Key Factors for Predictable Aesthetics in Single Tooth Immediate Implantation with Provisionalization

Marco Redemagni[1], Giuliano Garlini[1], Salvatore D'Amato[2]

[1]Private Practice: V. Trento 23, 22074 Lomazzo [Como], and Milan, Italy. [2]Seconda Università degli Studi di Napoli, Italy, Facoltà di Medicina e Chirurgia, Universitary Department of Head, Neck and Oral Surgery, Aggregate Professor in Maxillo-Facial Surgery, Italy.

Abstract

Early implant placement is one treatment option for implant therapy following a single-tooth extraction in the anterior maxilla. In this article some key factors are presented to analyze and follow in an effort to obtain a predictable and acceptable esthetic result. The creation of predictable peri-implant esthetics requires proper preservation of the osseous and soft tissues around the failing teeth, proper 3-D implant placement and proper understanding of the prosthetic management. The surgical technique presented here is characterized by tooth extraction without flap elevation, implant placement in a correct three-dimensional position, simultaneous contour augmentation on the facial aspect with connective tissue grafting combined with heterologous bone chips filled into the implant bone gap.

Key Words: Soft Tissues, Implant; Patients

Introduction

Since the early concept of osseointegration was published by Branemark, implant surgery has undergone a continuous evolution of executive protocols to achieve acceptable results [1]. In the 1980s the prevailing predictable desired objectives concerned the achievement of a functional prosthetic. Thus, the classic methods, referred to as "according to the Sweden School" took place. In the 1990s, aesthetics became more relevant, the consideration for not only the elimination of disease and/or subjective disorders, but also the psychosocial needs of the patients began to come into the equation [2]. Many implant-prosthetic solutions are now available for the functional and aesthetic rehabilitation of the partial or totally edentulous jaw [3]. Among these, the traditional 2-stage technique, which plans the insertion of fixtures followed by a healing period, during which the implants remain submerged and are only loaded after a few months, has been well-documented for decades [4]. In the consecutive months between the first surgery and the final prosthetic phase, the patient is sometimes obliged to use a removable denture, with possible discomfort, especially during the initial periods following surgery. Other treatment options have been introduced to eliminate these functional and aesthetic problems, using temporary or final prostheses anchored to provisional or definitive implants immediately after insertion into the residual alveolar ridge [5]. This therapeutic alternative reduces the number of surgical operations, drastically shortens prosthetic times, and may reduce costs considerably [6]. The main studies concerning the full arch immediate load in the mandible give percentages of implant success that do not differ significantly from those obtained with traditional rehabilitation methods [5,7,8-13]. The excellent results obtained in the mandible have encouraged clinicians to perform the same treatment in the maxilla, and consequently to treat partial edentulism, even up to the single missing tooth [14].

The factors that are able to influence the immediate load success, and with a very short list that can be summarized as follows:

1. Surgical factors;
2. Factors concerning the patient;
3. Factors concerning the implant system;
4. Factors concerning the prostheses; and
5. Factors concerning the occlusion [15].

All of these factors are relevant to reach the final result. Among the surgical factors, especially for the single implant, the most relevant one is to reach adequate primary stability. Thus, the researchers have proposed some suggestions on how to reduce the micromobility of the implants. Many of these proposals are not validated by scientific research, but are based solely on the evidence of many personal observations [16]. Many authors suggest that post-extraction immediate single implant placement and provisionalization are effective in maintaining the existing papilla, and do not have the risk of creating scar tissue, but are not able to maintain the correct parabola contour and root bump prominence. Instead, the delayed load has the advantage of preserving the parabola, but loses the papilla [17-19]. Thus, the logical question is: what would be the best choice? If the initial anatomic conditions are favorable, the differences between the two methods are minimal, but from an esthetic point of view, the immediate post-extraction implant placement and provisionalization is the best choice. However, it is a highly technique-sensitive treatment. Immediate implant placement and provisionalization is usually the preferred method if ideal pre-existing tissue conditions, e.g., a thick biotype, an appropriate gingival level, osseous-gingival relationship, and the presence of adequate buccal bone plate [19]. The immediate load technique has an unquestionable advantage because the interpapillary and alveolar-gingival fibers preserve the interproximal bone peaks when the interdental peri-implant

Corresponding author: Marco Redemagni, Private Practice: V. Trento 23, 22074 Lomazzo [Como], and Milan, Italy, Tel: +390296370705; Fax: +390296778831; e-mail: marco@redemagni.it

tissues are provided with an immediate support by a healing screw or an immediate provisional restoration [17].

