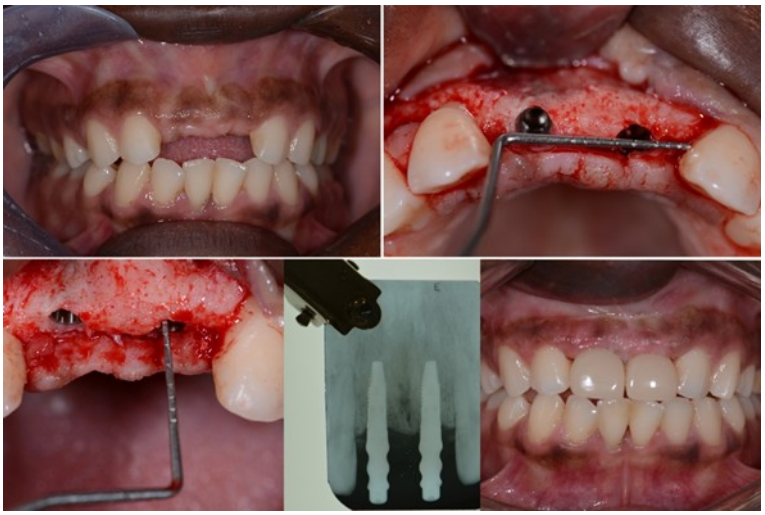

Figure 2. – Initial case; implant placement; The moment that the patient received the provisional crown.

Figure 3. – Metal-ceramic crown on the gypsum cast; Gingival curvature after the use of provisional crowns; The crowns installed on the implants with radiographic observation.

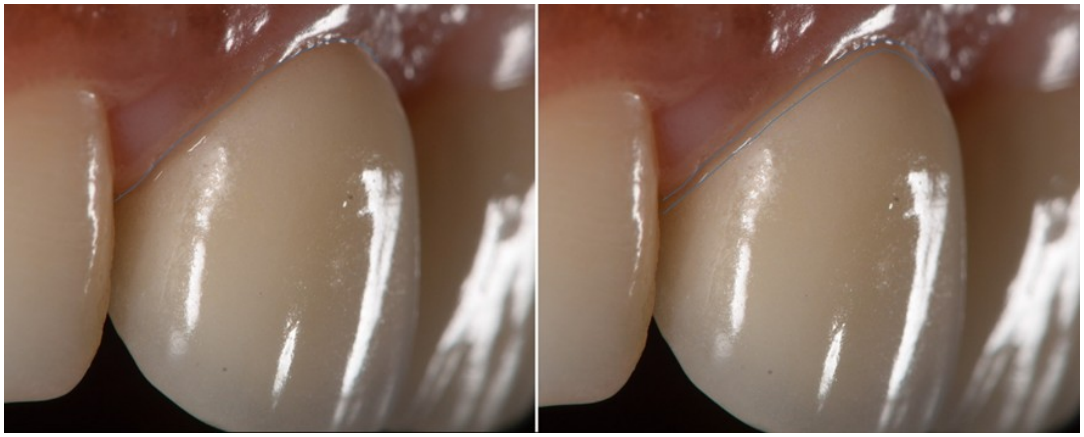

Figure 4. – Pictures taken showing the BS in the buccal face in the tooth #11 after 1 year in function.

Case report 2 (Figs. 5-7)

Patient 2, female, middle age, received implant placement and provisional fixed crown in 2015 (Fig. 5). After soft tissue preparation with that crown, a personalized impression was done using pattern resin with the transfer, in order to obtain a more precise and adapted metal-ceramic crown (Fig. 6), which was installed in September 2015. After 1 year, the patient was scheduled, to show the new panoramic x-ray and verified the cuticle-pellicle (Fig. 7).

