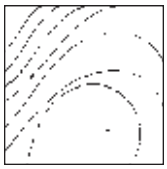
Evaluation of Human Peri-Implant Soft Tissues Around Alumina-Blasted/ Acid-Etched Standard and Platform-Switched Abutments



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This study evaluated the histometric characteristics of the peri-implant mucosa of human subjects that received textured implant abutments with conventional (implant and abutment with same diameter) or platform-switched (implant diameter wider than that of the abutment) configurations. Wider and longer connective tissue around platform-switched implants was observed compared to that with conventional abutments. Despite the different dimensions between the two abutment types, the abutment–soft tissue interaction was similar for both groups at the histometric level. (Int J Periodontics Restorative Dent 2013;33:e51–e57. doi: 10.11607/prd.0938)

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Analysis of the interface between teeth and dental implants with their surrounding structures has been well documented in the literature.[1–9] Previous human and animal studies have demonstrated that the peri-implant mucosa formed around titanium implants following abutment connection had many similar features with that of gingival tissue around teeth.[10]

Peri-implant biologic width has been described as being composed of epithelium overlying connective tissue. In proximity of the implant, the connective tissue is characterized by an absence of blood vessels and abundant fibroblasts, which are interposed between thin collagen fibers. More abundant connective tissue fibers are located over a distance from the implant and are oriented in various directions.[9,11]

The importance of the mucosal attachment is critical to the maintenance of osseointegration, esthetics, and function. The existing implant literature suggests that peri-implant bone loss may be related to the location of the abutment-implant interface or microgap, suggesting that when this interface

is more apical, greater bacterial contamination and bone loss is likely to occur.[12–14] Other studies also suggest that reduction of the abutment diameter may decrease peri-implant bone resorption.[15,16]

In a previous study, implants with a smaller-diameter abutment on a larger-diameter implant have shown promising biomechanical results relative to implants featuring an implant platform and abutment of the same diameter even though their initial biomechanical load potential was lower from a theoretical standpoint.[17] Another study evaluated how abutment connection timing or the presence of a microgap influences the composition of inflammatory cells immediately adjacent to the implant. The absence of a microgap at the bone crest was associated with reduced peri-implant inflammatory cell accumulation and minimal bone loss.[18] Thus, the body of literature regarding the interaction of the implant, abutment, and surrounding tissues has been increasing over the past years.

While few studies have investigated the effect of the implant and abutment on the surrounding tissue morphology,[19] little is known regarding how material properties (ie, abutment surface texture), along with abutment geometric alterations, may influence the surrounding tissue morphology. The purpose of this human histologic study was to evaluate the histomorphologic characteristics of the peri-implant mucosa around acid-etched abutments in a conventional (implant and abutment of the same diameter) or platform-switched (implant diameter wider than that of the abutment) scenario.

Method and materials

Ten healthy adult patients (three men, seven women; age range, 25 to 58 years) were included in this study. Informed consent was obtained from all patients, who were partially edentulous in the posterior mandible. Each patient received two endosseous dental implants of 4-mm diameter (various lengths) (internal hex; Seven, MIS Implant Technologies). All sites for implant placement had an adequate zone of keratinized mucosa prior to surgical intervention. Implant surgery was performed under local anesthesia using a conventional surgical protocol. Full-thickness flaps were elevated, osteotomies were made, and the implants were placed. Radiographic and clinical evaluations were completed at the time of implant insertion and at 1, 3, 12, 16, and 24 weeks.

Abutment connection was performed approximately 6 months after implant insertion (range, 5 to 7 months). Each patient received one conventional and one platform-switched abutment. The abutments (MIS Implant Technologies) presented an alumina-blasted/acid-etched surface texture. Following abutment connection at periods of 1, 4, 8, and 12 weeks, plaque control, clinical observations, and radiographic examinations were initiated.

Three months after abutment connection, soft tissue samples were collected from each implant. With patients under local anesthesia (3% Carbocaine, DFL, without epinephrine), a punch or incision was made 2 mm around the abutment circumferentially, and the abutment was retrieved with the surrounding tissues. Meticulous effort was made to preserve the mucosa surrounding the abutment. After the abutments were removed, a new abutment was inserted for the continuation of prosthetic treatment. The soft tissue samples were fixed in a 10% buffered formaldehyde solution for 48 hours and were then referred for paraffin embedding and histologic processing.

