

# Influence of tissue biotype in the morpho-esthetic-functional behavior of the peri-implant tissue: A literature review

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## Abstract

**Introduction:** The current focus of Implantology is the planning of a rehab contemplating, besides the function, the esthetical success. The expectation is to create an esthetic restoration that is indistinguishable from the natural tooth, as well as returning the contour of peripheral structures (peri-implant mucosa and papilla) that resemble the same contralateral structures. It is a field of multiple variables in which the identification of tissue biotype is a factor that competes for the achievement of such success. **Objective:** The purpose of this present work was to review the influence of gingival biotype on morpho-functional and esthetic behavior of peri-implant tissues, indicating protocols of diagnosis and management of these tissues. It was used as source of research the data base of PubMed, selecting articles published from March 2008 to June 2011. **Conclusion:** Within the limits of this review, it was possible to conclude that tissue biotype has influence on the esthetic in the therapy with implants, specially on the facial peri-implant mucosa levels; presenting the thin biotype greater susceptibility to recession. In this condition, the conversion of a thin biotype into a thick biotype, through grafting of conjunctive tissue seems to positively influence on the level of facial marginal mucosa. On the other hand, the tissue biotype showed little influence on the height of the interproximal papilla.

**Keywords:** Dental implant. Biotypology. Periodontics.

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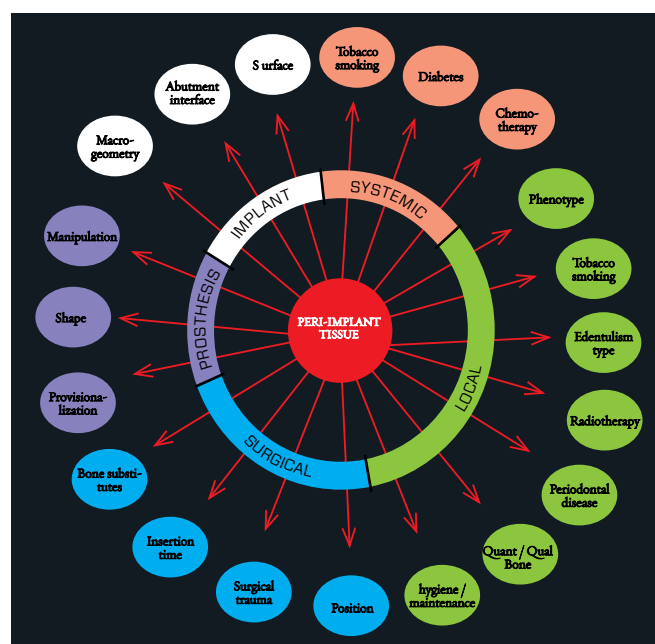
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## Introduction

Albrektsson et al<sup>1</sup> and Smith and Zarb<sup>2</sup> proposed the criteria of success and survival for dental implants extremely relevant on the evaluation of the osseointegration. Today, with the high survival rates and success of therapy with implants, the objective has been to create an esthetic restoration that is indistinguishable from the natural tooth and that is stable through the years.<sup>3,4,5</sup> The periodontal and peri-implant mucosa and interproximal papillae must keep the same peculiarity of shape and color with one another.<sup>6</sup> Multiple variables compete to achieve the desired esthetic success on rehabs by implants. The peri-implant tissues are directly or indirectly affected by five main large groups of determinants: 1 - Surgical (surgical trauma, implant position, use of graft or bone substitute and period of insertion); 2 - Prosthetic (type of provisionalization, shape, manipulation of components); 3 - Geometry of implants (macrogeometry, interface implant/abutment and surface); 4 - Systemic (smoking, diabetes, chemotherapy); 5 - Local factors (hygiene, maintenance, bone quantity and quality, periodontal disease, radiotherapy, type of edentulism, smoking and periodontal biotype)<sup>7-10</sup>, (Fig 1).

Even though these factors work together, over the last years it has been published studies with the purpose

of establishing if there are factors with higher degree of importance, or that can be considered critical. In this context, it has been studied the influence of the tissue biotype on the morphology of the peri-implant esthetic and on its long term stability.<sup>3,11,12</sup> For that, many concepts were brought from Periodontics, such as basic description of two categories of gingival biotypes: Thick and flat biotype and thin and scalloped biotype (Fig 2 A and B).<sup>13</sup>



**Figure 1** - Determinants of peri-implant morphology.



**Figure 2** - Clinical illustration of patients with different periodontal biotypes. **A)** Thin scalloped biotype: Observe the high triangular shape of the papillae. **B)** Biotype thick and flat: Observe the low triangular shape of the papillae.