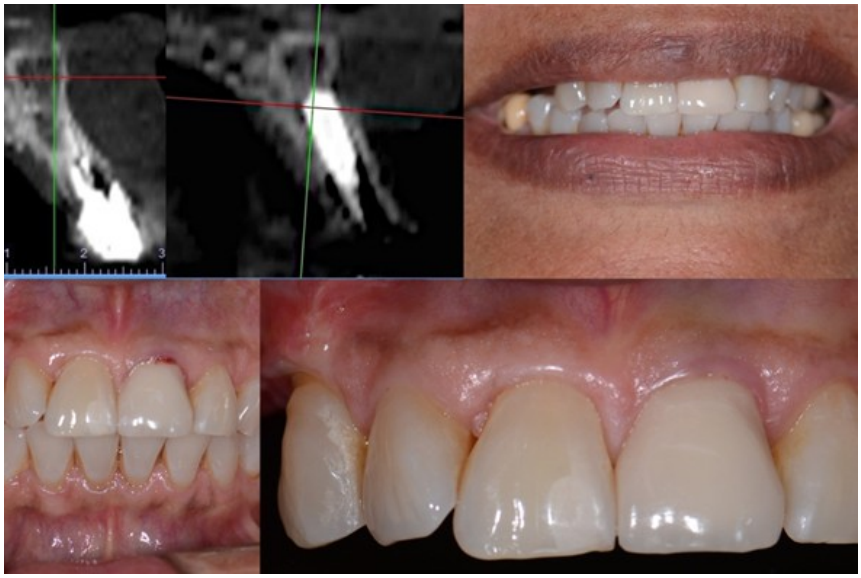

Figure 5. – Tomography images (CBCT) showing the implant placement with the provisional crown installed.

Figure 6. – Pictures showing the gingival conformation after using provisional crown; personalized impression was made.

Figure 7. – X-ray showing the osseointegrated implant and metal-ceramic crown (top); angled pictures showing the presence of the harmonic BS.

Case report 3 (Figs. 8-17)

Patient 3 (F.B.A.), young male, appeared for an initial appointment in September 2011, requiring dental implants in the esthetic anterior area of the maxilla (#12 and #22). In October 2011, the implants were placed in a correct 3D position (using a surgical guide), after confirmed the position with the pin of parallelism (Fig. 8). After around 5 months using adhesive crowns, in March 2012, a new panoramic was evaluated before starting the second surgical step (Fig. 9), which was proceed inserting the healing caps associated with connective tissue graft on the buccal face; those caps were substituted by the provisional crowns 2 weeks after (Fig. 10).

Figure 8. - Implants placed in a correct 3D position (using a surgical guide).

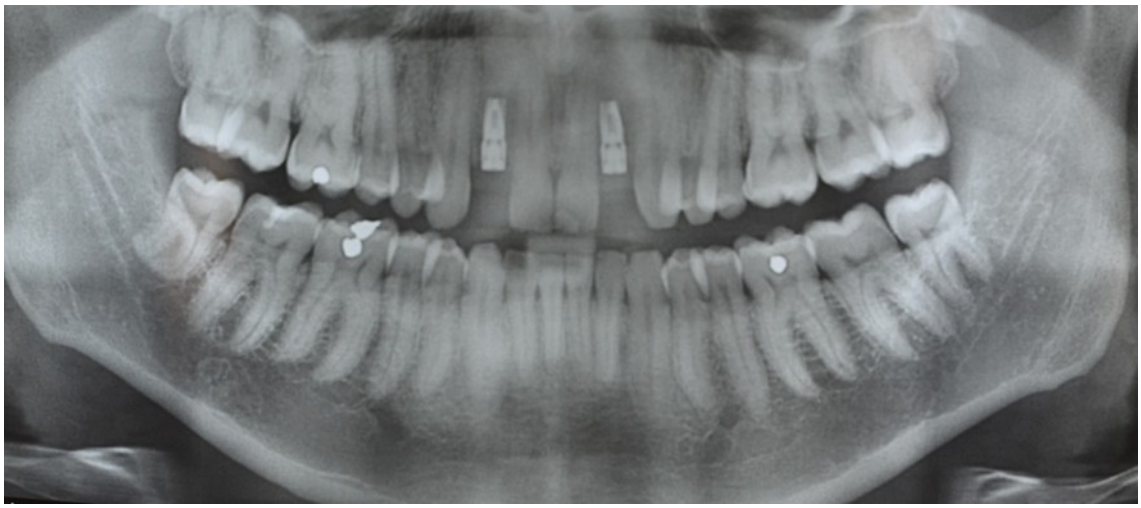

Figure 9. - Panoramic to follow-up the implants.

Figure 10. – Second surgical step, inserting the healing caps with connective tissue graft on the buccal face; Provisional crowns 2 weeks later.

After 2 months (May 2012), the patient was recalled for a review of the tissue healing around the provisional crowns (Fig. 11). The same occurred after more 1 month (June 2012), when was planned to remove the crowns and starting the process to obtain the final crowns (Fig. 12). After 1 month (August 2012), the

final crowns were in position which were adjusted to achieve a correct function and esthetic (Fig. 13).

Figure 11. – Follow-up after 2 months.