The problem now is how could it be possible to anticipate the buccal soft tissue final esthetic outcome?

To answer this question it would be of interest to analyze the following 6 Key factors:

2.1 soft tissue levels;

2.2 soft tissue thickness;

2.3 bone;

2.4 implant position;

2.5 biotype conversion; and

2.6 abutment design

Soft tissue levels

It is possible to encounter three different situations. The parabola of the tooth to be extracted could be more apical, more coronal and the same level as the controlateral or the adjacent tooth. Most extraction and surgery usually heals with some recession, so the most favorable situation would be one with the parabola in the coronal position. If recession occurs the soft tissue will recede to the correct place with a pleasing result. In the other situations mentioned here the recession could only worsen the final result. The unfavorable tissue level could be modified before extraction and/or implant placement by some periodontal therapy, orthotherapy or regenerative therapy. Logically, increasing the therapy time increases the overall difficulties.

Soft tissue thickness

According to Olsson and Lindhe [20] 85% of the population has a thick and flat biotype, while the remaining 15% has a thin and scalloped biotype, and it is more susceptible to recede after each surgery. Moreover, if the teeth have a triangular shape, it would be extremely difficult to obtain a perfect papilla, instead with rectangular-shaped teeth, it would be easier to obtain a nice papilla without an unaesthetic black space between the teeth [21]. There are many methods to classify tissue thickness. The easiest method is to look at a probe inserted into the sulcus. If it is possible to see the probe transparently through the gingiva, then the tissue is thin, otherwise it is thick [22]. Kan et al. [23] have suggested that a tissue is thick if the thickness is > 1 mm, in contrast a tissue is thin if the thickness is < 1 mm. The tissue thickness has a direct involvement in influencing the recession. Kan [24] has demonstrated that 35 implants after 90 months averaged recession a recession of 1 mm. If the thick biotype alone was considered, the medium recession was < 0.5 mm; with the thin biotype, the recession would average 1.5 mm. In addition, prominent roots bring about a further thinning of the buccal tissues, with an increased risk of recession [21,25].

Bone

Kois introduced the concept of the Dento-Gingival-Complex [DGC] in 1994, and extended the definition of biological width by adding to the probe up to the bone crest. Kois established three classes of DGC; the bone crest could be normal, high, or low depending on the probing depth. Of the studied population 85% had a probing depth of 3 mm and was classified as normal and consequently stable from a prosthodontic point of view; the 2% with < 3 mm was classified high and thus almost stable, the remaining 13% was low and unstable [26]. Beginning with this definition, the question that arises is "what is a bone crest below the gingival margin when extracting a tooth?" The answer is generally 3 mm. Thus, it is possible to find a correspondence between the DGC and implantology, and from this definition to understand how to manage the site or what is possible to achieve in any situation [21]. The second question is "could the bone stay above the implant head?" The answer is usually no [27]. In 2005, Grunder, removing a crown and an abutment from a healthy and with a high quality esthetic implant and raising a flap to have a direct view onto the implant head and the surrounding bone, demonstrated that there was a 1.5 mm wide circumferential defect around the implant head, non-visible with the standard peri-apical radiographic examination. Because the bone buccal cortex was intact the X-rays were not able to record the presence of the defect. He established that to avoid losing bone height it is necessary to have at least 2 mm, and even better with 4 mm of bone around the implant shoulder. This is especially important on the buccal side to maintain bone plate stability and consequently to maintain the defect inside the bone walls without flowing in to a soft tissue recession [27].

