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Immediate implant placement and provisionalization of maxillary anterior single implants

JOSEPH YUN KWONG KAN, KITCHAI RUNGCHARASSAENG, MATTEO DEFLORIAN, TOMMASO WEINSTEIN, HOM-LAY WANG & TIZIANO TESTORI

Achieving and maintaining optimal gingival esthetics around anterior single implants is a demanding task (49, 73). In spite of the high success rates achieved with osseointegrated implants, gingival recession of up to 16% has been reported in anterior single implants (38). On the other hand, spontaneous rebound of the receded gingiva has also been observed after a few years of function (20, 45, 50). These changes in the peri-implant mucosa were postulated as being an attempt to establish a stable biologic dimension (9). An understanding of the dentogingival complex and its implant counterpart (the peri-implant mucosa) allows clinicians to balance the biologic/physiologic requirements and esthetic demands of single-implant restorations in the esthetic zone.

The impending loss of a single tooth in the esthetic zone in a patient with an otherwise healthy periodontium can be a distressing experience (48–50, 56), and the inevitable loss of soft and hard tissue following tooth extraction often results in a compromised site for implant placement in terms of esthetics. Various surgical augmentation techniques have been advocated as corrective procedures, but they are challenging and the results are not predictable (7, 44, 67, 70). Since 1998, when Wöhrle (87) first demonstrated success with immediate implant placement and provisionalization of single anterior maxillary implants, numerous studies have substantiated the viability of such treatments (6, 14, 18, 27, 29, 32, 39, 43, 51, 52, 55, 69, 71, 81, 84). One of the most desirable features of immediate implant placement and provisionalization is its efficacy in optimizing esthetic success by preserving the existing osseous and gingival architecture (37, 48, 52, 87).

The esthetic success of immediate implant placement and provisionalisation procedures is influenced by a number of factors that can be categorized as intrinsic and extrinsic (53). Intrinsic factors are patient-dependent and include the relationship between hard and soft tissues, gingival biotype and sagittal root position in the alveolar bone (47, 57). Extrinsic factors, on the other hand, are clinician-dependent and include three-dimensional implant position and angulation, as well as the contour of the abutment and the provisional restoration (48, 57).

The aim of this paper was:

- To review the literature in order to address topics related to immediate implant placement and provisionalization of maxillary anterior single implants, specifically:
  - advantages of the flapless procedure;
  - the opportunity to fill the gap between the implant and the buccal bone;
  - augmentation of soft tissue at immediate implants;
  - the true advantage in terms of esthetics;
  - the esthetic evaluation and patient-centered outcome; and
  - advantages and disadvantages with respect to other delayed approaches.
- To provide a full clinical protocol for immediate implant placement and its provisonalization in the esthetic area.

Advantages of the flapless procedure

The traditional approach in implant surgery involves flap reflection to prepare the site for fixture positioning. The flapless approach avoids this step, inserting the implant without raising any flaps, simplifying the procedure, reducing operative time and patient discomfort, and favoring acceptance of the implant protocol (3, 61, 80). On the other hand, there is a learning curve associated with this technique, and complications such as bony dehiscence and fenestration occur. A clinical study reports a dehiscence rate of 4.73% with flapless surgery (13).

From a biologic point of view, the main advantage of a flapless procedure is preservation of the periosteum and supraperiostal plexus and consequently the blood supply to the alveolar bone is maintained (24, 82). Some clinical studies suggest that flapless surgery prevents marginal bone loss (8, 76). A recent meta-analysis (61) compared marginal bone loss and implant survival rate between flapless and flapped procedures. They found no statistically significant difference between the two, concluding that the flap design should be chosen for patient comfort, need for access and ridge augmentation, and experience level of the surgeon (61). A case-series study evaluated soft-tissue alterations in anterior maxilla that were rehabilitated with immediate implant placement and with conventional implant treatment (74). Immediate implant placement was performed with a flap or a flapless procedure. Sixteen patients were treated with immediate implant placement and 23 with conventional treatment. The immediate implant placement group showed only 7% recession, while in the control group the recession was approximately 43%. Specifically, the flapless approach had significantly less recession than the flap approach at the 26-week follow-up. Flapless surgery is usually combined with guided implant surgery templates. In the esthetic area, with proper case selection, flapless surgery could be very useful in maintaining soft-tissue health and in obtaining good esthetics with peri-implant papilla preservation (40). Fürhauser et al. (35) evaluated, in terms of three-dimensional accuracies and pink esthetic score, 27 patients rehabilitated with flapless single-tooth implants for delayed replacement of upper incisors. The results showed that this is a predictable treatment modality in terms of esthetics (median pink esthetic score = 13) and accuracy. Nevertheless, the authors highlight that a deviation of as little as 0.8 mm at the implant site is enough to compromise implant esthetics. These findings highlight that computer-guided surgery is a reliable procedure only in the hands of skilled surgeons because it is not free of complications (75). Before planning a computer-guided surgery we should bear in mind that the accuracy of cone-beam computed tomography, measured in dry skulls, is 0.6 mm (60) and the accuracy of three-dimensional printers, frequently used to produce surgical templates, is between 0.25 and 0.5 mm (79). Therefore, after three-dimensional planning a global inaccuracy of 0.85–1.1 mm, before surgery, is predicted. Clinicians should be aware of these data in order to plan and prepare for surgery.

The opportunity to fill the gap between the implant and the buccal bone

In the literature, there are many studies investigating various approaches to deal with the residual space between the implant surface and the alveolar walls in cases of immediate implant placement. Many animal studies have quantified the amount of bone in direct contact with the implant; they found that spontaneous bone formation occurs only after 4 months with a maximum gap between the implant and the buccal bone of 1–1.25 mm (11). The scientific evidence is scarce in humans. Paoloantonio et al. (72) found the degree of bone–implant contact after immediate placement to be 70% in the mandible and 64.8% in the maxilla, which was similar to that found for implants placed in healed sites. Connective tissue without inflammatory cells in the coronal portion of the implant was found in very few cases. Cornelini et al. (23) found that the degree of bone–implant contact was 61.4% and 3.2 mm of supracrestal connective tissue. Wilson et al. (86), in a human model, found the average degree of bone–implant contact to be 50% with a 1.5 mm gap. The degree of bone–implant contact was reduced in cases with a 4 mm gap. Bone resorption following tooth extraction is not reduced by immediate implant placement *per se* but is influenced by the apicocoronal and buccopalatal position of the implant (47). Human studies show that demineralized autologous graft, or other alloplastic grafts, left residual granules surrounded by connective tissue or by immature bone after 6–9 months (4, 17, 33). Deproteinized bovine bone has been analyzed in animal studies in postextraction sites and revealed osteoconductive properties in the new-bone formations (10). Artzi et al. (4) tested

deproteinized bovine bone in 15 postextraction human alveoli, followed by biopsies after 9 months, and showed that using this approach the bone is preserved. Deproteinized bovine bone has been evaluated using preoperative and postoperative computed tomography scans (30 and 90 days postoperatively) in order to assess the resorption of bundle bone. Authors found that bone resorption was reduced by 20% in areas where biomaterials were used (68).