Fig. 12 – Follow-up after 3 months.

Figure 13. – After 4 months, metal-ceramic crowns were installed.

In July 2013, the patient returned for a new follow-up, showing stability of the tissue around the metal-ceramic crowns (Fig. 14). Three years after the final

crowns were placed, in August 2015, a new follow-up occurred, and the Fig. 15 can show a good tissue adaptation, without inflammatory reaction, but with a scar in the distal papilla of the #22. In June 2016, the patient was followed-up, showing adequate esthetic result (Fig. 16) and angled pictures were taken to evaluate the BS in both crowns (Fig. 17).

Figure 14. – 11 months in function, the patient was recalled.

Figure 15. – After 3 years, a new follow-up was done.

Figure 16. – Around 4 years, new recall was done to re-evaluate the case.

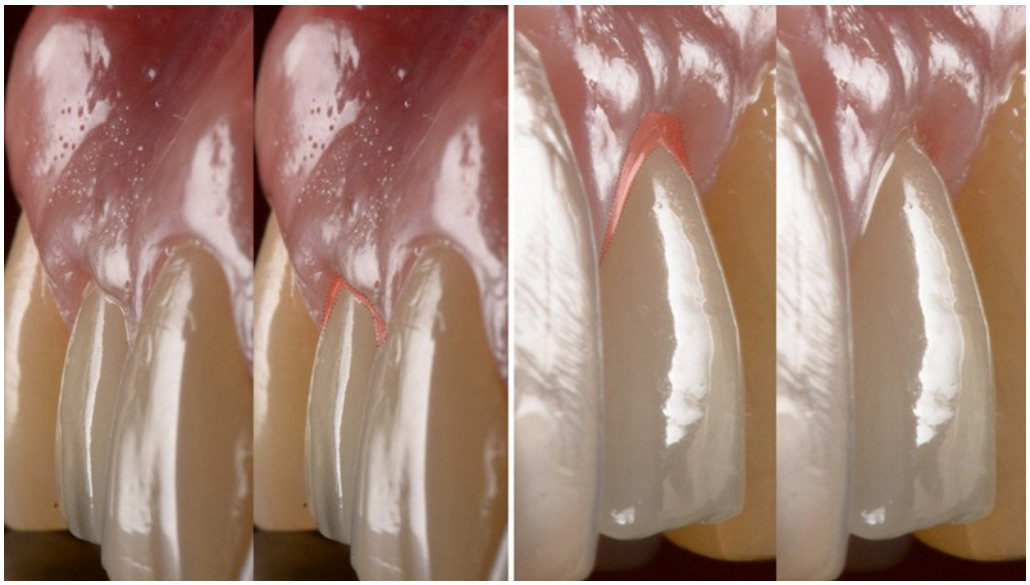

Figure 17. – Angled pictures showing the BS in the buccal face.

Although cases 1 and 2 had 1-year follow-up and case 3 around 4 years, the common findings for all treatments done were: (i) oral rehabilitation with crowns on dental implants; (ii) patients satisfied with the esthetic and functional result; (iii) stability of the soft tissue around the crowns; (iv) all the patients had a good oral hygiene; (v) presence of a thin membrane associated with the acquire pellicle, similar to an annular cuticle, which we named cuticle-acquired pellicle complex or tertiary cuticle or prosthetic-implant cuticle.

This complex (cuticle-crevicular fluid-acquired pellicle) is suggested to be the responsible by the BS on dental implants, which depends on the harmony between them. Moreover, the cuticle (epithelial part in the peri-implant sulcus), although similar to teeth, may be considered a tertiary pellicle due to be found on ceramic crowns on dental implants, differently of the primary and secondary pellicle.

DISCUSSION

Patients and professionals always are analyzing color of the gingiva and tooth, shape of the crowns and soft tissues, and the mimetic result found after rehabilitation, which will influence directly on the esthetic result. Periodontal or peri-implant anatomy details are found mainly in pre-clinical studies, such as using dogs, goats, monkeys, and others (BERGLUNDH et al., 1991; RUGGERI et al., 1992; IKEDA et al., 2002; FUJISEKI et al., 2003; ATSUTA et al., 2005; TETÈ et al., 2009).