The thin biotype has been related to a higher risk of recessions in buccal area,<sup>14</sup> greater difficulty to papillary filling,<sup>15</sup> translucency creating transgingival metallic appearance, greater susceptibility of bone loss, fenestration and dehiscence (Kao and Pasquinelli).<sup>16</sup> It was also observed that there was a gain of soft tissue after procedure of crown lengthening in patients with thick gingiva when compared to patients with thin gingiva.<sup>17</sup> This observation coincides with a greater prevalence of gingival recession reported before by Olsson and Lindhe.<sup>18</sup> The gingival biotype has also been described as one of the key elements for the success of restorations on implants.<sup>19</sup> Particularly, the presence of papilla between immediate single implant and adjacent teeth was significantly correlated to a thick peri-implant mucosa.<sup>20</sup> The tendency of greater gingival recession in immediate single restorations on an implant in patients with a thin peri-implant mucosa was also described.<sup>21</sup> Similarly, the gingival recession was most found after the regenerative surgery in patients with thin gingiva.<sup>22,23</sup> These observations show that the discrepancies on the treatment esthetic result may come as consequence of the variability of the tissue response to surgical trauma. Especially patients with thin and scalloped biotype seem to have higher risk of esthetic failure and therefore need to be identified precisely. The purpose of this work is to review the literature about the influence of the gingival biotype on the morpho-functional and esthetic behavior of the peri-implant tissues, indicating protocols of diagnosis and management of these tissues that privilege the esthetic success and its stability on partial rehabs.

### Literature review

It was performed a bibliographic research on PubMed data base using the keywords "periodontal biotype", "peri-implantar biotype", "peri-implantar esthetic" and "dental implants". It was selected articles published from March 2008 to June 2011.

### Characterization and identification of tissue biotypes

Kao et al<sup>24</sup> in 2008 described their observations around the comparison between thick and thin gingival biotype as key determinant on the dental implants treatment plan. They related the thin biotype to a scalloped, delicate and friable architecture; minimum gingiva inserted; subjacent bone characterized by dehiscence and fenestrations; and respond to trauma and to the periodontal disease with gingival recession. On the other hand, related the thick biotype to a healthy, fibrous periodontium, with large zone of gingiva inserted; a flat architecture and thick bone, as well as more resistant to trauma; respond to periodontal disease with formation of pockets and intraosseous defects; the healing and stabilization of the soft and hard tissues contours post-surgical trauma are more predictable than on thin biotype. They concluded that the surgeon must use periodontal and surgical procedures to minimize the alveolar resorption and provide a better quality tissue for the installation of implants. Januarío et al<sup>25</sup> described a method of visualization and measurement of soft and hard tissues through Cone-Beam computerized tomography (CBCT). Therefore, it was selected three patients with different gingival biotypes, and they were submitted to two tomographic takes of the same site. The first take (CBCT) was performed conventionally of the maxilla. The second take (ST-CBCT) was performed the same way as the first one but with the use of lip retractor and asked to retract the tongue to the mouth floor. From the ST-CBCT they registered the measurements of the distance from gingival margin to cemento-enamel junction and thickness of buccal gingiva. They concluded that the described method is necessary and of great value on the evaluation of the dimensions and relations between the several periodonto structures and the complex of dentogingival insertion. De Rouck et al<sup>12</sup> revised the method of transparency of periodontal probe in a transverse study (n=100), aiming identify the different gingival biotypes.

The gingival thickness was evaluated introducing a periodontal probe in the buccal gingival sulcus of the two upper central incisors (UCI); if the probe turned transparent through the gingiva of the two UCI, this would be categorized as score 0; if it could not be seen through the gingiva of only one of the central incisors, it would be categorized as score 1; and if it could not be seen through any of the two UCI gingivae it would be score 2. Crossing the morphometric data, it was identified three groups: Group A1, with thin and scalloped biotype, small zone of keratinized gingiva and crowns with delicate form (37%); Group A2, with thick biotype and same characteristics of the crowns on group A1 (34%); and Group B, with thick and flat biotype, large zone of keratinized gingiva, low papillae, greater probing depth and quadrangular crowns (29%). The authors also concluded that the method of transparency of probe for identification of gingival biotype is simple and reproducible. Eghbali et al<sup>26</sup> in 2009, performed transverse study (n=100) to evaluate the efficiency of the visual method on the identification of the several gingival biotypes. Participated in the work: 5 prosthetists (Group R); 5 periodontists (Group P) and 5 students of odontology (Group S). To all groups it was requested that, through standardized photographs, categorized the gingival biotypes in: Thin-scalloped or thick-flat or thick-scalloped. There was coincidence with a gold standard: 52% of the thin-scalloped biotypes identified by Group R; 61% by Group P; and 57% by Group S. The thick-flat biotype was more easily identified with mean of 73% for Group R; 70% for Group P and 51% for Group S. The thick-scalloped biotype was more rarely identified with 45% for Group R; 26% for Group P and 43% for Group S. Intra-examiners the accuracy ranged from 57% and 78%. Inter-examiners the reproducibility ranged from 34% to 72%. They concluded that the visual inspection cannot be a reliable method on the identification of gingival biotype, for its main error