Soft-tissue augmentation at immediate implants

Immediate implant placement is an effective procedure from an esthetic point of view. Nevertheless, this approach is usually associated with soft-tissue recession (9, 29, 52, 71). The absence of a vestibular bone plate and the presence of a thin periodontal biotype are considered to be risk factors for recession of peri-implant tissues (47). In the esthetic area, the ultimate goal for clinicians in implant therapy is to re-create a natural restoration. Therefore, care must be taken, in any chosen surgical procedure, to reduce any potential risk factors that might hinder the provision of such a restoration. Surgical intervention should include augmentation of bone volume and thickening of soft tissues in order to achieve stability over time. For thickening of soft tissues, different techniques, such as connective graft, or a tunnel or a bilaminar technique, have been proposed (22, 54, 89), all with the objective of re-creating thicker soft-tissues. It is easier to obtain this result in patients with a thick periodontal biotype (65, 66) and therefore there is no indication to perform any additional surgery. On the contrary, in patients with a thin periodontal biotype and usually thinner bundle bone, greater bone resorption (34) is usually observed followed by soft-tissue contraction (41). Regardless of the use of bone grafts, connective tissue grafts alone thicken soft tissues and, at the same time, compensate for the unavoidable tissue contraction following tooth extraction, leading to optimal esthetic results. A recent systematic review found that a combination of immediate loading of implant and connective tissue graft allows for better stability of the gingival margin and thickens the peri-implant soft tissues (59).

The main advantage in terms of esthetics

Immediate implant placement postextraction does not reduce bone resorption (16). Recent publications demonstrate that postextractive immediate implant placement is a favorable clinical protocol, in terms of esthetics, only through the combination of different factors (19, 83). A careful presurgical diagnostic phase includes evaluation of the morphology of the alveolar process (47) and the periodontal biotype (41), followed by surgical planning to provide a guide for implant placement (41), to manage the peri-implant gap (15, 88), and management of the less-invasive soft tissue (using the flapless approach) and eventually its thickening (54). Immediate loading plays an important role in conditioning the soft tissues during healing with the provisional prosthetic restoration (77) and, on its own, is capable of shortening treatment time.

Esthetic evaluation and patient-centered outcomes

Implant therapy has been evaluated in various ways over the years, starting with 'fixture survival', being the only parameter considered to judge successful therapy. Together with technical advances, esthetics, in terms of soft-tissue contour and prosthetic restoration, became another important parameter by which to judge rehabilitation. Most recently, the patient's perception of their surgery emerged as an important parameter for comprehensive evaluation of the therapy. In the literature, there are a large number of studies but no consensus regarding the correct method to undertake this type of research (63). Nevertheless, the available literature reports some interesting findings. Hof et al. (42) interviewed 150 patients about their perception of implant therapy. Regarding the time of treatment, fewer interviewees anticipated a healing period of at least 2 months after tooth extraction compared with a healing period of at least 2 months after implant placement (89% and 96%, respectively) and only 12% were willing to tolerate increased risk of implant failure for the sake of shortening treatment duration. De Bruyn et al. (28) published a systematic review of oral health-related quality of life in implant dentistry, with 'quality of life' being defined as the patients' evaluation of their health in their daily lives (63). Regarding the timing of implant placement, the authors found no significant differences in shortening treatment time from a patient's perspective. A 10-year retrospective study analyzed the vertical dimension of vestibular bone of the one-stage postextraction implant with simultaneous bone regeneration and also evaluated patient-related parameters.

Seventeen patients were evaluated after 10 years using a questionnaire with a visual analog scale in aspects including chewing function, esthetic satisfaction, peri-implant soft-tissue health, access for oral hygiene, speaking ability and overall satisfaction (58). A self-assessed score on a visual scale (of 1–10) for chewing function was 10, for esthetic appearance was 9, for mucosal health was 8, for cleansability of the restoration was 9, for overall satisfaction was 9 and for speaking ability was 9.5. Interestingly, these encouraging results were not associated with loss of facial bone, the concern most commonly recognized in esthetic implant therapy. The authors found no correlation between vertical bone loss and the position of the facial mucosal margin or the papilla index system scores. However, this clinical study has limitations: the radiographic images provide limited data of the facial bone volume and the vestibular bony wall; and the thickness of the peri-implant tissue at baseline was not assessed.

The advantages and disadvantages with respect to other delayed approaches

In the esthetic area, the immediate placement of an implant and its immediate provisionalization are delicate procedures with favorable results, as demonstrated by the 5-year, multicenter, prospective evaluation by Cooper et al. (21). The authors analyzed 55 implants in fresh sockets and 58 in healed ridges. The survival rate was, respectively, 94.6% and 98.3%, with all the failures occurring in the first year: this difference was not statistically significant. The same result was noted in interproximal crestal bone levels and soft-tissue levels. The authors remark that these results could be obtained by using appropriate guidelines and with careful patient selection. On the other hand, Cosyn et al. (25), in another 5-year prospective study, found that the mean mid-facial recession increased with borderline significance between 1 and 5 years. The authors wondered if it was feasible to recommend this approach in daily practice. A recent literature review evaluated immediate implant placement and immediate restoration with a single crown in the anterior maxilla; it reported 626 implants with a success rate of 97.96% and a survival rate of 98.25% (medium follow-up: 31.2 months) (85) in accordance with the systematic review of the literature by Del Fabbro et al. (30), who reported an overall implant survival rate of 97.62% (range: 78.6–100%) after 1 year of function.

Table 1. Advantages and disadvantages of immediate implant placement and provisionalization

Advantages	Disadvantages
Shorter treatment time	Risk of mucosal recession
Preserves soft-tissue morphology	Skilled operator required
Better immediate esthetics	

Table 2. Checklist for diagnostic and surgical prerequisites

Diagnosis: parameters to be evaluated	Gingival level in relationship to adjacent teeth
	Osseous tissue–gingival tissue relationship at facial aspect
	Bone sounding of adjacent teeth (peri-apical X-rays)
	Gingival biotype
	Sagittal root position (cone-beam computed tomography if needed)
	Labiopalatal width
	Inter-radicular mesiodistal width
	Diagnostic wax-up (tooth shape)
Surgical procedure prerequisites	Minimally traumatic extraction
	Evaluation of the labial bony plate with a periodontal probe
	Correct three-dimensional implant position
	Primary implant stability
	Evaluation of the gap morphology (implant and vestibular bone plate)

Table 3. Predictive factors for post-extractive immediate implant placement

Variable	Low risk	High risk
Biotype	Thick	Thin
Gingival form	Flat scallop	High scallop
Tooth position/free gingival margin	Coronal	Ideal or apical
Tooth shape	Square	Triangular
Position of the osseous crest: < 3 mm from adjacent teeth and facially	High crest	Low crest

Modified from Kois & Kan (57).