Specimens were dehydrated in a series of graded ethanols and mounted in paraffin wax. Five-micrometer-thick sections along the abutment long axis were obtained. Specimens were stained with hematoxylin-eosin for transmitted optical microscopy evaluation at various magnifications using a light microscope (Leica DM2500M, Leica Microsystems). Histometric evaluation was carried out using computer software (ImageJ, National Institutes of Health), and vertical linear measurements using the most cervical region of the sulcus at baseline were performed to determine the apical extension of the long junctional epithelium and the apical extension of the inflammatory cell infiltrate.[20] Area fraction measurements were carried out to determine the maximum area occupied by inflammatory cells.[21] Statistical evaluation was performed using the Mann-Whitney test at a 95% level of significance.

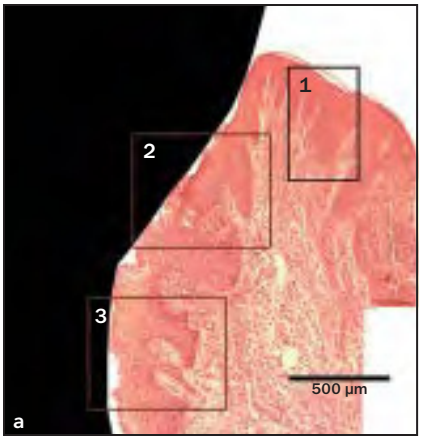
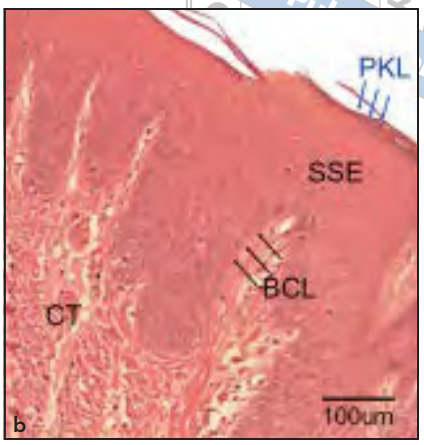


Fig 1a *Gingival tissue around a grit-blasted standard implant abutment (hematoxylin-eosin; original magnification ×20).*

Figs 1b and 1c *Higher-magnification view of regions 1 and 2 in Fig 1a. Stratified squamous epithelium (SSE) and a connective tissue (CT) layer underlying a parakeratinized epithelial layer (PKL), along with its basal layer (BCL), were observed. (c) Note the sharp transition from parakeratinized to nonkeratinized tissue (NKT) (dashed line). A thicker epithelial layer was observed with slight hyperplasia (hematoxylin-eosin; original magnification ×100).*



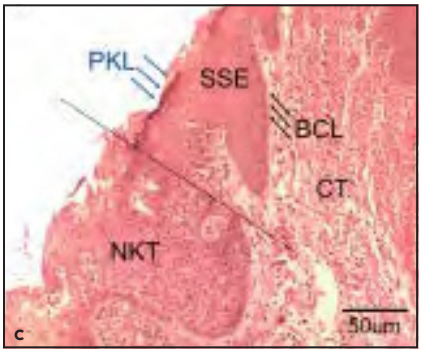
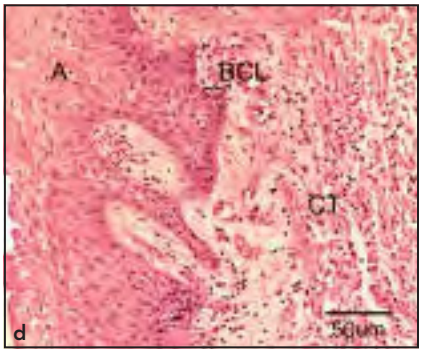


Fig 1d *Higher-magnificaiton view of region 3 in Fig 1a. At the NKT tissue region, a mild chronic inflammatory response was observed in the connective tissue (CT), and a basal layer (BCL), along with a spinous layer (with acanthotic morphology [A]), was observed (hematoxyline-eosin; original magnification ×100).*