occurs on the identification of the thin biotype which can be tragic for its high risk of esthetic complications after surgery or restorative therapy. Kan et al<sup>27</sup> performed transverse study (n=48) evaluating the reliability of the visual methods of identification of gingival biotype, comparing to the method of direct measurement through adapted gauge thickness. The method of simple visualization was efficient when the gingiva was 0.6 mm thick for thin biotype and >1.0 mm for thick biotype; still on the visual method, in the interval between 0.7 mm and 1.0 mm there was a predisposition for classification in thick biotype. Now on the visual method of transparency of probe it was efficient on thin biotypes when the gingiva was 0.6 mm thick and on thick biotypes when it was >1.2 mm thick. The authors concluded that the method of simple visualization is not sufficient for a diagnosis and an appropriate esthetic planning.

#### ***Papilla height and peri-implant mucosa recession***

Kan et al<sup>3</sup> (2009) reported a case series (n=20) where they evaluated the effects of increasing soft tissues using subepithelial conjunctive tissue grafts (SCTG) with immediate single implant. It was observed that there was no statistically significant difference between the obtained results on the level of marginal bone of patients with thick biotypes and patients with thin biotypes. On the measurement of facial gingival levels (FGL) it was also observed absence of statistically significant difference between the several tissue biotypes. Their observations indicate that, with the appropriate three-dimensional positioning of the implant, bone graft in the gap between the alveolar wall and implant, and graft of conjunctive tissue may contribute to the maintenance of the marginal gingiva levels, independently of initial gingival biotype. That is, thin gingival biotype can be converted in thick, on its morphology and behavior through these procedures. Chow and Wang<sup>15</sup> in 2010 performed a literature review

evaluating the factors that affect the appearance of the peri-implant papilla. The research on MEDLINE was the base for their study, identifying articles published until September 2007, related to esthetic in implants as peri-implant papilla. The study suggests that thicker gingival tissue, not only resists better to physical trauma and subsequent to gingival recession, but also allows a better management of the tissues (Fig 3), facilitating the filling of the interproximal niche by the

papilla and makes the surgical result more predictable. The authors concluded that the gingival thickness as much as other factors as: Bone crest height, interproximal distance, teeth size and width of the keratinized gingiva zone affected the appearance of the peri-implant papillae. Nisapakultorn et al<sup>14</sup> in 2010 performed a transverse study (n=40) to determine the factors that may affect the facial marginal mucosal level and the papilla level around single implants on the anterior maxilla.

Characteristics	Gingiva	Peri-implant mucosa	
		Thin	Thick
Soft tissue interface	Hemidesmosomes and basal lamina (reduced enamel epithelium).	Hemidesmosomes and basal lamina (oral adjacent epithelium).	
Junctional epithelium and connective tissue	Collagen fibers inserted perpendicularly to the cementum	Fewer amount of collagen fibers parallel and circular	Greater amount of parallel and circular collagen fibers
Tissue quality	Lower proportion of collagen	Lower proportion of collagen	Higher proportion of collagen
Connective Tissue Composition	Higher proportion of fibroblasts	Delicate and fine	Dense and fibrotic
Vascular provision	Increased vascularization	Smaller vascularization Smaller blood supply	Increased blood supply
Biological distance	Junctional epithelium - 1 mm Connective tissue attachment - 1 mm	Lower thickness of connective tissue	Junctional epithelium - 2 mm Connective tissue - 1 mm Higher thickness of connective tissue
Probing depth	≤ 3 mm	Trend to gingival recession	2.5 - 5.0 mm Gingival recession resistance. Trend to formation of peri-implant pocket
Bleeding on probing	Clear sign of inflammation	No indication of inflammation	
Proprioception	Provided by the presence of periodontal ligament	No proprioception	
Profile	Determined by the tooth size.	Determined by the implant position, abutment profile, shape of the crown, the implant platform	
		Scalloped soft tissue Hard tissue with fenestrations and dehiscences	Relatively flat soft tissue Hard tissue with thick edges

**Figure 2** - Characterization and differentiation between gingiva and peri-implant tissue on thin and thick biotype (adapted from Chow<sup>15</sup>).

