Esthetic risk assessment of immediate implant: position paper and proposal of a novel diagnostic parameter

La determinazione dei fattori di rischio estetici negli impianti post-estrattivi: stato dell’arte e proposta di un nuovo parametro diagnostico

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Abstract

Objectives: The aim of this paper is to assess the risk factors that could influence the esthetic and long term results of implant placement in fresh extraction sockets.

Materials and methods: The immediate implant risk factors that could influence the final outcome are analyzed and could be summarized in: the peri-implant soft tissue biotype, the vestibular bone thickness, the alveolar host infected site, the residual peri-implant gap and the final implant position. Furthermore a diagnostic parameter that could influence the therapeutic approach is proposed.

Discussion: Several factors have been proposed as being important in determining the stability of the peri-implant mucosa, including implant shoulder position in the buccal-lingual and apico-coronal direction and tissue biotype. The initial thickness of the buccal crestal bone

Key words: Alveolar socket, Bone graft, Bone resorption, Immediate dental implants, Post-extraction site

Parole chiave: Alveolo, Innesto, Riassorbimento osseo, Impianti dentali immediati, Siti post-estrattivi

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may be a factor in determining the extent of the vestibular bone resorption. Thick soft and hard peri-implant tissues could contribute to marginal stability. Infected alveolar site is not a contradiction to implant placement and the peri-implant gap should be grafted in order to minimize the horizontal resorption. The implant position and diameter should be carefully analyzed in order to preserve peri-implant soft tissue stability.

Conclusions: Marginal tissue recession, occurred at both thin and thick biotype sites. When implants are placed immediately after tooth extraction, the implant-vestibular plate distance is a critical parameter to evaluate, and can be a useful diagnostic parameter that guides the clinician in the choice of the most appropriate grafting procedure. Grafting the marginal defects may limit the horizontal resorption, however “overbuilding” the buccal aspect may be a suitable technique to compensate for the physiological alveolar bone changes.

Key points

- Achieving an esthetically pleasing restoration involves not only harmonizing the size, shape, position and color of each prosthetic tooth with the adjacent teeth; but establishing a stable peri-implant tissues compatibility with the surrounding gingiva and mucosa is also essential.
- The task of a long term esthetic and functional implant is to carefully assess each risk factors that could compromise the final result.
- The majority of the studies deal with immediate (Type 1) placement and report mean recession of the facial marginal mucosa ranging from 0.5 to 0.9 mm. Approximately one-third of the sites demonstrated recession of 0.5 mm or more.
- The minimal buccal width required to avoid vertical crestal resorption has yet to be established but the thickness of the buccal bone crest significantly influenced the amount of the vertical resorption.
Introduction

One of the most challenging objectives of implant procedures is the preservation of hard and soft tissue following the loss of one or more teeth. From a surgical perspective, the current concept is that a proper soft tissue morphology and symmetry can be achieved with correct three-dimensional implant placement, that optimizes the emergence profile of the restoration.

- The placement of immediate implants in chronically infected sites may not be necessarily contraindicated if appropriate clinical procedures like antibiotic administration, meticulous cleaning and alveolar debridement are performed before implant surgical procedure.
- Implants that were placed facially within the sockets demonstrated significantly greater recession than sites where implants were more palatally positioned. With immediate implant placement in the anterior maxilla, the implant should be placed in a slightly palatal position in the socket and prevent the implant shoulder from being placed in the “facial danger zone”.
- Grafting of the marginal defect with bone or bone substitutes can reduce the extent of horizontal resorption and can be undertaken with immediate and early placement protocols.
- In order to preserve the vestibular alveolar bone profile, overbuilding the buccal aspect in combination with immediate implant placement may be a suitable technique to compensate for the physiological alveolar bone changes.