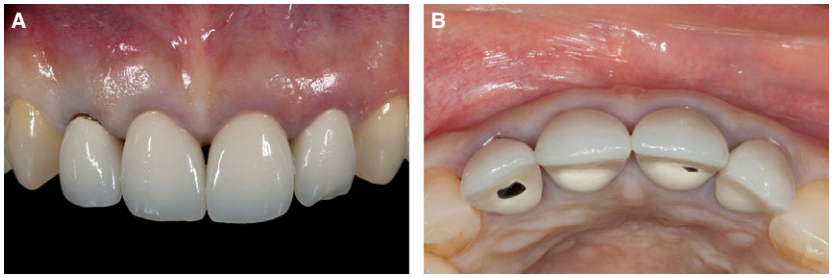

Fig. 1. (A) The gingival level of the failing tooth (#7) should be (i) at the same level as (or more coronal than) that of the contralateral tooth and (ii) harmonious with the adjacent dentition. (B) Harmonious horizontal facial gingival tissue contour is observed in the maxillary anterior region.

Fig. 2. The osseous–gingival tissue relationship can be evaluated by bone sounding and should measure 3 mm on the facial aspect of the failing tooth.

The Osteology Consensus Group (40) stated, in 2011, that the survival rate of postextraction implants in the esthetic area is high but there is also a very high risk of mucosal recession. Accordingly, case selection should be carried out evaluating the following potential risk factors:

- smoking.
- < 1 mm vestibular bone.
- thin biotype.
- vestibular position of the implant.

In the same way, a recent International Team for Implantology consensus statement underlines that, with immediate implant placement, the risk of mucosal recession increases (64). The research group recommends a careful case selection, to ensure:

- intact socket walls.
- facial bone wall at least 1 mm in thickness.
- thick soft-tissue.
- no acute infection at the site.
- availability of bone apical and palatal to the socket to provide primary stability.

The use of surgical templates is suggested as well as a provisional fixed restoration.

Regarding the timing of loading, the guidelines of the International Team for Implantology group are as follows (36):

- a torque of 20–45 N for immediate loading.
- no systemic health contraindication.
- more benefits than risks.

In the anterior region, immediate loading should be performed with caution and by experienced clinicians and should not be considered a routine procedure (Table 1).

The American Academy of Fixed Prosthodontics (5) remarks that:

> "The risk–benefit of immediate loading in scenarios in which support and stability from the

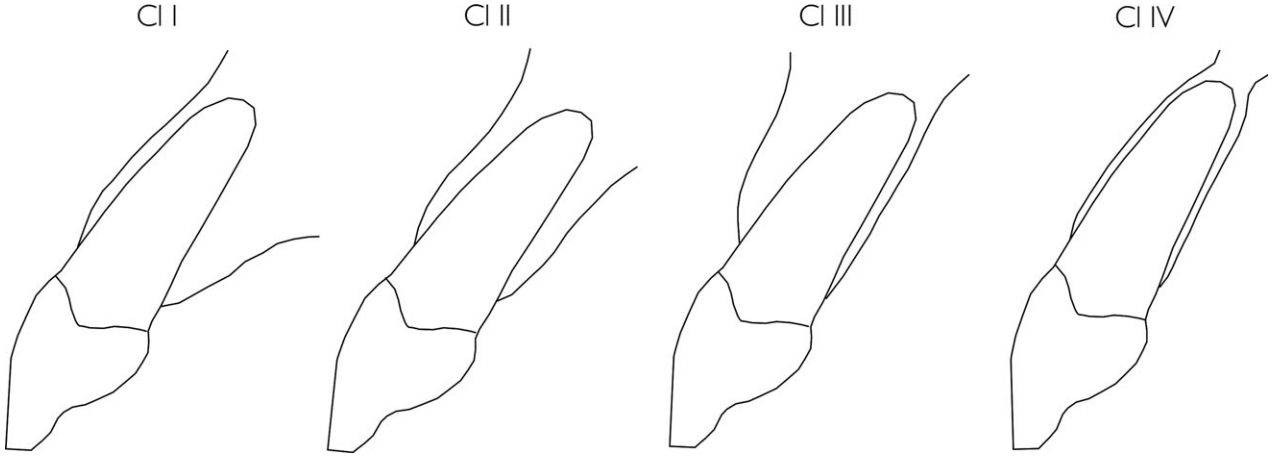

Fig. 3. Sagittal root position classification. Class I (Cl I): the root is positioned against the labial cortical plate. Class II (Cl II): the root is centered in the middle of the alveolar housing without engaging either labial or palatal cortical plates at the apical third of the root. Class III (Cl III): the root is positioned against the palatal cortical plate. Class IV (Cl IV): at least two-thirds of the root is engaging both labial and palatal cortical plates.

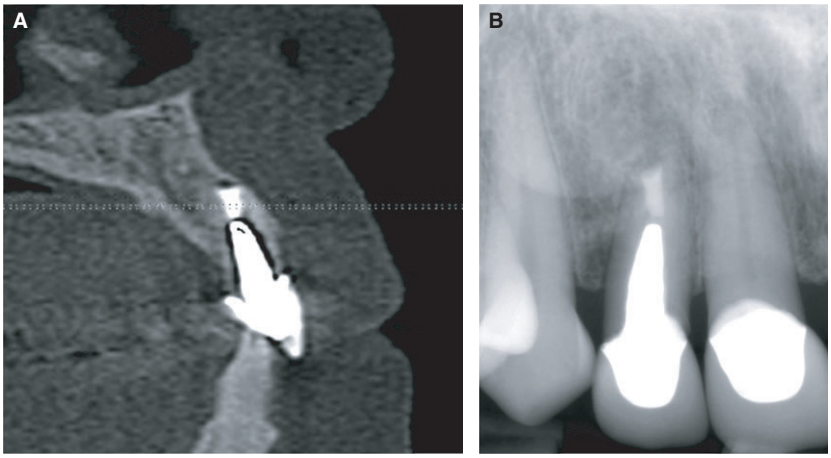

Fig. 4. Cone-beam computed tomography image (A) and periapical radiograph (B) of the failing tooth.

recipient site is diminished must be critically evaluated because of the difficulties in achieving esthetic outcomes after failure."