It was performed clinical measurements on the implants and on contralateral teeth, especially with periodontal probe obtaining probing depth, as well as the categorization of gingival biotype. They concluded that there is no relation between peri-implant tissue biotype and interproximal papilla level; on the other hand the association between peri-implant biotype and facial marginal mucosal level was positive with risk of greater recession of peri-implant mucosa on thin biotypes. Wiesner et al,<sup>28</sup> on a randomized clinical trial (n=10), evaluated the effectivity of conjunctive tissue grafts used on the placement of implants on the increase of volume of the peri-implant soft tissues. On one side of the lower dental arch of each patient it was performed the installation of implant with increase of soft tissue with conjunctive tissue graft removed from the palate; on the other side only installation of implant. For the measurement of results, factors such as thickness of soft tissues and esthetics, among others, were considered and evaluated using standardized levels of evaluation and digital intraoral radiographs. This study shows that the side with graft obtained a mean of 1.3 mm of increase on the thickness of the soft tissue. The authors concluded that the use of conjunctive tissue graft is efficient on the increase of the thickness of peri-implant tissue, improving the esthetic results. Grunder<sup>29</sup> in a case series evaluated the buccal thickness of peri-implant soft tissues on the installation of immediate implants after extraction, with and without subepithelial graft. Therefore it was installed 24 implants of which 12 received subepithelial tissue graft and 12 did not received graft at all. It was performed clinical measurements with the use of periodontal probe on the moment of insertion of the implant and after 6 months of healing. These measurements showed that on the group that did not received graft, there was an average reduction in volume of 1.063 mm. On the other hand, on the group that received conjunctive graft, it was obtained an average gain in volume of 0.34 mm.

It was observed a greater gingival recession on cases where it was not used the conjunctive graft, concluding that, providing a thicker gingival biotype, compensates the loss of gingival volume expected and keeps fine esthetic results. Tsuda et al<sup>30</sup> in 2011 reported a case series (n=10) aiming to evaluate the response of the peri-implant tissue after the installation of immediate implant after extraction with bone graft in the gap between buccal bone wall and implant (Bio-Oss®), immediate provisionalization and subepithelial conjunctive tissue graft. In this study it was evaluated, clinical and radiographically, after 3, 6 and 12 months since performed the surgery. After one year, it was observed a mean marginal bone alteration of 0.10 mm and a change on the facial gingival mean level of -0.05 mm. It was concluded that the favorable responses of the bone tissue and the peri-implant facial gingival level can be achieved and kept when the implant is well positioned and if bone and conjunctive grafts are performed properly. Raes et al<sup>31</sup> in 2011 performed a clinical study (n=39) to evaluate the dynamic of facial soft tissues after treatment with immediate single implants (IIT) and treatment with conventional implants (CIT) on the anterior maxilla. All patients received implants on ideal position; flapless surgery for the IIT group and conventional surgery with full-thickness flat elevation for group CIT and immediate provisionalization. On the aspect of papilla height, it remained stable. However regarding the gingival margin level, the results on the last evaluations were: On group IIT the levels remained relatively stable with loss of over 1 mm in 7% of the cases. On the other hand on group CIT the same loss was observed in 43% of the cases. Besides, it was also observed a gain of tissue height in over 1 mm on group IIT in 13% of the cases. The authors concluded that the technique used on group IIT showed itself effective on the preservation of the peri-implant soft tissues contours, as long as the selected patients have thick gingival biotype, and the flapless technique is used. They also concluded that