Punti chiave

- Per ottenere una riabilitazione estetica non è sufficiente armonizzare dimensione, forma, posizione e colore del restauro protesico con quello degli elementi naturali adiacenti, ma è di fondamentale importanza ottenere tessuti peri-implantari stabili e integrati con la gengiva circostante.
- Per ottenere impianti funzionali e risultati estetici a lungo termine è necessario valutare attentamente qualsiasi fattore di rischio in grado di compromettere il risultato finale.
- La maggior parte degli studi che riguarda l’inserimento di impianti post-estrattivi (tipo 1) riportano recessioni medie del margine gengivale vestibolare di 0,5-0,9 mm. Circa un terzo dei siti analizzati mostra recessioni di 0,5 mm o più.
- Lo spessore della cresta vestibolare minima per evitare il riassorbimento verticale deve ancora essere stabilito, ma questo spessore influenza significativamente l’entità del riassorbimento verticale dei tessuti molli peri-implantari.
- L’inserimento di impianti post-estrattivi in siti con infezioni croniche non è necessariamente controindicato se vengono svolte procedure cliniche appropriate, come la somministrazione di antibiotici e la pulizia meticolosa dell’alveolo residuo prima del posizionamento implantare.
- Siti con impianti posizionati vestibolarmente hanno mostrato recessioni maggiori rispetto ai siti in cui gli impianti erano posizionati palatalmente. Implant post-estrattivi posizionati nel mascellare anteriore devono essere leggermente palatali in modo che la spalla implantare non sia posizionata nella “facial danger zone”.
- L’innesto del difetto marginale con osso autologo o sostituti ossei può diminuire l’estensione del riassorbimento orizzontale e può essere eseguito contestualmente all’inserimento implantare immediato o precoce.
- L’inserimento di impianti post-estrattivi con il contestuale sovrariempimento vestibolare dell’innesto può essere considerata una tecnica adeguata per compensare il fisiologico rimodellamento alveolare.
Immediate implants have been advocated to preserve soft tissue contour and bone dimensions, to minimize the period of edentulism and to reduce the overall treatment time [1–3]. The concept of immediate placement of dental implants is a well accepted protocol even after removal of a tooth with periapical pathology [4–6]. However other studies have questioned the statement that immediate implant placement can prevent bone resorption [7,8]. Flapless surgery was proposed to preserve bone vascularization and minimize bone resorption. If a full-thickness flap is reflected, disruption of the blood supply will occur with subsequent bone loss [9]. Due to the close relationship between osseous structure and the overlying gingival architecture, the bone resorption resulting from full thickness flap elevation may cause gingival recession. However, a recent human clinical study showed that immediate implant placement with or without a full-thickness flap elevation can be equally successful [10].

When immediate implants are placed, peri-implant voids are frequently present due to a gap between the alveolar socket and the implant. Healing of the peri-implant bone defect is a process involving both bone apposition and bone resorption, the latter occurring to a larger degree than the former. Resorption prevails during healing when the gap is large and the biotype is thin [8,11]. However, the presence of a thick buccal bone wall does not consistently prevent crestal resorption [12]. It has been suggested that the gap between an implant and the socket can be filled with a bone graft in order to preserve the volume [13]. The preservation of bone volume and soft tissue morphology is considered of the outmost importance for achieving a highly esthetic result [14]. The aim of this paper is to assess the risk factors that could influence the esthetic and the long term results in implant placement in fresh extraction sockets.

**Materials and methods: critical evaluation of clinical parameters**

Immediate implant placement (Type 1) [15] involves some advantages but some disadvantages too. The single surgical procedure is considered the main advantage for both the patient and the clinician. It is often considered to result in the reduced overall treatment time as compared to Type 3 and Type 4 implant placement. The implant placement at the time of the tooth extraction can facilitate the implant position for the optimal availability of space to the implant. The marginal defects usually present as two or three wall defects, which are favorable for simultaneous bone-augmentation procedures. The disadvantages of the immediate implant procedure could deal with the morphology of the socket that may lead to a compromised implant position and implant initial stability. There is a lack of soft tissue volume for the flap management and tension free primary closure that could result in an increased risk of vestibular marginal recession.

Generally speaking, the immediate implant insertion is considered a more complex surgical procedure compared to Type 2 and Type 3 implant placement [15] (table I).

In order to achieve an esthetically pleasing restorations involves not only harmonizing the size, shape, position and color of each prosthetic tooth with the adjacent teeth; establishing a stable peri-implant tissues compatibility with the surrounding gingiva and mucosa is also essential. Therefore, the task of a long term esthetic and functional implant is to carefully assess each risk factors that could compromise the final result.

| TABLE I – CLINICAL ADVANTAGES AND DISADVANTAGES OF IMMEDIATE IMPLANT POSITION |
|---------------------------------|-------------------------------------------------|
| **Advantages**                  | Only one surgical procedure                      |
|                                 | Reduced overall treatment time as compared to Type 3 and Type 4 placement |
|                                 | Optimal availability of space to the implant     |
|                                 | Marginal defects usually present as two or three wall defects, which are favorable for simultaneous bone-augmentation procedures |
| **Disadvantages**               | Morphology of the socket may lead to a compromised implant position |
|                                 | Morphology of the socket may lead to a compromised initial implant stability |
|                                 | Lack of soft tissue volume for flap management and tension free primary closure |
|                                 | Increased risk of marginal recession             |
|                                 | Complexity of the procedure is increased as compared to Type 2 and Type 3 placement |
The immediate implant risk factors that could influence the final outcome are analyzed:
• Marginal peri-implant soft tissue stability
• Vestibular bone thickness
• Alveolar host bone with infected sites
• Implant position
• Peri-implant alveolar gap