It is also important, after the tooth extraction, that the buccal bone plate is intact and well represented, since it will be useful to maintain the correct root bump, and it will serve as a scaffold to contain some biomaterial. The thickness of this buccal bone plate seems to be irrelevant. Its effect at the time of implant placement is not understood completely and may be related to the fact that approximately 90% of labial plates in the maxillary anterior region were 1 mm or less in thickness. It is unknown whether a thick buccal plate is required or a thin buccal plate might be sufficient. Some studies demonstrate significant loss of buccal plate when no grafting is performed. If it were thick, of course it would be better. The thickness could be problematic when a flap is elevated, which would compromise the blood supply from the periostium [28]. It is not recommended to place an implant below the bone crest, because it could cause a long path from the implant head up to the gingival margin. This is because the more apical the implant is placed, the bigger the distance between the implant and tooth has to be, due to the triangular shape of the bone loss [29]. So, with a low crest (probing DGC depth plus 3 mm), which is a very unfavorable situation, is it possible to obtain an esthetic stable result? The following criteria need to be addressed:

1. Is it better to establish an immediate provisionalization or a delayed one?

2. Does it need a gingivoplastic?

3. Which role does bone morphology play?

The main risk is that a recession could occur. In this situation the parabola will be higher, while the papillae will

remain almost stable, but obviously it would be not a pleasant esthetic case. In this situation the solution could be to differ the implant insertion, and or to provide additional surgery such as a guided-bone regeneration and connective tissue grafting associated or not at a pre-extractive orthodontic extrusion [21] (*Figures 1-6*). The interproximal bone peaks are important, too. In fact, it would be possible to have the correct papillae beside an implant only if the proximal bone peaks are in the right position. In this situation the papilla length was about 3.5 mm between two adjacent implants, or around 4.5 mm between an implant and the adjacent teeth [30] (*Figures 7 and 8*).

Implant position

In addition to all the precedent para meters, to reach a predictable aesthetics result, it is mandatory to place the implant in a correct 3D position into the bone. Vertically, the correct depth is 2-3 mm below the gingival margin from which it is desired that the crown will rise. If too coronal, it will miss the space for a correct emergence profile; if too deep, it will form a peri-implant crater with a long and unpredictable transmucosal path [27,29]. In the case of an immediate post-extraction implant placement, where an inadequate socket exists, it would be important to insert the implant about 4 - 5 mm beyond the apical position of the extracted root to obtain an ideal primary stability [31]. The buccal-lingual position is also relevant. If an implant is positioned with a buccal direction, the consequence would be the atrophy of the thin bone buccal plate with the consequent parabola recession. If too lingual, probably from an esthetic point of view the result is notcompromised; but, it would not be a biomechanics success and it would also be difficult to clean during the normal hygiene operation. In the esthetic area an implant is well inserted when its platform is positioned in a slightly palatal direction, so that the hole access for the crown retainer screw stays in a space included between the incisal edge and the cingulum. In the posterior area, instead, the implant stays almost in the center, or just lingual of the post-extraction

Figure 1. *A 15 mm long probe inside the socket moves the soft tissue, a sign of buccal bone resorption.*

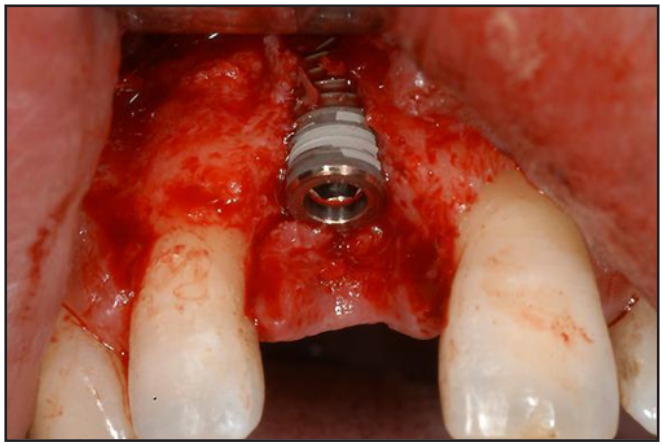

Figure 2. *Evident bone dehiscence defect around the implant (Xive, Dentsply Implant, Mannheim, Germany).*