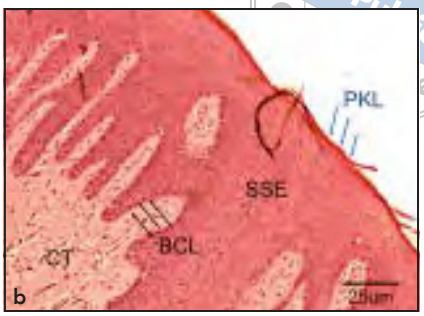
Results

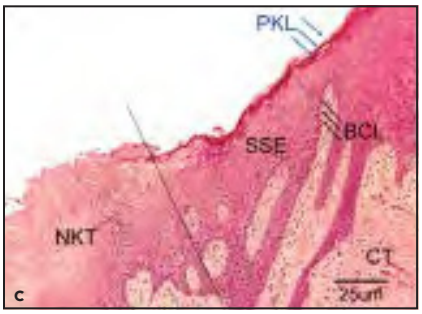
The healing period was uneventful for all patients. The soft tissue healing after abutment placement was uneventful in all but one patient, who presented clinical signs of inflammation in the proximity of one implant at 4 weeks after abutment connection. This patient was treated with local chlorhexidine 0.12% rinses along with amoxicillin and clavulanic acid (875 mg and 125 mg, respectively) every 12 hours for 7 days. No signs of inflammation were observed at 7 days subsequent to inflammatory treatment.

Representative hematoxylin-eosin–stained sections for the standard and platform-switched samples are presented in Figs 1 and 2, respectively. Wider and longer connective tissue around platform-switched implants was observed compared to that with standard abutments. Despite the different dimensions between the two abutment types, similar abutment–soft tissue interaction was observed for both groups. Stratified squamous epithelium was observed at the free, marginal, and gingival sulcus regions (Figs 1a and 1b and 2a and 2b). The tissue morphology in these regions was consistent with noninflammed tissue, presenting the connective tissue layer without inflammatory infiltrate underlying a parakeratinized epithelial layer. The parakeratinized tissue presented with basal and spinous layers, no granular layer, and keratin cells with nuclei (Figs 1b and 2b).

A sharp transition from a parakeratinized to nonkeratinized tissue morphology was observed for both the platform-switched and standard abutment configurations (Figs 1c and 2c) and extended deeper into the sulcular region. Immediately adjacent to this transition to nonkeratinized tissue, a thicker epithelial layer was observed with slight hyperplasia. At the nonkeratinized tissue region, a mild

Fig 2a *Gingival tissue around a grit-blasted platform-switched implant abutment (hematoxylin-eosin; original magnification ×20).*





Figs 2b and 2c *Higher-magnification view of regions 1 and 2 in Fig 2a. Stratified squamous epithelium (SSE) and a connective tissue (CT) layer underlying a parakeratinized epithelial layer (PKL), along with its basal layer (BCL), were observed. (c) Note the sharp transition from a parakeratinized to nonkeratinized tissue (NKT) (dashed line). A thicker epithelial layer was observed with slight hyperplasia (hematoxylin-eosin; original magnification ×100).*

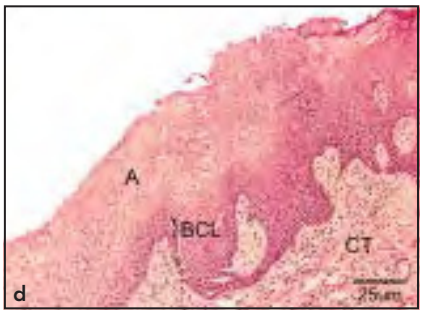


Fig 2d *Higher-magnification view of region 3 in Fig 2a. At the NKT tissue region, a mild chronic inflammatory response was observed in the connective tissue (CT), and a basal layer (BCL), along with a spinous layer (with acanthotic morphology [A]), was observed (hematoylin-eosin; original magnification ×100).*

chronic inflammatory response was observed in the connective tissue, and a thicker basal layer with more than 1 to 1.5 cell layers was observed along with a spinous layer that comprised the remaining tissue thickness (Figs 1c and 2c). This tissue region presented an acanthotic stratified squamous epithelium, with areas where the spinous cell cytoplasm was paler.

The tissue that had presented clinical signs of inflammation after abutment connection presented signs of inflammation at the time of sample retrieval; tissue hyperplasia at both the marginal and sulcular gingival regions was observed (Fig 3). These regions presented areas where the spinous cell cytoplasm was paler below the keratin cells presenting nuclei. The transition between parakeratizined and nonkeratinized sulcular tissue regions was sharp. The nonkeratinized tissue region presented morphologic features similar to those described for tissue retrieval without clinical signs of inflammation.

The histomorphometric results for the vertical linear measurements are presented in Table 1.

Discussion

This study addressed the morphologic features of soft tissue surrounding textured surface conventional and platform-switched abutments placed using a submerged implant healing protocol.