Marginal peri-implant soft tissue stability

Post-extraction implants are often considered for the replacement of teeth in the esthetic area, and the esthetic outcome is the most an important factor when selecting the appropriate treatment approach. It is important to understand that the soft tissue around an implant behaves differently from that around a tooth. The key difference between natural teeth and implants is the dimension and position of the biological width. Human and animal studies have shown that the biological width around an implant is approximately 1 mm longer than that around natural tooth [16]. In addition, the implant platform is commonly placed at the crestal level, resulting in the interproximal biological width of healthy peri-implant mucosa being subcrestal, compared to the supracrestal biologic width around a natural tooth.

Bone remodeling after implant placement also results in a bone loss to the first thread, creating a bony “sauceration” around the implant ad modum Branemark. Consequently, a subcrestal location of the biological width, a flat interproximal profile and bone remodeling around the implant may jeopardize the esthetic outcome.

Recent studies show data on soft-tissue and aesthetic parameters, including randomized controlled trials [4–6,17,18] and several prospective and retrospective case series studies [19–22]. The majority of these study deal with of immediate (Type 1) placement and report mean recession of the facial marginal mucosa ranging from 0.5–0.9 mm. The frequency of recession with immediate implants (Type 1) is high, with recession of 1 mm of more affecting between 8% and 40% of implants sites. Approximately one-third of the sites demonstrated recession of 0.5 mm or more. A recent prospective cases series documented esthetic outcomes following early (Type 2) implant placement and only 1 out of 20 cases (5%) showed a recession of 0.5 mm to 1 mm after 3 years of follow-up [23] (table II).

In order to withstand the surgical trauma procedures the thickness of the peri-implant mucosa has a relevant role. Seibert and Lindhe [28] coined the term periodontal biotype to describe different

**TABLE II – CLINICAL STUDIES OF POST-EXTRACTION IMPLANTS**

<table>
<thead>
<tr>
<th>Authors</th>
<th>Loading</th>
<th>Insertion Time</th>
<th>Frequency Recession</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wohrle et al., 1998 [24]</td>
<td>Immediate Type 1</td>
<td></td>
<td>14.3%-rec 1-1.5 mm</td>
<td>Mean recession 0.6 mm</td>
</tr>
<tr>
<td>Grunder et al., 2000 [19]</td>
<td>Delayed Type 1</td>
<td></td>
<td>Mean recession 0.5±0.53 mm</td>
<td></td>
</tr>
<tr>
<td>Kan et al., 2003 [20]</td>
<td>Immediate Type 1</td>
<td></td>
<td>0.2±1.5 mm enamel matrix</td>
<td></td>
</tr>
<tr>
<td>Cangini et al., 2005 [25]</td>
<td>Delayed Type 1</td>
<td></td>
<td>0.9±1.3 mm collagen membrane</td>
<td></td>
</tr>
<tr>
<td>Cornelini et al., 2004 [26]</td>
<td>Immediate Type 1</td>
<td></td>
<td>Mean recession 0.75 mm</td>
<td></td>
</tr>
<tr>
<td>Lindboomp et al., 2006 [5]</td>
<td>Delayed Type 1</td>
<td></td>
<td>8.7% rec. 1-2 mm 30% rec. &lt;1 mm</td>
<td></td>
</tr>
<tr>
<td>Chen et al., 2007 [18]</td>
<td>Conventional Type 1</td>
<td></td>
<td>33.3% with rec.</td>
<td></td>
</tr>
<tr>
<td>Juodkaykys et al., 2007 [21]</td>
<td>Delayed Type 1</td>
<td></td>
<td>21.4% rec. 1-2 mm</td>
<td></td>
</tr>
<tr>
<td>Kan et al., 2007 [27]</td>
<td>Immediate Type 1</td>
<td></td>
<td>34.8% rec. &gt;0.5 mm</td>
<td></td>
</tr>
<tr>
<td>Evans and Chen 2008 [22]</td>
<td>Conventional Type 1</td>
<td></td>
<td>45.2% rec. 0.5 mm 21.4% rec. 1 mm 19.1% rec. &gt;1.5 mm</td>
<td>Mean recession 0.9±0.78 mm</td>
</tr>
<tr>
<td>Buser et al., 2011 [23]</td>
<td>Delayed Type 2</td>
<td></td>
<td>One site with rec 0.5-1 mm</td>
<td></td>
</tr>
</tbody>
</table>
gingival architecture types based on bucco-lingual thickness. It was proposed that a thick gingival biotype was flat, whereas a thin gingival biotype was scalloped. In implant dentistry the peri-implant mucosa has been differentiated in thick, medium and thin tissue biotype [29]. Each biotype has its specific characteristics. The lower risk is posed by a thick, broad band of attached mucosa, typically resistant to recession. The thick mucosa is able to mask the color of the implant and their submucosal metallic component, reducing the risk of not achieving a pleasing esthetic result. In contrast, a thin tissue biotype have the highest esthetic risk of mucosal recession. A recent study by Nisapakultorn et al. [30] found that peri-implant tissue biotype was significantly associated with facial marginal mucosal level. Also, patients with a thin biotype had less papilla fill and an increased risk of peri-implant facial mucosal recession. A limited number of clinical trials in the literature were found to have investigated the relationship between tissue biotype and implant esthetic (table III). Although no clinical trial has been conducted to thoroughly examine the influence of peri-implant tissue biotype on post-extraction immediate implant esthetics.