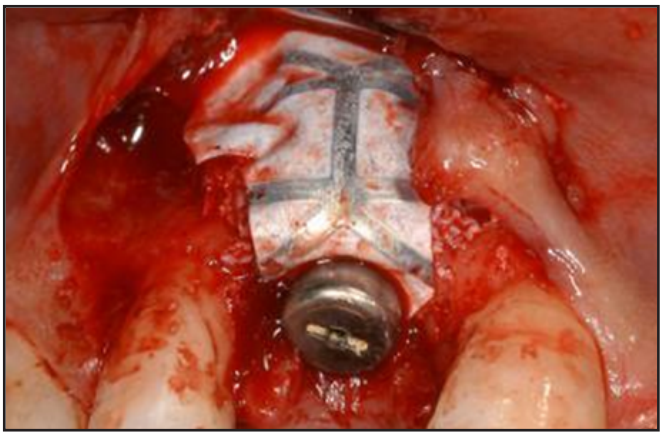

Figure 3. *A non resorbable e-PTFE titanium reinforced membrane fixed with the healing screw and two tags (Dentsply Implant, Mannheim, Germany), covering some Bio Oss granules (Geistlich Pharma AG, Wolhusen, Switzerland) to obtain the necessary bone regeneration to optimize the tissue level. The healing screw is necessary to sustain and maintain the papillaes during the healing period.*

Figure 4. *One year after the surgery the tissues are stable and well optimized by the provisional crown.*

Figure 5. *The definitive Zirconia abutment and the final all ceramic restoration.*

Figure 6. *The definitive Zirconia abutment and the final all ceramic restoration.*

Figure 7. *The left central incisor (post-extractive immediate implant placement and provisionalization) has perfect papillaes because the interproximal bone peaks are in the correct position, and the implant is at the right distance from the adjacent teeth.*

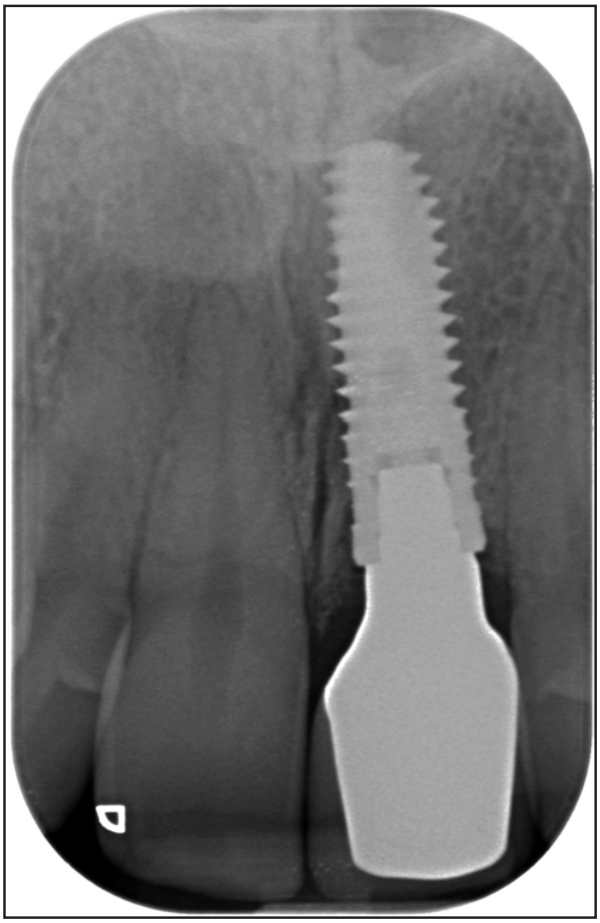

Figure 8. *Periapical radiograph of implant.*

alveolus, respecting always the minimum distance of at least 2 mm from the external buccal plate. As already stated, it is always mandatory to place the implant in a precise direction so to leave at least 2 mm of bone externally to the implant in the buccal side [27]. Mesio-distally, it would be recommended to maintain a distance of at least 1.5 mm between the implant and the adjacent teeth, so that the interproximal bone peaks remain stable over time and consequently preserve and maintain stable the papillae [27,29,30].