Among histological findings, the literature describes biological limits of the tooth with its bone crest, gingival sulcus, cementum, and periodontal ligaments. In order to protect and seal the periodontal/peri-implant apparatus, the BS must be preserved, which is located inside the dental alveolar sulcus (depth average of 3 millimeters within the gingival sulcus). This BS is protected by the thickness of the gingival tissue and by the crevicular fluid existent in the sulcular epithelium due to inflammatory responses, that acts as a liquid barrier to protect the BS healthy (ZUHR AND HÜRZELER, 2012).

When it is installed a single crown on tooth with the finishing line inside the gingival sulcus, it appears to be a tendency occur biological adjusts respecting the crown's margins until the distance to the bone crest. Therefore, the BS is always maintained. When the implant and crown are installed, it is suggested a biological recreation and reorganization (NEVINS et al., 1984). It is known that, due to the absence of cement and periodontal ligaments, only circular and oblique fibers are predominantly set, becoming the BS more fragile. Otherwise, if the peri-implant tissue is thick, it will have an increased resistance, enhancing the BS (TARNOW et al. 1986; ZUHR AND HÜRZELER, 2012).

Analyzing the normal tooth movement in the alveolus, the crevicular fluid tends to be expelled to the buccal medium with a constant volume and flow. Therefore, because of the osseointegration, the impact of the forces affects the bone, which has a different resilience and behavior compared to teeth. Consequently, the crevicular fluid produced by the inflammatory process in the groove does not have the capacity to be adequately expelled, being deposited as a film on the crowns together with the epithelial presence, similarly to the annular cuticle. This fact was observed in all cases presented. Hence, it is important to re-think in the best pathway to do periodontal treatments and maintenance therapies (prophylaxis/maintenance), due to be considered the possibility of breaking the BS presented (BERGLUNDH et al., 2019).

There were limitations associated with the presentation of these 3 cases reports. First, (i) the number of included cases is low because it is an article of cases reports. Then, we can suggest larger research study, clinical trial, in order to replicate the methodology used in this article. Also, (ii) the photographic assessment is not completely reliable. Even though we kept the same standard and operator, might have differences and variances when the pictures are taken. Thus, we suggest different methodologies to evaluate it in future studies. (iii) In this study was used always the same type of material to rehabilitate the patients, which was the standard established; Then, we suggest to be used different types of materials in order to verify and compare the biological responses.

CONCLUSION

Whitin the limitation of these three cases reports using metal-ceramic crowns to rehabilitate dental implants, it was possible to verify that there is an extremely importance in the maintenance of the tissues around the crown, in order to seal and protect the peri-implant apparatus. Moreover, the thickness of the gingival tissue and the crevicular fluid existent in the sulcular epithelium helps to keep the BS healthy. Thus, the BS was reported in this study and can be introduced the new concept: “cuticle-crevicular fluid-acquired pellicle complex” or “prosthetic-implant cuticle”. However, more studies should be developed comparing this BS with different types of prosthesis materials, as well as the real benefit thereof, demonstrating histological and clinical results in longitudinal comparisons.

REFERENCES

1. Atsuta I, Yamaza T, Yoshinari M, Goto T, Kido MA, Kagiya T, Mino S, Shimono M, Tanaka T. Ultrastructural localization of laminin-5 (gamma2 chain) in the rat peri-implant oral mucosa around a titanium-dental implant by immuno-electron microscopy. Biomaterials 2005;26:6280-7. doi:10.1016/j.biomaterials.2005.03.046

2. Bauer WH. Histogenesis of the so-called secondary enamel cuticle and dental cuticle. Surgery. 1943;29(11):B626-34. doi.org/10.1016/S0096-6347(43)90173-5

3. Berglundh T, Jepsen S, Stadlinger B, Terheyden H. Peri-implantitis and its prevention. Clin Oral Impl Res. 2019;30:150-5.

4. Berglundh T, Lindhe J, Ericsson I, Marinello CP, Liljenberg B, Thomsen P. The soft tissue barrier at implants and teeth. Clin Oral Implants Res. 1991;2:81-90. doi:10.1034/j.1600-0501.1991.020206.x
5. Cekici A, Kantarci A, Hasturk H, Van Dyke TE. Inflammatory and immune pathways in the pathogenesis of periodontal disease. Periodontol 2000. 2014;64(1):57-80. doi: 10.1111/prd.12002

6. Chai WL, Brook IM, Emanuelsson L, Palmquist A, van Noort R, Moharamzadeh K. Ultrastructural analysis of implant – soft tissue interface on a three dimen- sional tissue-engineered oral mucosal model. J Biomed Mater Res A. 2012;100:269-77. doi:10.1002/jbm.a.33245