the greater gingival recessions occurred on group CIT explained by the technique of full-thickness flat elevation, with no differences between thin or thick gingival biotype. Fu et al<sup>32</sup> in 2011 proposed the “PDP triad management”: Implant position (P), implant design (D) and prosthesis design (P), as a way to increase the soft tissue thickness around implants. The PDP triad management suggests the use of implant design with parallel walls and switching platform, the use of implants with smaller diameter with its positioning more palatine and apical, and the concave prosthesis design. This preserves the buccal bone thickness, allows growth of soft tissue around the abutment level, increasing the soft tissue thickness and minimizing the potential to recession of the peri-implant mucosa. Although the tissue biotype is a characteristic that varies from patient to patient, this can be converted through an accurate management of PDP triad so that the desired esthetic result is achieved. Kan et al<sup>33</sup> in 2011 performed a prospective study (n=35) with assistance from 2 to 8 years in which evaluated the peri-implant response after the installation of immediate single implants in esthetic zone of the maxilla and the effects of gingival biotype on peri-implant tissues. It was observed that sites with a thick gingival biotype showed slighter changes on gingival levels when compared to sites of thin biotype both on first year of assistance (-0.25 mm versus -0.75 mm respectively) as on recent exams (-0.56 mm versus -1.50 mm respectively). The authors concluded that the effects of gingival biotype seem to be limited to facial gingival recession, being greater in thin biotypes, on the other hand, not affecting the height of the interproximal papilla or on the proximal marginal bone levels (Fig 4).

## Discussion

### **Diagnosis and description of gingival biotype.**

Some works that were mentioned in this literature review emphasize the importance of identification of

gingival biotype, for its decisive impact on the morpho-functional and esthetic behavior of peri-implant tissues.<sup>3,21,24</sup> This way, methods have been used with this purpose: Method of direct visualization,<sup>13</sup> method of transparency of periodontal probe,<sup>11</sup> direct measurement,<sup>27</sup> transgingival probing<sup>29</sup> and Cone Beam Computerized Tomography - CBCT.<sup>25</sup> The method of direct visualization seems to be non-reliable as shown on the work of Eghbali et al,<sup>26</sup> 2009. The same way, Kan et al<sup>27</sup> in 2010 did not recommend the method of direct visualization, however, said that the method of transparency of periodontal probe is appropriate and reliable for diagnosis, surgery planning and restorative procedures; these observations agree to the conclusions of De Rouck et al,<sup>12</sup> 2009 that asserted it is yet a simple and reproducible method. The CBCT method, however, showed itself accurate, non-invasive, since performed with appropriate lip and tongue retraction; on the other hand, has as disadvantage: High cost, necessity of prepared technician and high doses of radiation.<sup>32</sup> Before this, it is extremely important the identification of gingival biotype by, at least simplified, the method of transparency of probe and, when possible, through the CBCT.

### **Recession of peri-implant mucosa**

The thick gingival biotype has been related to a healthy periodonto, with large gingiva inserted, flat architecture and thick bone; resistant to surgical trauma. On the other hand, the thin gingival biotype has been related to scalloped architecture, delicate and friable, minimum gingiva inserted, subjacent bone characterized by dehiscence and fenestrations; and greater tendency to gingival recession. These characteristics of thin tissue biotype carry an unpredictability on post-surgical esthetic results.<sup>24</sup> From these observations, it seems to be feasible the indication of subepithelial conjunctive tissue graft, especially on areas of thin biotype, aiming to prevent recession of peri-implant mucosa.<sup>3,29,30,33</sup>