Diagnosis and treatment planning

Proper diagnosis of the patient's condition is vital to allow clinicians to formulate an optimal and predictable treatment plan (Tables 2 and 3). By recognizing unfavorable conditions, adjunctive procedures can be incorporated to avert compromised situations. The following parameters must be evaluated for an immediate implant placement and provisionalization procedure:

- The gingival level of the failing tooth should be: (i) at the same level as (or more coronal than) that of the contralateral tooth; and (ii) harmonious with adjacent dentition, as some gingival recession can be expected after the procedure (Fig. 1) (49). Therefore, when the gingival level of the failing tooth is more apical than that of the contralateral tooth, orthodontic forced eruption is recommended before immediate implant placement and provisionalization (78).
- The osseous tissue–gingival tissue relationship can be evaluated by bone sounding and should measure 3 mm on the facial aspect of the failing tooth and 4.5 mm on the proximal aspect of adjacent teeth (Fig. 2). There is a propensity for tissue recession after extraction, with or without immediate implant placement, in low crest situations where bone sounding measurements are greater than those indicative of an optimal relationship (57). Depending on the level of the gingival tissue, orthodontic and/or periodontal treatment can be used to improve the osseous tissue–gingival tissue relationship.
- Gingival biotype can be assessed during bone sounding and categorized according to the visibility of the underlying periodontal probe (SE Probe SD12 Yellow; American Eagle Instruments Inc., Missoula, MT, USA) through the gingival tissues with higher visibility corresponding to reduced thickness of tissues (Fig. 2) (46, 56). A thin gingival biotype, which has been shown to sustain more tissue recession after surgical insults than a thick biotype, can be enhanced by using a bilaminar subepithelial connective tissue graft at the time of implant placement and provisionalization (53).
- A sagittal root position (47) of the failing tooth in the alveolar bone can be identified via cone-beam computed tomography and can be categorized as one of four different classes (Fig. 3):
  - Class I: the root is positioned against the labial cortical plate.
  - Class II: the root is centered in the middle of the alveolar housing without engaging either labial or palatal cortical plates at the apical third of the root.

Fig. 5. Minimally traumatic extraction results in intact soft and hard tissues.

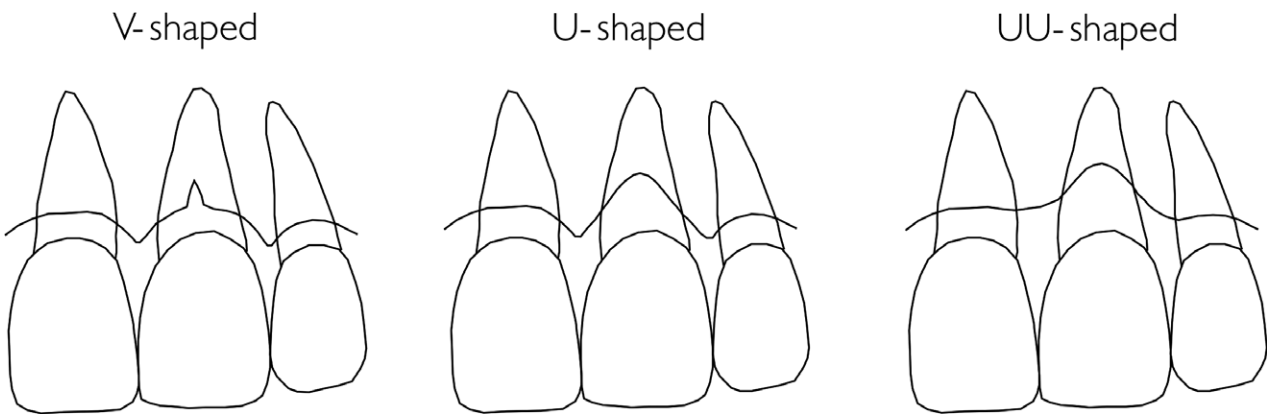

Fig. 6. Facial bone-defect classification. V-shaped defect: isolated only to the mid-facial portion of the facial bony plate. U-shaped defect: extends to mesial and/or distal aspects of the failing tooth. UU-shaped defect: extends to the mesial and distal aspects of the immediately adjacent teeth.

- Class III: the root is positioned against the palatal cortical plate.
- Class IV: at least two-thirds of the root is engaging both labial and palatal cortical plates.

It is important for clinicians to recognize cases that are favorable for immediate implant placement and provisionalisation (Class I sagittal root position), cases that are more technique-sensitive and entail additional attention (Class II and Class III sagittal root position) and cases that are contraindicated for immediate implant placement and provisionalization, requiring augmentation of hard and/or soft tissue before implant placement (Class IV sagittal root position) (47).

- Buccolingual width and inter-radicular mesiodistal widths of the failing tooth determine the diameter of the implant to be used and can be evaluated using cone-beam computed tomography and periapical radiographs (Fig. 4).

Clinical procedure

Diagnostic wax-up

A diagnostic wax-up of the failing tooth on the study cast should: (i) represent, as closely as possible, the definitive restoration; (ii) match the contralateral tooth; and (iii) be harmonious with the adjacent dentition. Proper diagnostic waxing provides information necessary for treatment planning, especially when adjunctive procedures (orthodontic and/or periodontal intervention) are required. Provisional restoration, as well as implant and soft-tissue surgical templates, can be accurately fabricated from a well-crafted diagnostic wax-up. In situations where the coronal portion of the failing tooth is intact and esthetically

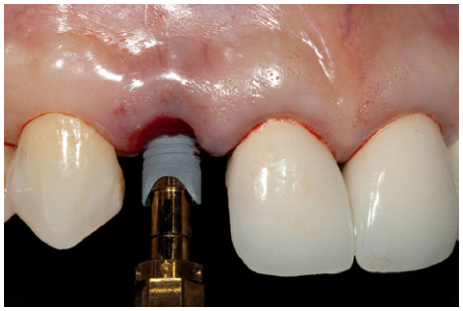

Fig. 7. The implant should be placed at the center of the predetermined mesiodistal width of the final restoration with a minimal distance of 2 mm from the adjacent tooth.

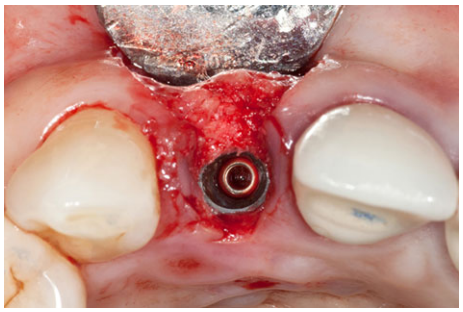

Fig. 8. Papilla-sparing incisions are used for grafting procedures. Bone graft material is placed into the gaps between the implant and the bony socket to maintain a facial osseous contour.

Fig. 9. A screw-retained provisional restoration is placed.

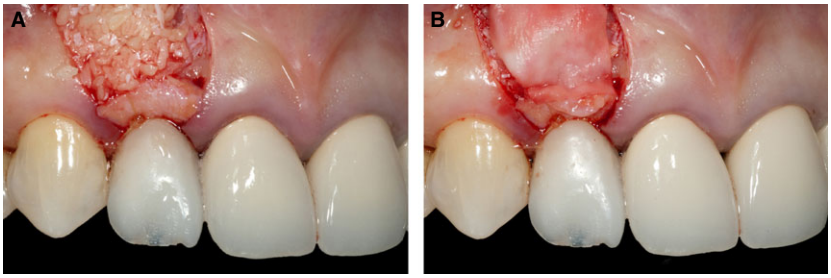

Fig. 10. (A) Bone graft material and subepithelial connective tissue graft are placed. (B) Placement of absorbable membrane.