**Vestibular bone thickness**

In addition to soft tissue thickness, facial bone thickness is also an influential parameter for the esthetic result. The ability of the soft tissue to camouflage a bony defect is limited without the support of underlying bone. Several authors have attempted to measure the thickness of the vestibular plate. Variations in buccal bone thickness were speculated to be a result of differences in tooth positions, patient population, and study methodologies. It has been suggested that immediate placement of implants into extraction sockets may preserve the bony architecture. However, recent animal studies have clearly established that following tooth

<table>
<thead>
<tr>
<th>Study</th>
<th>Site</th>
<th>Sample size</th>
<th>Follow-up</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kan et al., 2003 [20]</td>
<td>Maxillary anterior region</td>
<td>45 patients 45 implants</td>
<td>1-year</td>
<td>Dimension of peri-implant mucosa was related to peri-implant biotype</td>
</tr>
<tr>
<td>Cardaropoli et al., 2006 [31]</td>
<td>Maxillary anterior region</td>
<td>11 patients 11 implants</td>
<td>1-year</td>
<td>Mean bone loss of 1.6 mm from time of implant placement to crown placement; mean peri-implant mucosa recession of 0.6 mm; ratio of mucosal thickness: height of free peri-implant marginal tissue=1:1.5</td>
</tr>
<tr>
<td>Chen et al., 2007 [18]</td>
<td>Maxillary anterior and premolar regions</td>
<td>30 patients 30 implants</td>
<td>3-4-year</td>
<td>Mucosal recession significantly related to buccal placed implants instead of tissue biotype</td>
</tr>
<tr>
<td>Evans and Chen 2008 [22]</td>
<td>Maxillary and mandibular anterior and premolar regions</td>
<td>42 patients 42 implants</td>
<td>19-month</td>
<td>Thin tissue biotype showed greater per-implant mucosal recession than thick tissue biotype, though not statistically significant</td>
</tr>
<tr>
<td>Romeo et al., 2008 [32]</td>
<td>Maxillary and mandibular anterior and premolar regions</td>
<td>48 patients 48 implants</td>
<td>1-year</td>
<td>A thick tissue biotype was associated with papilla fill</td>
</tr>
<tr>
<td>Chen et al., 2009 [33]</td>
<td>Maxillary incisors</td>
<td>85 patients 85 implants</td>
<td>1-year</td>
<td>Mucosal recession of more than 10% occurred at 24% of sites with thin tissue biotypes compared to 10.5% of sites with thick tissue biotype</td>
</tr>
<tr>
<td>Linkevicius et al., 2009 [34]</td>
<td>Unknow</td>
<td>26 patients 64 implants</td>
<td>1-year</td>
<td>Mean per-implant bone loss was inversely correlated with peri-implant mucosal thickness</td>
</tr>
<tr>
<td>Linkevicius et al., 2009 [35]</td>
<td>Unknow</td>
<td>19 patients 46 implants</td>
<td>1-year</td>
<td>Initial gingival thickness &lt;2 mm would have crestal bone loss of up to 1.45 mm; significantly more peri-implant bone loss in sites with thin tissue compared to those with thick tissue</td>
</tr>
<tr>
<td>Nisapakultorn et al., 2010 [30]</td>
<td>Maxillary incisors</td>
<td>40 patients 40 implants</td>
<td>–</td>
<td>Facial marginal mucosa level was significantly associated with peri-implant tissue biotype; a thin biotype was associated with an increased risk of facial marginal mucosal recession</td>
</tr>
</tbody>
</table>
extraction, the buccal and lingual walls of the alveolus undergo substantial resorption [36]. Belonging to the periodontal structures embryologically, the bundle bone was resorbed completely as a result of a lack of supporting function of the tooth following its extraction. Because the thin buccal wall is predominantly composed of bundle bone, its resorption had to result in a vertical reduction of the bony crest.