7. Chawhuaveang DD, Yu OY, Yin IX, Lam WY-H, Mei ML, Chua C-H. Acquired salivary pellicle and oral diseases: A literature review. J Dent Sci. 2021;16(1):523-9. doi: 10.1016/j.jds.2020.10.007

8. Fujiseki M, Matsuzaka K, Yoshinari M, Shimono M, Inoue T. An experimental study on the features of peri-implant epithelium: immunohistochemical and electron-microscopic observations. Bull Tokyo Dent Coll. 2003;44:185-99. doi:10.2209/tdcpublication.44.185

9. Ikeda, H., Shiraiwa, M., Yamaza, T., Yoshinari, M., Kido, M. A., Ayukawa, Y., Inoue, T., Koyano K, Tanaka T. Difference in penetration of horseradish peroxidase tracer as a foreign substance into the peri-implant or junctional epithelium of rat gingivae. Clin. Oral Implants Res. 2002;13:243-51. doi:10.1034/j.1600-0501.2002.130303.x

10. Jagelaviciene E. The Importance of Vitamin D for Periodontal Tissues. 2021. IntechOpen. doi.org/10.5772/intechopen.96968

11. Kawahara H, Kawahara D, Hashimoto K, Takashima Y, Ong JL. Morphologic studies on the biologic seal of titanium dental implants. Report I. In vitro study on the epithelialization mechanism around the dental implant. Int J Oral Maxillofac. Implants. 1998;13:457-64.

12. Kolenbrander PE, Andersen RN, Kazmerak KM, Palmer RJ: Coaggregation and coadhesion in oral biofilms. Community structure and co-operation in biofilms. Edited by: Allison DG, Gilbert P, Lappin-Scott HM, Wilson M. Cambridge, Cambridge University Press, Society for General Microbiology Symposium 2000;59:65-85.

13. Marsh PD. Dental plaque as a biofilm and a microbial community – implications for health and disease. BMC Oral Health. 2006;6:S14.

14. Naim J. Development of the Dento-gingival Junction. Tissue of the Teeth. 2011. University of Palestine.
15. Nevins M, Skurow HM. The intracrevicular restorative margin, the biologic width, and the maintenance of the gingival margin. Int J Periodontics Restorative Dent. 1984;4:30-49.

16. Ruggeri A, Franchi M, Marini N, Trisi P, Piatelli A. Supracrestal circular collagen fiber network around osseointegrated nonsubmerged titanium implants. Clin Oral Implants Res. 1992;3:169-75. doi:10.1034/j.1600-0501. 1992.030403.x

17. Sawada T, Inoue S. High resolution ultrastructural reevaluation of dental cuticle in monkey tooth. J Periodontal Res. 2001;36(2):101-7. doi: 10.1034/j.1600-0765.2001.360206.x

18. Schupbach P, Glauser R. The defense architec- ture of the human periimplant mucosa: a histological study. J. Prosthet. Dent. 2007;97:S15-25. doi:10.1016/S0022-3913(07)60004-3

19. Takahashi N, Sulijaya B, Yamada-Hara M, Tsuzuno T, Tabeta K, Yamazakic K. Gingival epithelial barrier: regulation by beneficial and harmful microbes. Tissue Barriers. 2019;7(3): e1651158. doi: 10.1080/21688370.2019.1651158

20. Tarnow D, Stahl SS, Magner A, Zamzok J. Human gingival attachment responses to subgingival crown placement. Marginal remodelling. J Clin Periodontol. 1986;13(6):563-9.

21. Tavares, L.T.R.; Saavedra-Silva, M.; López-Marcos, J.F.; Veiga, N.J.; Castilho, R.d.M.; Fernandes, G.V.O. Blood and Salivary Inflammatory Biomarkers Profile in Patients with Chronic Kidney Disease and Periodontal Disease: A Systematic Review. Diseases 2022;10: 12.

22. Tetè S, Mastrangelo F, Bianchi A, Zizzari V, Scarano A. Collagen fiber orientation around machined titanium and zirconia dental implant necks: an animal study. Int J Oral Maxillofac Implants. 2009;24:52-8.

23. Yeung SC. Biological basis for soft tissue management in implant dentistry. Aust Dent J. 2008;53(Suppl.1):S39-42. doi:10.1111/j.1834-7819.2008.00040.x

24. Zuhr O, Hürzeler M. Plastic-esthetic periodontal and implant surgery. A Microsurgical Approach. Chicago, Quintessence Publishing, 2012.