Extraction of a malpositioned maxillary anterior implant and simultaneous flapless ridge augmentation: a case report

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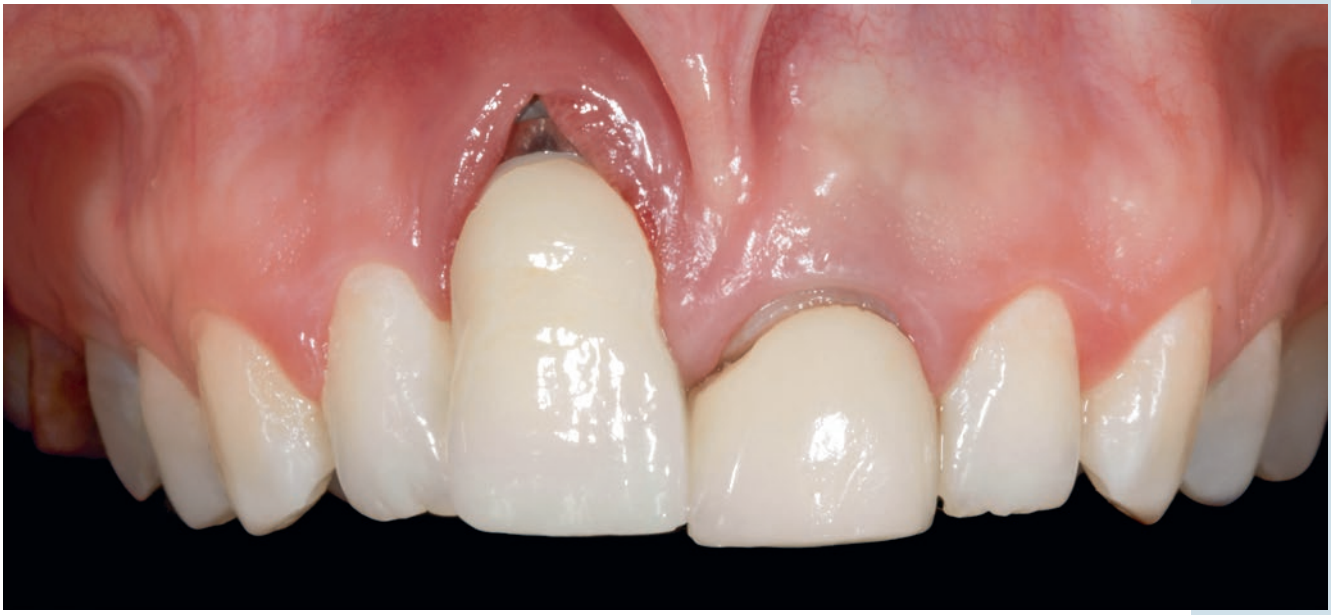

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Abstract

Periimplantitis in a malpositioned maxillary anterior implant is one of the most challenging situations in implant dentistry. Since the regenerative treatment can often be unpredictable and have esthetic consequences such as soft tissue recession due to flap raising, extraction is sometimes recommended. In order to place a new implant after extraction, a bone regeneration procedure must be carried out. This implies raising a flap and therefore the risk of further interproximal gingival recession. In the case presented in this article, a hopeless implant at position 11 presented severe periimplantitis and soft tissue recession, which also affected the mesial part of tooth 12. Tooth 21 had a root canal treatment and a crown. After the implant extraction, a minimally invasive simultaneous bone regeneration and soft tissue graft procedure was performed to reconstruct the remaining ridge using xenograft, a collagen membrane, and a connective tissue graft (CTG). Ten months later, in order to improve the ridge profile, an augmentation procedure was carried out using a CTG. Three months later, an implant was placed and immediately loaded. Three months after loading, the right lateral incisor that still presented a mesial gingival recession was slowly extruded by orthodontic treatment until the papilla was symmetrical to the contralateral one. At the end of the orthodontic extrusion, an implant-supported crown was placed at position 11 and a tooth-supported crown delivered in place of tooth 21. A composite restoration was performed on tooth 12. One year later, the soft tissue level was almost symmetrical at incisor level and the periimplant bone level at implant 11 was stable.