Biotype conversion

One of the most desired goals of an implantologist is to transform a thin and scalloped soft tissue into a thick and keratinazed one. The second goal is to maintain the soft tissue levels stable over time. To do this, especially in the esthetic area, would be to convert the patient buccal biotype by grafting some connective tissue, harvested from the palate, without raising a flap. By detaching an envelope close to the parabola and filling some biomaterial in the gap between the implant and the buccal side of the bone would prevent possible resorption with the consequence of esthetic damage [14] (*Figures 9-11*). A bilaminar subepithelial connective tissue graft augments the soft tissue resistance to the recession tendency after every surgery, and it reduces the tissue transparency, masking better the implant components. The technique is to place the graft at least up to 6 mm from the gingival margin [19,24]. This transplanted tissue contains cells that are also suggested to stimulate keratinization of the overlying mucosal tissue [32].

Figure 9. *A connective tissue graft is placed with a tunnel technique to improve the soft tissue aspect and tone.*

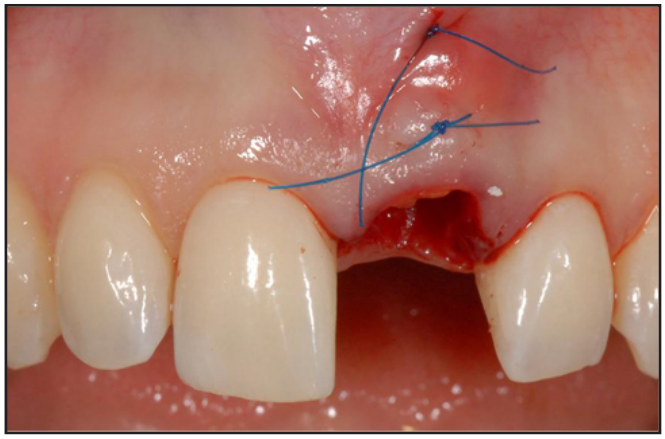

Figure 10. *The connective tissue graft just sutured inside the pouch.*

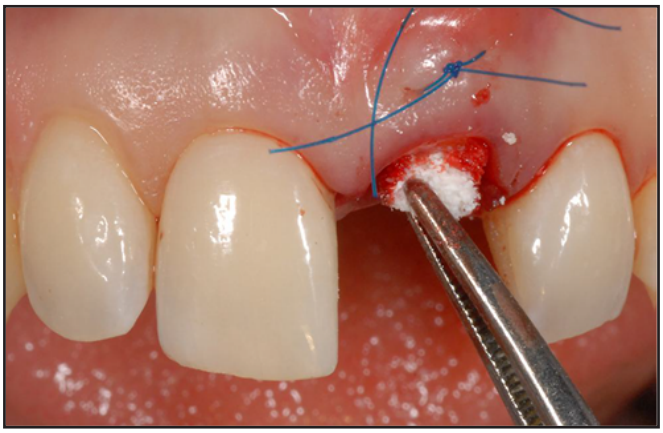

Figure 11. *After having sutured the connective tissue graft, without raising a flap, the bone-to-implant gap was filled with some biomaterial (Bio Oss Collagen).*

It seems that if the single implant is placed with a proper 3-D direction and some biomaterial is filled into the implant-bone gap, then the converted soft tissues will remain almost stable for the first year after the grafting procedure, regardless from the initial biotype [33]. Kan et al. in a recent study stated that after a mean follow-up time of 4 years [range, 2 to 8.2 years] the mean overall facial gingival level change [–1.13 mm] was significantly greater than that observed at the 1-year follow-up [–0.55 mm], suggesting that facial gingival tissue recession is a dynamic process and may continue beyond 12 months after implant surgery. Sites with a thick gingival biotype exhibited significantly less facial gingival level change than sites with a thin gingival biotype, and the effect of gingival biotype on peri-implant tissue response seems to be limited to facial gingival recession and does not affect interproximal papilla or proximal marginal bone levels [34]. In any case, it is recommended to fill some biomaterial into the gap, because as various authors have published, after implant placement into fresh extraction sockets without filling the gap with some biomaterial, both on the buccal and palatal sides, bone resorption occurs with consequent soft tissue contraction [35]. Four weeks later, the implant-bone gap is completely filled, but the buccal and lingual wall thickness is reduced and the thin buccal crest is reabsorbed. After 12 weeks, the buccal crest is localized 2 mm more apical than the initial position [35,36]. In contrast, to fill the gap with some biomaterial will prevent bone resorption and consequently it will reduce soft facial tissue recession in time [37-42].