Author/year	Type of study	Time	Sample	Technique	Conclusions
Januário et al <sup>25</sup>	Technique description	-	3 patients	Two tomographic takes: One with lip retractor and one without	The method described is necessary and of great value on the evaluation of dimensions and relations between several periodontium structures and the complex of dentogingival insertion.
Kan et al <sup>3</sup>	Case series	2 to 2,9 years	20 patients 20 implants	Single implant +immediate provisionalization + conjunctive tissue graft	The thin gingival biotype can be converted to thick on its morphology and behavior through conjunctive tissue graft
De Rouck et al <sup>12</sup>	Transverse study	-	100 patients	Use of transparency of probe aiming to identify groups with different morphometric combinations of soft tissues	The method of transparency of probe for the identification of gingival biotype is simple and reproducible
Eghbali et al <sup>26</sup>	Transverse study	-	100 patients	To evaluate the efficiency of the visual method on the identification of the several gingival biotypes through photographs	The visual insertion can not be a reliable method of identification of gingival biotype, for its main error occurs on the identification of the thin biotype
Nisapakutorn et al <sup>14</sup>	Transverse study	-	40 patients 40 implants	Measurements of heights of the clinical crowns of implants and contralateral teeth	There is no relation between tissue biotype and interproximal papilla level; however the association between biotype and facial marginal mucosal level was positive
Kan et al <sup>27</sup>	Transverse study	-	48 patients	Direct measurement comparing to visual methods of identification of gingival biotype	The simple visual method is not sufficient for a diagnosis and esthetic planning, on the other hand, the method of transparency of probe showed itself appropriate and reliable
Wiesner et al <sup>28</sup>	Randomized clinical trial	1 year	10 patients 20 implants	Implant + Conjunctive tissue graft	The use of conjunctive tissue grafts is efficient on the increase of thickness of peri-implant tissue, improving esthetic results
Grunder et al <sup>29</sup>	Case series	6 months	24 patients 24 implants	Immediate implant + Conjunctive graft	Use of conjunctive grafts can provide a thicker gingival biotype, achieving a fine esthetic result
Tsuda et al <sup>30</sup>	Case series	1 year	10 patients 10 implants	Immediate implant + Immediate provisionalization+ Bio-Oss graft+ Conjunctive tissue graft	Favorable responses can be achieved when the implant is well positioned and if bone and conjunctive grafts are performed
Raes et al <sup>31</sup>	Clinical trial	52 months	39 patients 39 implants	Immediate single implants (IIT) and conventional implants (CIT)	The technique used on group IIT showed itself effective on the preservation of the soft tissue contours. Greater gingival recession occurred on group CIT with no difference between tissue biotypes
Kan et al <sup>33</sup>	Prospective study	2 to 8 years	35 patients 35 implants	Immediate implant+immediate provisionalization	The gingival biotype seems to affect the facial gingival level, however has little impact on the height of the interproximal papilla

**Figure 4** - Summaries of the main experimental articles related to periodontal and peri-implant biotypes.



These works suggest that the thin gingival biotype can be converted to thick, on its morphology and behavior, through conjunctive graft, achieving more favorable esthetic results. On the other hand, it is still not very well documented the stability of this grafted tissue in the long-term. Still aiming to increase the thickness of the peri-implant mucosa, Fu et al,<sup>32</sup> 2011 proposed the PDP triad management, which is based in: Concave abutment and profile of the crown, design of the narrower implant, and three-dimensional positioning of the implant more apical and palatal. Thus, with the increase of the mucosa thickness it is possible to maintain the margin levels. The authors Kan et al,<sup>3</sup> 2009 and Tsuda et al,<sup>30</sup> 2011 similarly, in study about immediate implants, defended the appropriate positioning of the implant (to palate), as well as the performance of bone grafts on eventually gap between alveolar wall and implant, and conjunctive tissue graft to achieve more favorable responses on bone levels and peri-implant mucosa levels. The observations of Raes et al,<sup>31</sup> 2011 suggests that flapless surgery can also prevent peri-implant recessions, on the technique of immediate implants installation, as long as selected the patients with thick biotype; however, the same authors refer the high risk of recession of the peri-implant mucosa, on the installation of immediate implants in patients with thin tissue biotype. Thus, it seems recommendable a more apical and palatal positioning of the implant, as well as contraindicate immediate implants in patients with thin biotype, in order to prevent recession of peri-implant mucosa. The flapless surgery suggested by Raes et al<sup>31</sup> shows it self efficient, however demands accurate technique and preparation from the surgeon.

### **Height of peri-implant papilla**

The papillary filling of the interproximal niche seems to be related to several factors: Gingival biotype, bone crest height, interproximal distance, teeth size and width of the keratinized gingiva zone. A thick tissue biotype was described as more resistant to surgical trauma, making the result more predictable.<sup>15</sup> On the other hand, Kan<sup>33</sup> in 2011 did not find statistically significant difference when evaluated the papilla heights in different gingival biotypes. Similarly, Nisapakultorn<sup>14</sup> in 2010 also did not find relation between tissue biotype and papilla height, confirming the conclusions by Raes<sup>31</sup> in 2011. The papilla behaves with extremely sensibility to trauma and it is fundamental on the composition of the peri-implant morpho-functional and esthetic complex; therefore, it is suggested that each and every trauma must be avoided: On the moment of extraction or of reopening surgery.

### **Conclusions**

Within limits of the present literature review, it was concluded that:

- 1) The identification of tissue biotype is necessary for better restorative surgical planning on therapy with implants.
- 2) The thin biotype presents a higher risk of recession of the peri-implant mucosa.
- 3) The conversion of a thin tissue biotype into thick biotype, through conjunctive tissue graft seems to affect positively the facial marginal mucosal level.
- 4) The tissue biotype seems to have little influence on the height of the interproximal papilla.
- 5) It is still necessary long-term control studies establishing the relation between biotype.

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