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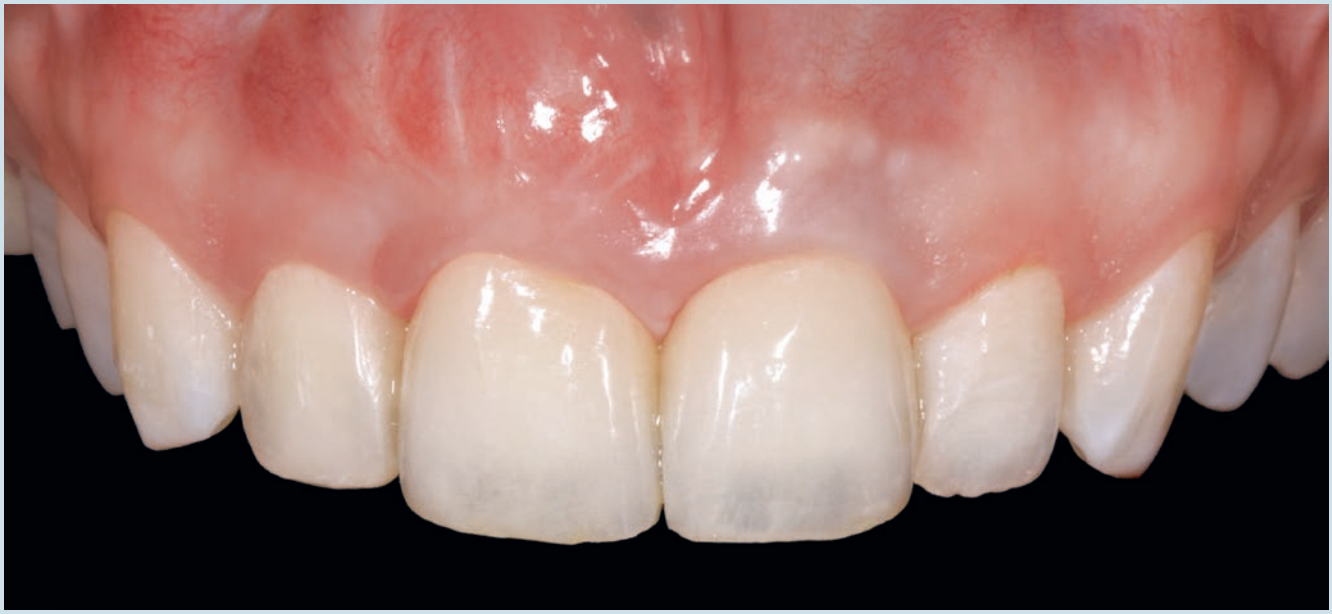


Introduction

An implant treatment in the maxillary anterior area should take into account health, function, and esthetics.[1,2] An inadequate three-dimensional (3D) position of the implant may be a risk factor for periimplantitis. A very deep implant is more susceptible to periimplant pockets. Moreover, an implant located too far labially is more prone to marginal bone loss and soft tissue recession.[3]

The treatment of a malpositioned implant with severe periimplantitis should not be carried out because even if some amount of bone regeneration is obtained, the result will be an esthetic failure due to potential soft tissue recession.[4,5] Furthermore, if the implant is malpositioned, specifically if the positioning is too far labial, the stability of the regenerated bone would be highly questionable due to the inadequate environment outside the bone contour of the regenerated bone.[6-10] Therefore, implant extraction (explantation) is the correct approach for such a situation.[11]