According to Vignoletti et al., the wider the gap between the implant and the bone, the less the bone resorption will be and the bone remodeling will be more rapid [43]. To avoid a second surgery to harvest the connective tissue graft, current therapy proposes using membranes for guided tissue regeneration, such as Dynamatrix [Keystone Dental, USA], Mucoderm [Botiss Dental, Germany] or Mucograft [Geistlich Biomaterials, Swiss], capable to substitute the autologous tissue, but this technique requires more time to assess its effectiveness [44,45].

Abutment design

In contrast to the standard abutment shape, the abutment transmucosal design, when possible, should be concave, rather than convex (*Figures 12 and 13*). Technicians are used to shaping the abutment without considering the biology of the soft tissue. They usually shape the abutment modifying per subtraction the master model stone, but a convex abutment causes a soft tissue compression and thus ischemia of the same tissue with consequent possible recession. This concave abutment shape is able to assist with the preservation as well

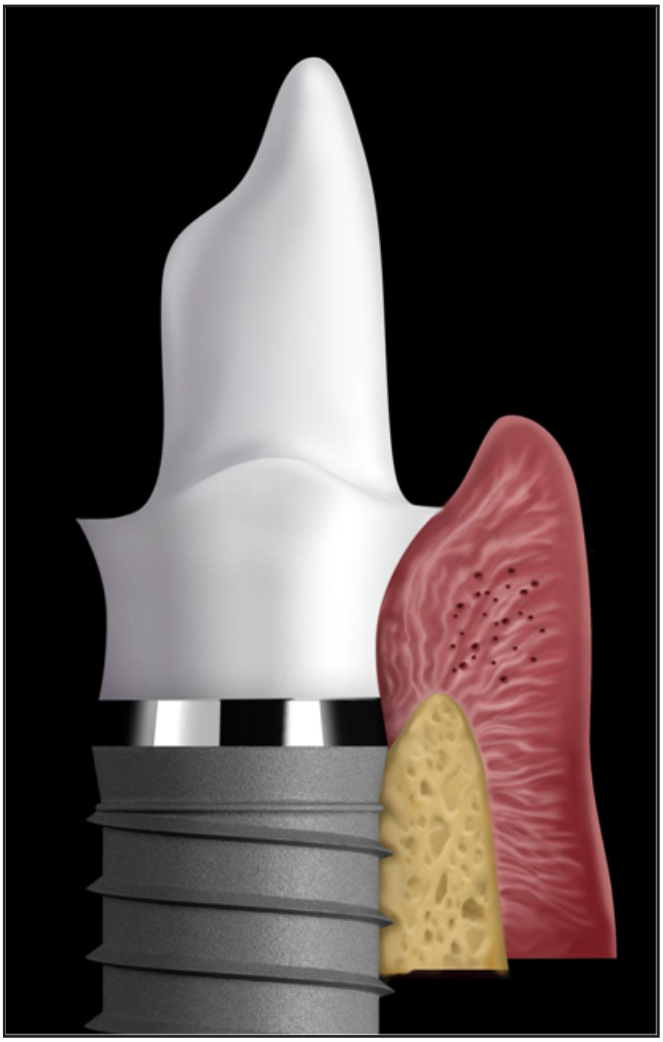

Figure 12. *The concave transmucosal profile doesn't press the surrounding tissues, reducing their recession, and improving their stability. It allows more space for the connective tissue creating a sort of O-ring with the function of barrier for the bone-implant interface. On the contrary, an abutment with a convex transmucosal profile would be tissue compressive.*