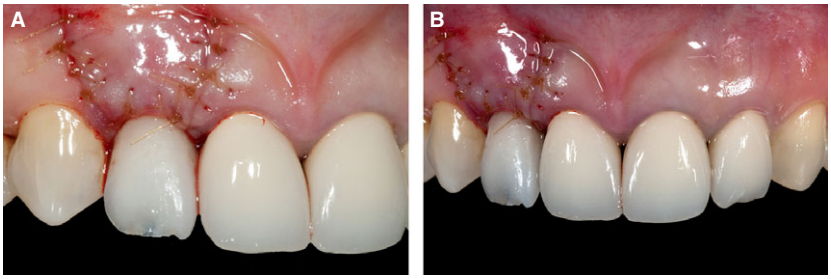

Fig. 11. Lateral (A) and facial (B) views showing primary closure achieved using chromic gut suture.

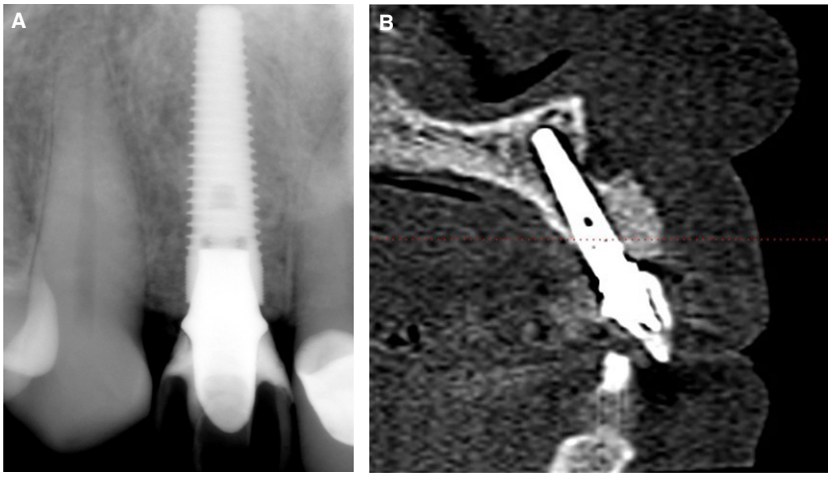

Fig. 12. Periapical radiograph (A) and cone-beam computed tomography image (B) after immediate implant placement and provisionalization of tooth #7.

acceptable, it can be modified after extraction to be used as a natural-looking provisional restoration.

Surgical procedure

Immediate implant placement entails extraction of the failing tooth followed by implant placement. The extraction must be minimally traumatic with controlled expansion of the bony socket to avoid soft- and/or hard-tissue damage (Fig. 5). This can be accomplished by first using Periotome (Nobel Biocare, Yorba Linda, CA, USA) to make a sulcular incision with transeptal fiberectomy that extends apically beyond the marginal bone. This incision separates the tooth from the periodontal tissue, facilitating extraction with minimal damage to the usually thin labial bony plate. After the extraction, the integrity of

Fig. 13. Clinical image of provisional restoration after 4 months of healing.

the labial plate must be verified using a periodontal probe. Fenestrations located at least 5 mm apical to the intact facial marginal bone are generally inconsequential to the immediate implant placement and

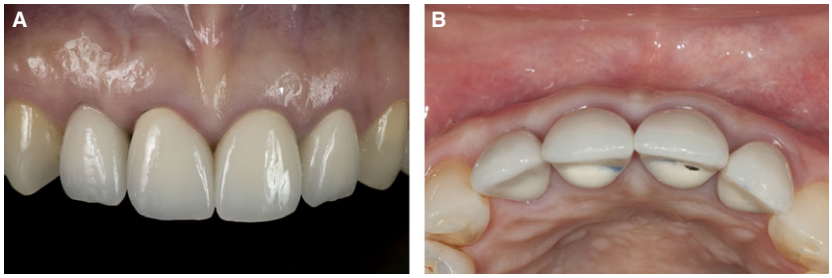

Fig. 14. Frontal (A) and occlusal (B) images of the definitive restoration 3 years after the surgery. Note the negligible changes in vertical and horizontal gingival tissue architecture, resulting in an esthetically pleasing result.

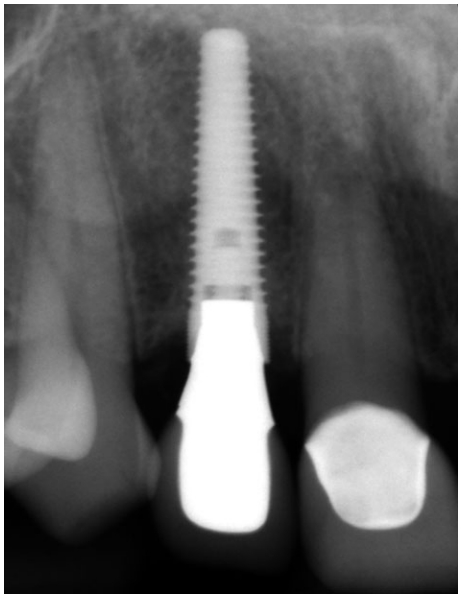

Fig. 15. Periapical radiograph of the definitive restoration 3 years after the surgery.

Fig. 16. (A, B) Intra- and extra-oral vision of the case. Patient complains about mobility of tooth #52 and unpleasant esthetics because of the morphology of teeth #52-11-21-22 and their gingival contour.

Table 4. Checklist for procedures after implant insertion

1. Immediate provisionalization	Relining and connection of provisional crown to a prefacbficated abutment
2. Regenerative procedure and soft-tissue management	Bone regeneration
	Subepithelial connective tissue graft (thin biotypes)
3. Postoperative instruction	Antibiotics, analgesics
	Soft diet (4 months)
4. Definitive restorations	6 months after surgery

provisionalization procedure, as these defects can be addressed predictably with grafting.

When a facial osseous dehiscence/defect is detected, the predictability of immediate implant placement and provisionalization, in conjunction with guided bone-regeneration procedures, is determined by the shape/size of the defect (54). A V-shaped defect, which is confined only to the mid-facial portion of the facial bony plate, responds favorably to immediate implant placement and provisionalization with guided bone regeneration (Fig. 6). It should be noted, however, that significant facial gingival recession, after 1 year of function, has been reported when this technique was attempted on failing teeth with U-shaped (extending to the mesial and/or distal aspects of the failing tooth) or UU-shaped (extending to the mesial and distal aspects of the immediately adjacent teeth) defects (Fig. 6) (54). Therefore, a failing tooth with a U-shaped or a UU-shaped defect is contraindicated for immediate implant placement and provisionalization.