The minimal buccal width required to avoid vertical crestal resorption has yet to be established. In a clinical study Spray et al. [37] found that bone loss decreased significantly and some bone gain was observed as the buccal bone thickness approached 1.8 to 2 mm after implant placement. In a recent publication by a panel of expert and master clinicians in the field of implantology, clinical guidelines were elaborated for implant placement in the esthetic anterior healed sites. Once the implant osteotomy site was performed, an ideal buccal bone width of 2 mm was recommended to achieve an optimal biological and esthetic outcome. Thus, based on very few studies and general consensus [38], the scientific community seems to agree that ideally a minimum of 2 mm of buccal bone wall is mandatory once the implant has been prepared in healed site to ensure proper soft tissue support and avoid the resorption of the facial bone wall following restoration. When placing implants in fresh extraction sockets it would be of interest to know the anatomical dimensions of the socket wall and how often they actually meet what is considered to be the minimal requirement, i.e. 2 mm of buccal bone width. It can be speculated that in the case of immediate implant placement, an even greater width would be needed to account for the dimensional changes following tooth extraction.

A recent human study of Huynh-Ba et al. [39] revealed that only a minority (6.5%) of the maxillary teeth including incisors, canine and premolars have a buccal bone wall width of 2 mm or more. When incisors and canine were considered, then, only one site out of 39 (2.6%) displayed a 2 mm wide crestal buccal bone (fig. 1). In a larger subject sample study [40] by measuring the thickness of the facial bone wall with a computed tomography scans confirmed that most tooth sites in the anterior maxilla have a thin facial bone wall. The bone crest of the six maxillary front teeth demonstrated the presence of a facial bone wall that, in most locations in all teeth examined, was ≤1 mm thick and that close to 50% of all teeth and sites had

Fig. 1
Frequency distribution of the width of the buccal plate.
a thickness that was ≤0.5 mm (fig. 2). It has been estimated that the width of the alveolar bone proper may vary between 0.1-0.4 mm. Hence, the findings from the current study indicate that the facial bone wall at many sites is very slender and may solely be comprised of alveolar bone proper. As alveolar bone proper is a tooth-dependent tissue, the loss of the teeth will result in the loss of bundle bone and ridge reduction. Thus, the thinner the facial bone wall, the more extensive the facial bone loss [11]. The thickness of the buc\nal bone crest significantly influenced the amount of the vertical resorption. Ferrus et al. [12] assessed that in sites with a thick buc\nal bone crest >1 mm, the mean amount of vertical resorption of the buc\nal crest was small (~0.4 ± 1.3 mm). On the other hand, at sites with a thin buc\nal wall <1 mm, there was a substantial loss of the vertical dimension (~1.2 ± 2.1 mm).

Another clinical aspect is represented by the integrity of the facial bone. Kan and co-worker [27] assessed the frequency of marginal tissue recession in relation to the dimensions and shape of the dehiscence of the facial bone wall. Only 8.3% of the sites with narrow or V-shaped defects were associated with recession of 0.5 mm or more. The corresponding recession frequency for sites with wide U-shaped defects and defects that involved the adjacent teeth was 42.8% and 100%, respectively.

In order to reduce the horizontal and to improve the esthetic outcomes, adjunctive soft-tissue graft have been advocated for contour augmentation, maintenance of an adequate zone of keratinized mucosa and to increase tissue thickness sites with thin tissue biotype. The question is if by thickening the soft tissue with a soft tissue graft, the loss of bone volume in the labial area can be compensated for and maintained over time. A recent study [41] assessed that esthetic cases with subepithelial connective tissue graft using a tunnel technique show to preserve the labial volume whereas in non grafted group the results demonstrate an average loss of volume, (0.34 vs 1.06 mm). Another study [42] confirmed that augmentation procedure was effective in increasing the thickness of the peri-implant soft tissues which resulted in a statistically significantly better PES (Pink Esthetic Score) after 1-year control.