Figure 13. *A provisional screw retained crown with a clear concave transmucosal profile.*

as to help maintain more tissue stability over time, creating a sort of soft tissue O-ring with the function of a barrier for the bone-implant interface [14,46,47] (*Figure 14*). This concave abutment is able to assist in the preservation and to maintain the tissue more stable over time. The soft tissue will appear very healthy with a clear pink color and sometimes with a characteristic similar to orange peel stippling like the one around natural teeth. Unfortunately, this shape cannot be standardized, but should be individualized for every tooth. The concavity should begin where the crown emerges from the gingiva, as it moves from the finishing line of the prepared natural tooth for a prosthetic crown, and finishes at the implant border, and should be more marked in the buccal direction [14] (*Figures 15 and 16*). A convex shaped abutment compresses the buccal soft tissues causing ischemia and sometimes the tissue reacts by thinning; in the thinnest area a fenestration could be created assuming the appearance of a fistula, the only difference being that it is not elaborating any pus (*Figure 17*). Another advantage of a custom-made abutment is that it is possible to position the finishing line exactly where it is desired. The best position is juxta-gingival, or just under the gingival border, as for the finishing line of the tooth prepared for a prosthetic crown. In this way, it is easy to accurately remove the cement after the crown cementation. In fact, according to Wilson [48], failure to remove the excess dental cement was associated with signs of peri-implant disease in the majority [81%] of cases (*Figure 18*). To

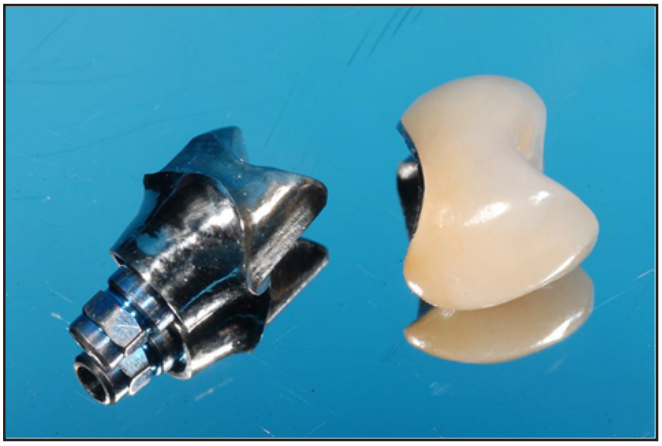

Figure 14. *A definitive gold-ceramic crown and the titanium custom made abutment; the concave transmucosal profile is clear. The transmucosal portion of the abutment is the exact replica of the provisional one.*

Figure 15. *The definitive crown (second premolar) after the cementation. It is evident that the tissue has a adequate contour, shape, and its appearance is absolutely natural.*

Figure 16. *Pseudofistula on the left central incisor. If the transmucosal profile is compressive, this could create a thinning of the tissue, with the characteristic dark gingival colour and the possibility to create a fenestration in the soft tissue, similar to a phistula.*

Figure 17. *A custom made abutment allows for positioning of the finishing line exactly in the same position as for a prepared tooth for a crown. Thus, it is easy to remove accurately the cement after crown cementation.*

Figure 18. *The definitive all ceramic crown on the left central incisor three years after surgery (post-extractive immediate implant placement and provisionalization).*

enhance the positive characteristics of a concave abutment, it is recommended to associate it, when possible, with a platform switch technique. Peri-implant bone resorption is probably the result of an inflammatory process caused by the penetration of bacteria in the implant-abutment gap, which causes the presence of an inflamed connective tissue. This process covers about 0.5–0.75 mm in the coronal and apical direction to the Implant-Abutment Junction [IAJ] and remains separated from the bone with a layer of approximately 1 mm of healthy connective tissue with an apparent barrier function

against bacterial infiltration. Lazzara and Porter showed by radiographic findings that utilizing reduced prosthetic components obtained a lower peri-implant bone resorption due to the increased distance between the bone crest and the microgap. Thus, the inflammatory infiltration reduces the extension by 0.35 mm in both directions due to a reduced immune response to the microgap [42,49,50].

Conclusion

Single post-extraction implant placement and provisionalization is a challenge for every dentist. A common opinion on the correct treatment plan does not exist in the literature. Many authors recommend that the best solution is probably the delayed implant placement [18], while others recommend exactly the opposite [14,33,38,47]. The solution remains in the accurate examination of the tooth site that needs to be extracted. If all the parameters that have been mentioned previously are respected and followed in detail, the decision should be straightforward, and consequently the final result should be too. Thus, if the case is analyzed in all the parameters discussed above, and it is judged in a favorable manner for an immediate treatment, then the probability to obtain an ideal esthetic is high.

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