Explantation should be performed in an atraumatic way by using a high-force antitorque implant retriever to preserve the existing periimplant soft and hard tissue. In cases of severe bone and soft tissue loss, the usual treatment would be to extract the implant and, after healing, assess the amount of bone available for implant placement.[12] After evaluation, various treatment options can be carried out to place the implant such as simultaneous guided bone regeneration (GBR) or, in cases of severe vertical atrophy, a two-stage ridge augmentation can be performed so that a delayed implant can be placed in an optimal position.[13,14] These approaches are effective when placing a new, healthy implant but present the disadvantage of high morbidity and potential further soft tissue recession at the interproximal level of the adjacent teeth due to the creation of necessary flaps for bone regenerative surgery and implant placement.[14,15]

A flapless, minimally invasive regenerative approach involving bone xenograft, resorbable membrane, and a connective tissue graft (CTG) is desirable to reduce morbidity and prevent gingival recession. This procedure should be able to reconstruct the alveolar ridge, improving the soft tissue level.

The use of a CTG for socket preservation has been described in the literature.[16] This technique can also be used to seal the socket after immediate implant placement in cases of an intact alveoli.[17] Apart from some vertical soft tissue gain, the technique has the advantage of allowing an isolated environment for the healing of the bone graft.

The objective of this article is to suggest a protocol of treatment for malpositioned implants with severe periimplantitis in the esthetic zone. The protocol emphasizes the need to atraumatically remove the implant and perform a simultaneous bone graft for alveolar ridge augmentation, fulfilling the principles of GBR[18] and placing a CTG[19] for soft tissue reconstruction while keeping the mucogingival line level and even obtaining vertical soft tissue gain.

Case report

A 31-year-old female patient who was a non-smoker had received an immediate implant on the maxillary right central incisor 5 years previously. The implant was too deep and was situated too far labially. It was affected by severe periimplantitis and soft tissue recession as well as inflammation and suppuration. The implant bone loss was also affecting the adjacent right lateral incisor, presenting a zenith and mesial papillae recession. The left central incisor had a root canal treatment and a metal-porcelain crown (Figs 1 to 7).

Fig 1 Frontal facial photograph.

Fig 2 Lateral view. The patient's main complaint is the absence of a papilla between implant 11 and tooth 12 that is visible during smiling.

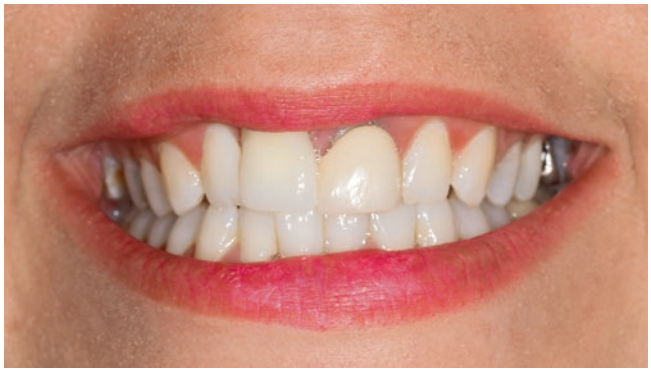


Fig 3 The lack of display of the esthetic defect during maximum smile in the frontal view is, however, an advantage. An average smile with 75% to 100% tooth exposure is displayed.

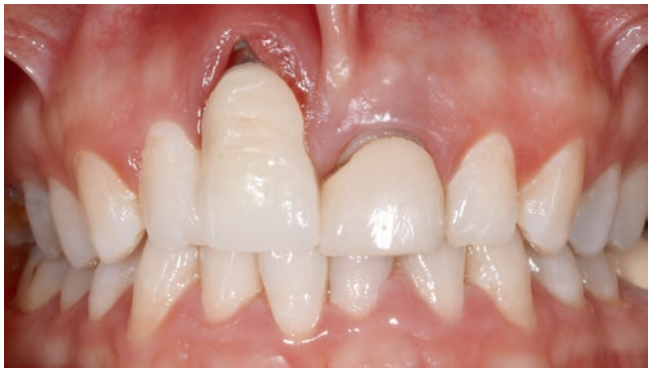


Fig 4 Initial intraoral view.