Another question could arise if thickening the soft tissue with a tissue graft is able to preserve the vestibular bone plate dimension after tooth extraction. In the same study assessed that marginal bone levels, there were no statistically significant difference for bone loss 1-year after loading between the two groups. Augmented sites lost 0.8 mm of peri-implant bone versus 0.6 mm at the control sites from implant placement. A recent study [34,35] have attempted to correlate tissue thickness and crestal bone stability

![Fig. 2](image-url)

**Fig. 2**
Frequency distribution of the width of the buc\nal plate of incisors and canine.
after implant placement. It was observed that within the first year of function, a maximum of 1.45 mm of crestal bone loss associated with a initial tissue thickness of less than 2.5 mm (thin biotype).

**Alveolar host bone with infected sites**

Often times, the clinical situation of teeth requiring extraction and implant placement exhibit periapical and/or periodontal pathology. Various authors have suggested that immediate placement of an implant into an infected site is contraindicated [43], as sites exhibiting pathology have been thought to compromise osseointegration. Periodontal infection has been correlated with an increased risk of implant failure [44]. More recent literature, however, has investigated placement into sites exhibiting periapical pathology with successful outcomes [6]. The questions that could arise are the following. Does the presence of infection compromise the osseointegration of immediately placed implants? Does the presence of infection compromise immediate implant placement success? What protocols have been used to address the infection prior to immediate implant placement? (table IV).

In terms of periapical infection impairing the process of osseointegration, the data from two dog studies [50,51] show a decrease in BIC compared to implants placed in non-infected sites. The difference was statistically significant in one study [51] but not in the other study [50]. Ligature-induced periodontitis lesions were show to not adversely affect osseointegration in dogs as measured by BIC. However, data from human study [52] suggested that periodontitis as a reason for extraction may adversely affect implant survival. Regardless of the difference in BIC values, which were significant in one study [51], no implant failures were observed in any of the animal models.

Data from human case series and prospective controlled trial studies demonstrated high levels of implant survival in the presence of periodontal and periapical infections. However, in a study by Lindeboom et al. [5] there was a 92% survival rate of immediately placed implants versus a 100% survival rate of delayed-placement implants. The authors surmised that this was due to the increase in keratinized tissue during socket wound healing. The flora cultivated from the infected sites revealed Gram-negative species typically associated with a root canal infection. The treatment protocol after tooth extraction included complete and thorough debridement of the socket and use of systemic antibiotics. It is assumed that antibiotics are usually used to suppress the residual infection that was not

**TABLE IV – HUMAN STUDIES OF IMPLANTS PLACED IN INFECTED SITES**

<table>
<thead>
<tr>
<th>Study</th>
<th>No. Patients</th>
<th>No. Implants</th>
<th>Follow-up</th>
<th>Type of infection</th>
<th>Treatment</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novaes and Novaes 1995 [45]</td>
<td>3</td>
<td>3</td>
<td>7-14</td>
<td>Endodontic</td>
<td>Debridement, GBR and 31 days of AB</td>
<td>100% survival</td>
</tr>
<tr>
<td>Villa and Rangert 2005 [46]</td>
<td>20</td>
<td>97</td>
<td>15-44</td>
<td>Endodontic and periodontic</td>
<td>Debridement, GBR cortisone injection into soft tissue AB</td>
<td>100% survival</td>
</tr>
<tr>
<td>Lindeboom et al., 2006 [5]</td>
<td>50</td>
<td>25 Infected 25 DL after 3 months</td>
<td>12</td>
<td>Chronic periapical pathology</td>
<td>AB 1 hour before, socket debridement and GBR</td>
<td>92% Infected 100% Controlled</td>
</tr>
<tr>
<td>Siegenthaler et al., 2007 [4]</td>
<td>34</td>
<td>29</td>
<td>12</td>
<td>Periapical pathology, fistula, suppurative</td>
<td>AB 1 hour before, socket debridement and GBR and ab 5 days post-surgery</td>
<td>100% survival</td>
</tr>
<tr>
<td>Villa and Rangert 2007 [47]</td>
<td>33</td>
<td>100</td>
<td>12</td>
<td>Endodontic and periodontic</td>
<td>Debridement, GBR cortisone injection into soft tissue AB</td>
<td>97.4% survival</td>
</tr>
<tr>
<td>Casap et al., 2007 [48]</td>
<td>20</td>
<td>30</td>
<td>12-72</td>
<td>Subacute periodontal, chronic periapical,chronic periapical, chronic periodontal</td>
<td>14 days of antibiotics, debridement, GBR and primary closure</td>
<td>97.7% survival</td>
</tr>
<tr>
<td>Novaes et al., 2009 [49]</td>
<td>1</td>
<td>3</td>
<td>36</td>
<td>Chronic periapical</td>
<td>AB 1 hour before, socket debridement and GBR</td>
<td>100% survival</td>
</tr>
<tr>
<td>Del Fabbro et al., 2009 [6]</td>
<td>30</td>
<td>61</td>
<td>10-21</td>
<td>Chronic periapical</td>
<td>Socket debridement and PRGF coating of implant</td>
<td>98.45% survival</td>
</tr>
</tbody>
</table>
removed during debridement or to decrease bacterial amounts preoperatively. As stated by Novaes et al. [44], the placement of immediate implants in chronically infected sites may not be necessarily contraindicated if appropriate clinical procedures like antibiotic administration, meticulous cleaning and alveolar debridement are performed before implant surgical procedure.