It is well documented that long junctional epithelium around implants is similar to the junctional epithelium around natural teeth.[8,22–25] In healthy patients with normal peri-implant tissue, histologic examination of the connective tissue commonly reveals neutrophils, macrophages, lymphocytes, mast cells, and a few plasma cells.[26,27] The results of this study are in direct agreement with previously published work.[26,27] However, one exception was the soft tissue, which presented signs of clinical inflammation 4 weeks after abutment connection. Even though local and systemic treatments led to regres-

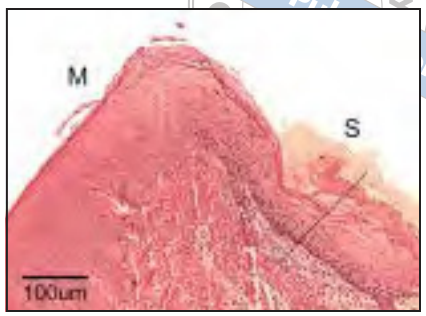


Fig 3 *Representative section of gingival tissue around a grit-blasted regular implant abutment that had presented clinical signs of inflammation at biopsy. Epithelial tissue hyperplasia at both the marginal (M) and sulcular (S) gingival regions was observed. The transition between parakeratizined and nonkeratinized sulcular tissue region was sharp and is represented by the dotted line. The morphologic features of the nonkeratinized tissue region were similar to those described for tissue retrieval without clinical signs of inflammation (see Figs 1c and 2c).*

Table 1 Histomorphometric results in mm (mean ± standard deviation)

	aJE	aICI	MAIC
Conventional	0.89 ± 0.24	1.06 ± 0.68	0.28 ± 0.09
Platform-switched	0.91 ± 0.32	1.11 ± 0.53	0.24 ± 0.07
P	.63	.48	.54

aJE = apical extension of the long junctional epithelium; aICI = apical extension of the inflammatory cell infiltrate; MAIC = maximum area occupied by inflammatory cells.

sion of the clinical signs of inflammation after 1 week, which was maintained for 7 weeks until specimen retrieval, cellular-level morphology showed tissue hyperplasia at both the marginal and sulcular gingival regions. Such an observation supports the notion that subclinical inflammation may persist over extended periods of time after regression of the clinical characteristics of inflammation.

It has been demonstrated that the configuration around conventional implant-abutment connections is similar to the soft tissue–tooth interaction, where a decrease in epithelial thickness is observed from coronal to cervical aspects.[9,11] However, when a platform-switched implant-abutment configuration was used, Romanos et al[22] showed that variations in epithelial thickness occurred along the length of the implant abutment. Such observations may be explained by the platform-switching protocol, which provided a horizontal dimension to the implant biologic width. Clinically, this is of particular relevance since esthetics, health, and function could be improved under such circumstances, and long-term clinical trials are warranted. Despite the different dimensions between the two groups of abutments, similar abutment–soft tissue interaction was observed for both groups, and in general, the characteristics of this peri-implant tissue are in agreement with previous studies, likely providing adequate sealing characteristics relevant to maintaining the health and esthetics of implants and their restorations over time.

A stratified squamous epithelium was observed at the free, marginal, and gingival sulcus regions, with a transition from parakeratinized to nonkeratinized tissue morphology observed deeper into the sulcus regardless of the implant-abutment geometric configuration. These observations are in agreement with a previous histologic study in humans on one-piece mini-implants with different surface textures in which the sulcular epithelium was noted to consist

of nonkeratinized basal and suprabasal cells.[23] The authors also demonstrated that oxidized and acid-etched implants presented less epithelial downgrowth and a longer connective tissue seal than machined implants.[23] Because of the importance of the mucosal attachment and location of the microgap and their relationship to the maintenance of osseointegration, esthetics, and function, further research is necessary to determine how different materials and configurations affect these clinical implications.

Conclusions

Although limited in the number of samples evaluated, this histomorphometric evaluation was in direct agreement with previous studies,[19,20] showing that despite the different configurations between the groups tested, the apical extension of the junctional epithelium, apical extension of the inflammatory cell infiltrate, and maximum area occupied by inflammatory cells did not differ between groups. While this study only considered alumina-blasted/acid-etched surfaces with two abutment geometric configurations, investigations concerning the same geometries presenting other surface textures (including a machined surface as a baseline) are warranted.

Acknowledgment

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