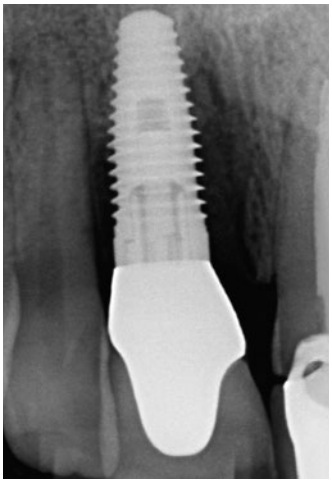


Fig 5 Radiograph of the maxillary central incisor implant 11. Notice the bone loss and the interdental bone level between the implant and the lateral incisor.

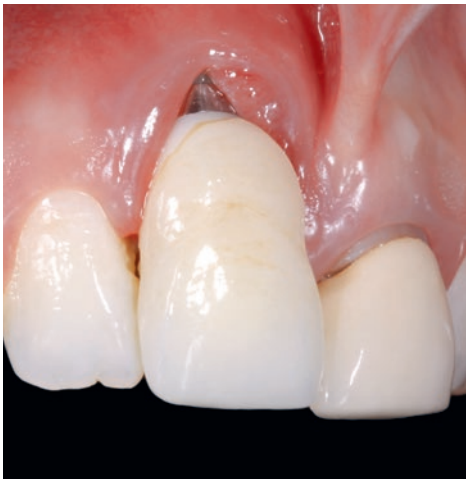


Fig 6 Initial intraoral close-up right view.

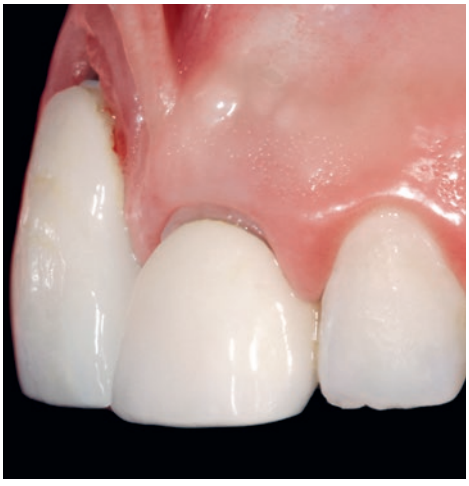
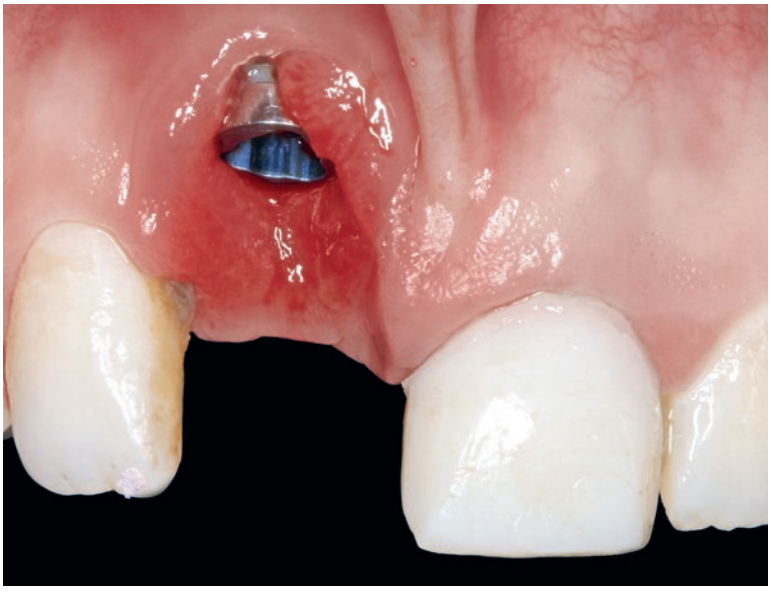
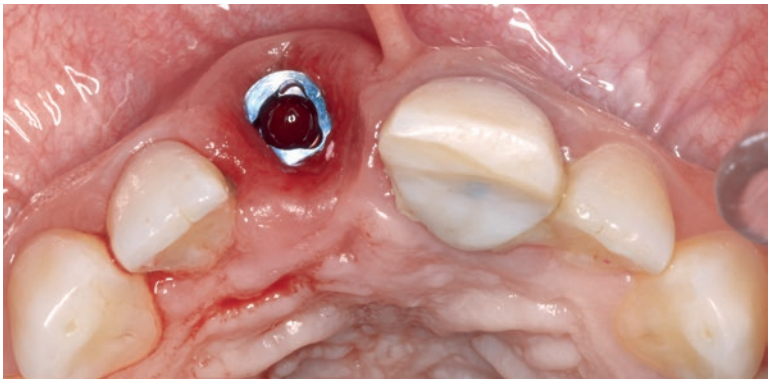