**Implant position**

The restorative, functional and esthetic success of an implant-supported restoration stems from the position of the implant in bone. The restorability of the implant body, the emergence profile, and the stability of the definitive esthetic outcome are determined by the three-dimensional placement of the implant. The implant should be placed in a position with at least 2 mm of buccal bone, approximately 3 mm apical to the cement-enamel junction of the adjacent teeth, and about 1.5 mm from the adjacent tooth root or 3 mm from the adjacent implant. However, in situations where more soft tissue growth on the facial surface of the implant is needed, a more palatal and apical position of the implant is advocated. It has been recommended that for every millimeter of palatal angulation, the implant should be placed apically by an additional millimeter [18].

As in pristine bone, the position of the implant shoulder within the extraction socket in immediate implant placements is an important factor as well. Implants that were placed facially within the sockets demonstrated significantly greater recession than sites where implants were more palatally positioned [22,53]. Chen and coworker [18] reported that at sites with recession, the implants had a significantly smaller orofacial defect depth of 1.1 ± 0.3 mm, compared to 2.3 ± 0.5 mm for sites with no recession. With immediate implant placement in the anterior maxilla, the implant should be placed in a slightly palatal position in the socket, maintain a facial marginal gap of 1 to 2 mm, and prevent the implant shoulder from being placed in the “facial danger zone” [53]. Oversized implants, such as wide-neck or wide-platform implants, should therefore be strictly avoided in the esthetic zone. In central incisors and canine sites, implants with an endosseous diameter of approximately 4 mm are recommended. If implants of this diameter have an expanded restorative platform of 5 mm, care should be taken to ensure that the palatal wall of the socket is prepared to accommodate this increased dimension so that the implant shoulder is not placed too far facially. When the socket dimensions are relatively small, such as in the maxillary lateral incisors sites, reduced diameter implants of about 3-3.5 mm should be chosen to maintain this minimum dimensional requirement.

**Peri-implant alveolar gap**

When immediate implants are placed, peri-implant voids are frequently present due to a gap between the alveolar socket and the implant. Healing of the peri-implant bone defect is a process involving both bone apposition and bone resorption, the latter occurring to a larger degree than the former. Resorption prevails during healing when the gap is large and the biotype is thin [11,20]. However, the presence of a thick buccal bone wall does not consistently prevent crestal resorption [12].

If all the bone wall are intact and the marginal peri-implant defect is 3 mm or less in width, simultaneous augmentation procedures are not required to promote bone regeneration with immediate implant. In these situations, the defect may be expected to fill with bone spontaneously. However, significant horizontal resorption should be anticipated. Grafting of the marginal defect with bone or bone substitutes can reduce the extent of horizontal resorption and can be undertaken with immediate and early placement protocols. As opposed to autogenous bone grafts, xenograft volume is rather stable over time since it is slowly resorbed [39]. This feature may justify the use of xenografts for filling the gap between an implant and the alveolar walls in order to reduce bone collapse [19].

Grafting the marginal defects may limit the horizontal resorption to about 25% of the original dimension [22]. Other studies investigating preservation of socket dimensions after tooth extraction have reported a gain in vertical bone height of about 1 mm by “overbuilding” the marginal defects [54] or by overlaying the buccal bone externally with the graft [55]. This concept was recently speculated in a study where immediate implant in anterior maxilla were frequently associated (87%) to a thin buccal walls (<1 mm) [39].
This means that augmentation procedures are needed to achieve adequate bony contours around the implant and optimal esthetic outcome. However, no clinical indication about the regenerative procedures and graft thickness was reported in the study.

**Clinical diagnostic parameter: implant-vestibular plate distance**

In order to estimate the peri-implant residual bone width necessary to allow the horizontal physiological bone resorption without esthetic compromises, it can be useful to measure the horizontal distance between the Implant to Vestibular Plate (I-VP). This intraoperative diagnostic parameter include the residual peri-implant gap and the vestibular bone thickness.