Primary implant stability is a prerequisite for immediate implant placement and provisionalisation and is usually achieved by engaging the palatal wall and the bone 4–5 mm beyond the apex of the extraction socket. Therefore, a Class I sagittal root position, with a considerable amount of bone present on the palatal aspect for implant engagement

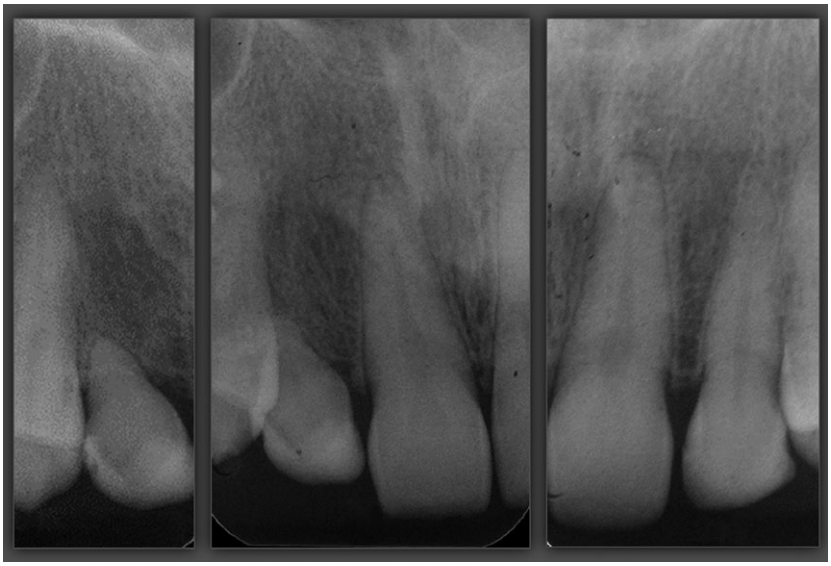

Fig. 17. Periapical radiograph shows radicular resorption on tooth #52.

to attain primary stability, is optimal for immediate implant placement and provisionalization; and a Class IV sagittal root position, with a limited amount of bone for implant engagement, is a contraindication (47). Class II and Class III sagittal root positions present compromised and/or challenging conditions for immediate implant placement and provisionalisation (47). In Class III sagittal root positions, implant stability must rely on its engagement with the available bone on the labial aspect, which can potentially lead to facial fenestration or perforation (47). In Class II sagittal root positions, as available bone on both the palatal and labial aspects is inadequate, implant stability relies primarily on the amount of available bone beyond the apex of the extraction socket (47).

The final implant diameter should be within the confines of the tooth socket but, in order to help prevent perforation, should not engage the usually thin coronal portion of the labial plate. Furthermore, a minimal distance of 2 mm between the implant and adjacent teeth is recommended to minimize marginal bone loss occurring as a result of encroachment (31). The final implant position and angulation are in accordance with the following guidelines:

- mesiodistally: the implant should be placed at the center of the predetermined mesiodistal width of the final restoration with a minimal distance of 2 mm from the adjacent tooth (Fig. 7)
- labiopalatally: the implant should be placed along the palatal wall of the extraction socket for primary stability. At the cervical level, the implant should emerge slightly lingual to the predetermined buccolingual width of the final restoration. At the incisal level, the implant should emerge at the incisal edge of the final restoration. With this labiopalatal position/placement, a gap of at least 1.5 mm between the implant and the buccal bone is maintained and the integrity of the labial bone is ensured.

Fig. 18. (A, B) Atraumatic extraction of tooth #52 and detection of the vestibular bone plate at the soft-tissue level.

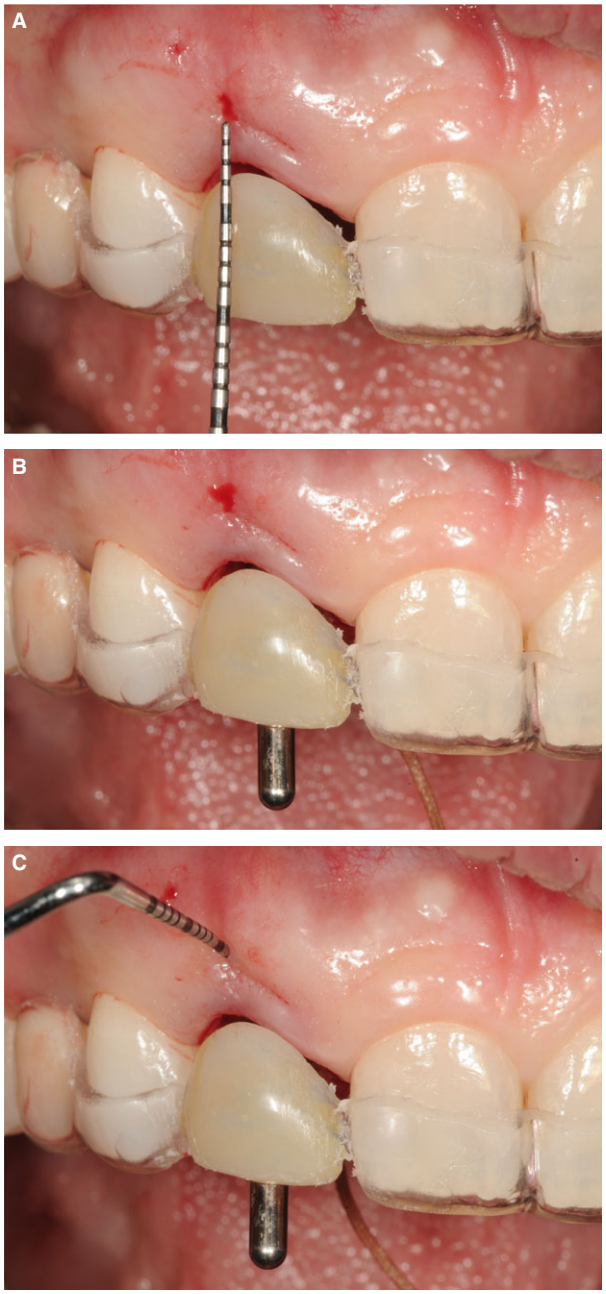

Fig. 19. (A–C) The implant site is prepared with the use of a surgical guide, based on a diagnostic wax-up.

- apicocoronally: the neck of the implant is placed approximately 3 mm apical to the predetermined facial free gingival margin of the final restoration.

Immediate provisionalization

For immediate provisionalization, a prefabricated zirconium abutment (Nobel Biocare) or metal temporary abutment is manually prepared extra-orally and then hand-tightened onto the implant. The provisional shell is then relined with light polymerized acrylic resin (Ultradent Products, Inc., South Jordan, UT, USA) to capture the cervical gingival emergence of the extracted tooth and adjusted to clear all centric and eccentric functional contacts. The provisional restoration can be screw-retained or cement-retained. A cement-retained provisional restoration is usually more esthetic, especially when the implant access opening is at, or facial to, the incisal edge. However, it also is at higher risk of gingival inflammation at the abutment–cement–restoration interface, as well as cement debonding. It has recently been demonstrated that following immediate implant placement in an anterior tooth socket, the facial bony plate would undergo remodeling, characterized by bone fill from the inside of the socket and resorption of the labial bony plate from the outside. Without the bone graft, this usually results in significant horizontal and vertical facial bone loss and subsequently in facial gingival tissue loss (1, 2, 12, 26).

Papilla-sparing incisions are used for grafting procedures (Figs 8 and 9). After facial flap reflection, the provisional restoration is secured either with screw (Fig. 9) or with provisional cement (Temp-bond; Kerr USA, Romulus, MI, USA) and excess cement is removed. To maintain a facial osseous contour, bone graft material [Bio-Oss (Osteohealth, Shirley, NY, USA) and Puros (Zimmer Dental, Carlsbad, CA, USA)] are placed into the gaps between the implant and the

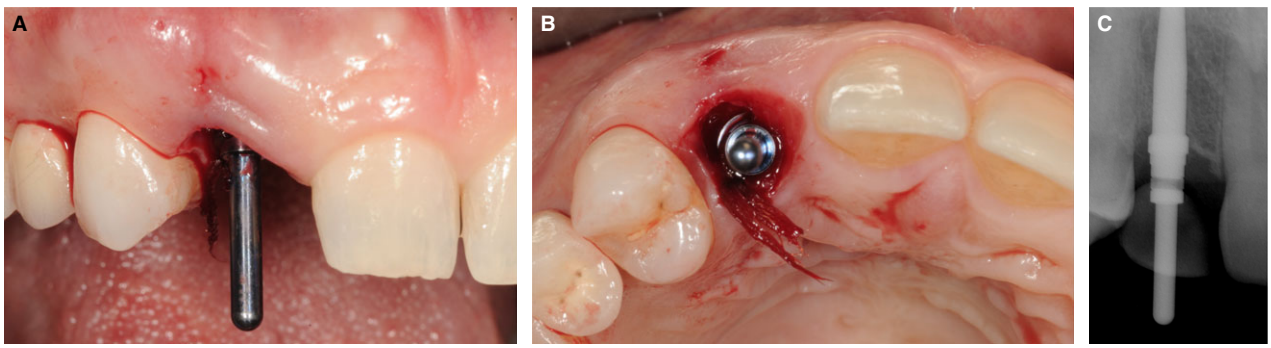

Fig. 20. (A–C) Clinical and radiographic control before implant insertion.

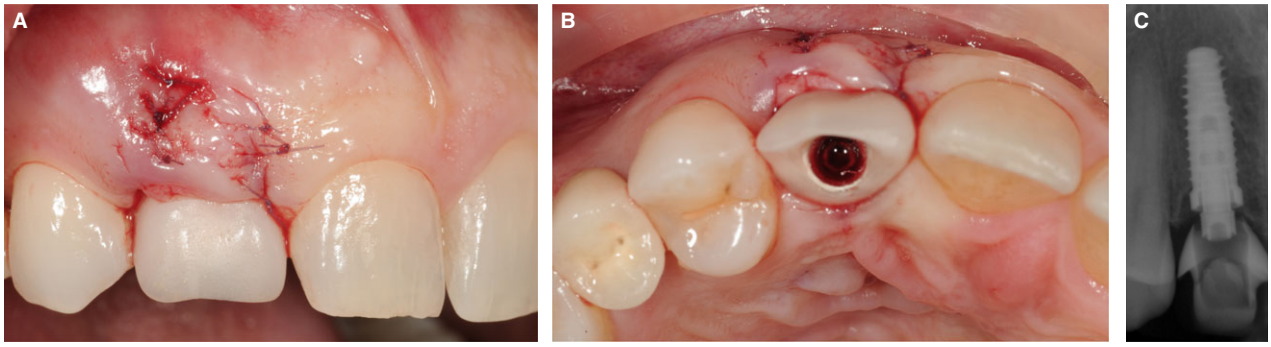

Fig. 21. (A–C) The provisional crown is prepared after implant insertion, post-extraction. Connective tissue graft is inserted to augment the vestibular soft-tissue volume before its connection.

bony socket (Fig. 8) as well as over the facial aspect of the socket in conjunction with absorbable membrane (Bio-Gide; Osteohealth) (Figs 9 and 10). If the thin gingival biotype is present, a subepithelial connective tissue graft can be placed facially at the gingival level to improve the gingival condition (Fig. 10A) (53, 62). Primary closure is achieved using 6-0 chromic gut suture (Johnson & Johnson Ethicon, Livingston, UK) (Fig. 11). The fit of the prosthesis and implant position can be ascertained using periapical radiographs and cone-beam computed tomography images (Fig. 12).

Postoperative instructions

Appropriate antibiotics and analgesics are prescribed for postoperative use. The patient is instructed not to brush the surgical site, but instead to rinse gently with 0.12% chlorhexidine gluconate (Peridex; Procter & Gamble, Cincinnati, OH, USA). A liquid diet is required for 2 weeks after the operation, and a soft diet is recommended for the remaining duration of the implant-healing phase, which typically lasts for 4 months (Fig. 13). The patient is also advised against any activity that could irritate the surgical site.

Definitive restoration

The final implant impression is usually made 6 months after the surgery. A customized zirconium/gold alloy abutment (Procera; Nobel Biocare) is fabricated, duplicating the gingival emergence profile of the provisional restoration. The abutment should be tightened onto the implant using the manufacturer's recommended amount of torque, and the fit should be verified with a periapical radiograph. Subsequently, definitive cement (RelyX™ Unicem; 3M ESPE, St Paul, MN, USA) should be used for the