In order to achieve adequate bone contour around the implant and optimal soft tissue contour, a critical distance of four mm from the implant surface to the vestibular plate should be obtained at the end of implant insertion and the graft procedure.

From a clinical stand point, we should deal with two different scenario. The first when we are dealing with an I-VP distance that is less than four mm and the second when the distance is more than four mm.

**I-VP distance <4 mm**

This clinical situation should be managed by means of an Internal-External Grafting (IEG) using deproteinized bovine bone, in order to achieve a width >four mm from the implant surface to the vestibular plate. A horizontal buccal bone width of at least two mm should remain at the end of the resorption phase allowing for the conical peri-implant bone resorption to be still inside the width of the bone wall. A resorbable membrane must be placed to stabilize the graft material. The membrane can be left intentionally exposed to the oral environment in order to increase the amount of the keratinized peri-implant mucosa without shifting the muco-gingival junction coronally (figs. 3–5).

**I-VP distance ≥4 mm**

When the distance between the implant surface and the outer surface of the alveolar bone wall is ≥four
mm, an Internal Grafting (IG) procedure alone could be adopted. The placement of a resorbable membrane left intentionally exposed is recommended to protect and stabilize the graft material (fig. 6-8).

**Discussion**

Immediate implant placement (Type 1) involves some advantages but some disadvantages too. The implant placement at the time of the tooth extraction can facilitate the implant position for the optimal availability of space to the implant. The disadvantages of the immediate implant procedure could deal with the morphology of the socket that may lead to a compromised implant position and implant initial stability. Several factors have been proposed as being important in determining the stability of the peri-implant soft tissue, including implant shoulder position in the bucco-lingual and apico-coronal direction and tissue biotype.

Implants with a shoulder position at or buccal to a line drawn between the cervical margins of adjacent teeth demonstrated three times more recession than implants with a shoulder position 2 mm lingual to this line. When the buccal plate is damaged, significant resorption could occur irrespective of the membrane and/or bone graft being used, leading to aesthetic problems.

Furthermore, when considering the frequency of marginal tissue recession, it was noted that this occurred at both thin and thick biotype sites [22]. This would suggest that a thick biotype alone does not prevent marginal tissue recession. However, recession at thin biotype sites tends to be of a greater magnitude. The initial thickness of the buccal crestal bone may be a factor in determining the extent of the vestibular bone resorption during the healing phase [11,12]. Such thin buccal bone, composed mainly of bundle bone, in the most coronal part is susceptible to the interruption of the vascular supply as a consequence of flap reflection.

Grafting the marginal defects may limit the horizontal resorption to about 25% of the original dimension [30]. This concept was recently speculated in a study where immediate implant in anterior maxilla were frequently associated (87%) to a thin buccal walls (<1 mm) [43]. This means that augmentation procedures are needed to achieve adequate bony contours around the implant and optimal esthetic outcome. However no clinical indication about the regenerative procedures and graft thickness was reported in the study. Grafting the residual gap around the implant is considered a promising clinical procedure to reduce the bone dimensional changes following tooth extraction.
However, this procedure can not prevent bone resorption and soft tissue stability. In order to preserve the vestibular alveolar bone profile, overbuilding the buccal aspect in combination with immediate implant placement may be a suitable technique to compensate for the physiological alveolar bone changes occurring after tooth extraction and immediate implant insertion.

Conclusions

When implants are placed immediately after tooth extraction many clinical risk factors should be assessed in order to obtain an esthetic and long term results.

One of the most important clinical aspect to obtain a predictable esthetic result is related to a marginal peri-implant soft tissue stability. Even the periodontal biotype seems to influence the marginal peri-implant soft tissue stability, no clinical trial has been conducted to thoroughly examine the influence of peri-implant tissue biotype on post-extraction immediate implant esthetics.

Grafting the residual gap around the implant is considered a promising clinical procedure to reduce the bone dimensional changes following tooth extraction. However, this procedure can not prevent bone resorption and soft tissue stability. The implant-vestibular plate distance concept is critical and could be a useful diagnostic parameter that guides the clinician in the choice of the most appropriate grafting procedure (IG vs IEG). In clinical cases in which the distance between implant surface and the vestibular plate is <4 mm an internal plus an external grafting (IEG) should be placed to maintain the ridge contour, in order to achieve a successful aesthetic outcome.

Conflicts of interest

The authors declare no conflicts of interest

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