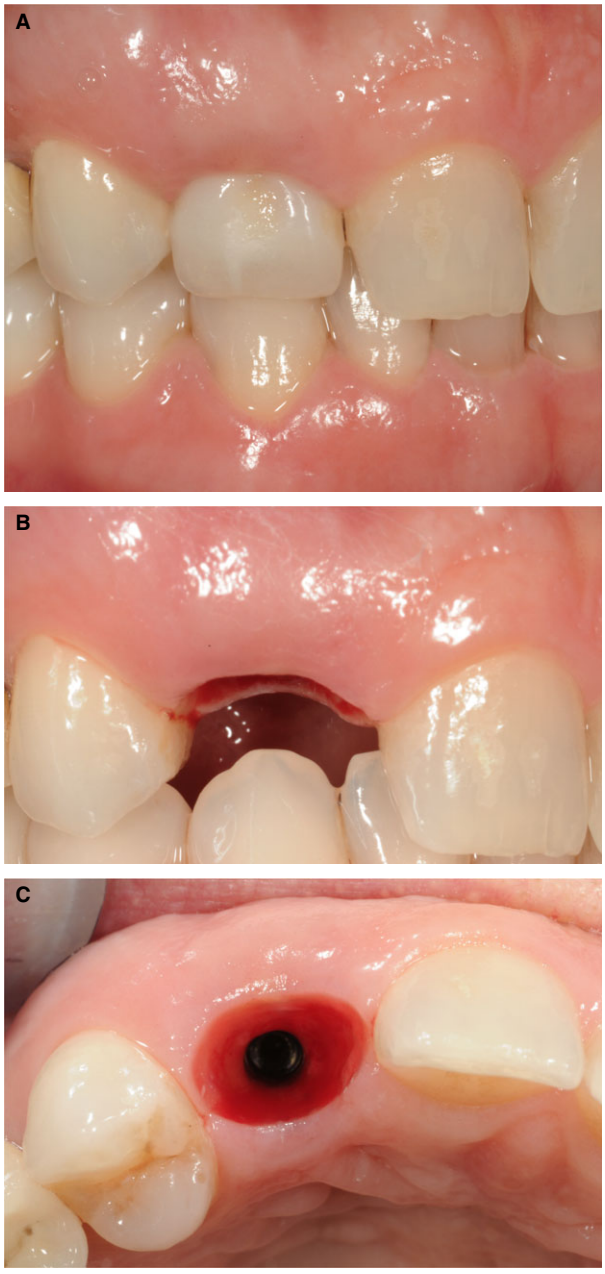

Fig. 22. (A–C) Clinical healing at the 6-month follow-up.

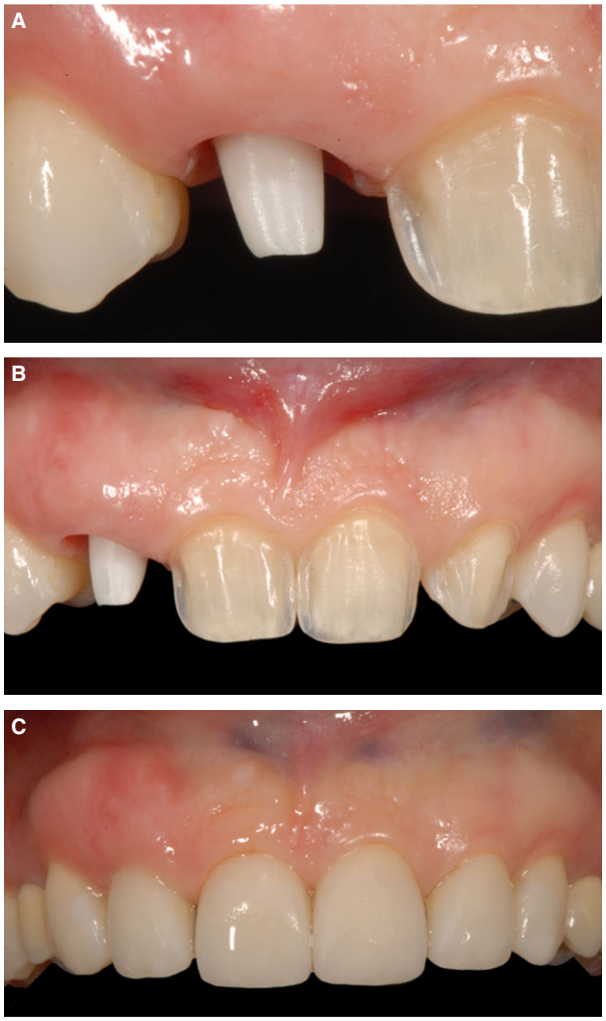

Fig. 23. (A–C) **Definitive prosthetic phase. Zirconia implant abutment and prepared teeth (#11, #21, #22) for veneer (Courtesy of Lorenzo Vanini MD, DDS, Visiting Professor in Esthetic Dentistry, University of Chieti, Chieti, Italy; Universite De La Mediterrannee, Marseille, France; Private practice, Chiasso, Switzerland).**

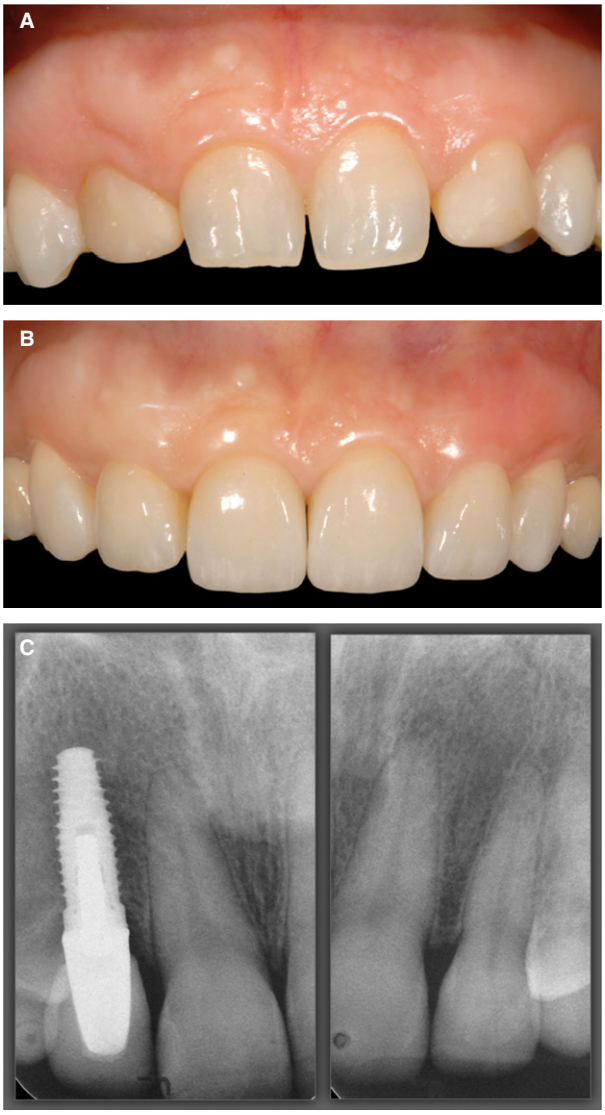

Fig. 24. (A–C) **Initial and clinical comparison at the 5-year follow-up. Peri-implant tissue appears stable around tooth # 12, and teeth # 11, # 21 and # 22 are now in accordance with dental esthetic guidelines and the final periapical radiograph.**

definitive restoration (Figs 14 and 15). Follow-up appointments with the patient should be made at 1, 3, 6 and 12 months, and annually thereafter, in order to ascertain the functional and esthetic outcomes (Table 4).

Conclusion

Immediate implant placement and immediate loading in the esthetic area are great opportunities in modern dentistry (Figs 16–24). Nevertheless, the final results are influenced by many surgical and prosthetic factors, not only the timing itself.

A review of the literature shows that:

- immediate loading positively influences the esthetic result.
- flapless procedures reduce surgical discomfort but a skilled clinician is required.
- it is important to fill the gap between the implant and alveolar socket with slow-resorbable biomaterial to prevent bone resorption after tooth extraction.
- in the case of a thin biotype, soft-tissue augmentation is suggested.

Careful case selection is the key for clinical success. Immediate implant placement and immediate loading should be performed only in certain types of patients. The clinician should relate the difficulty of the case to his experience and dexterity, evaluating

other techniques such as the delayed or traditional approach.

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