Fig 7 Initial intraoral close-up left view.





Figs 8 and 9 Frontal and occlusal views of the clinical situation after removing the crown and abutment.

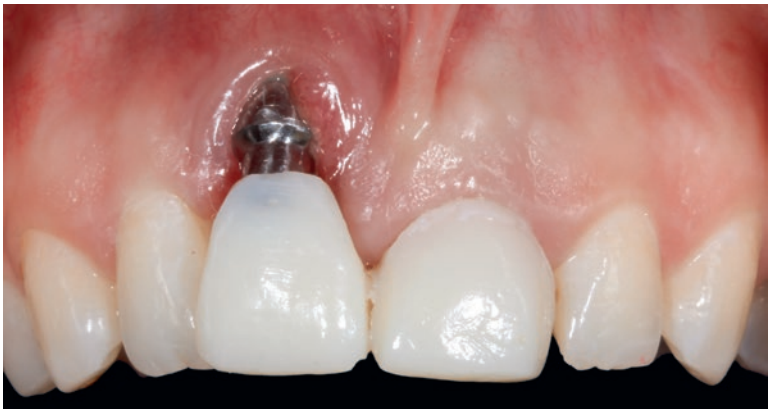


Fig 10 Clinical view immediately after placing a new temporary bridge supported by tooth 21 with a cantilever that touched but was not supported by the new temporary abutment placed at position 11.

Anti-inflammatory phase

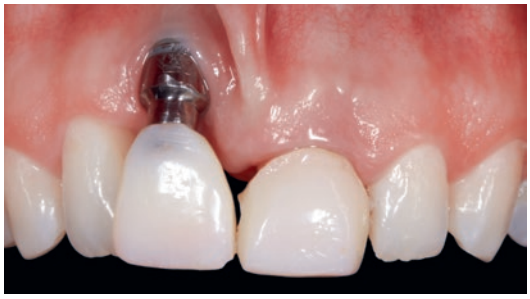
The first step to controlling inflammation was removing the crown (Figs 8 and 9), curetting the implant surface, changing the abutment, and scaling and root planing the whole dentition. A new temporary acrylic prosthesis was placed, supported by the left central incisor and a cantilever that was in contact but not cemented to the new abutment on the implant at position 11 (Fig 10).

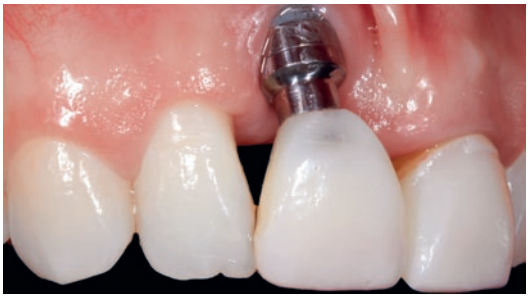
One month after removing the temporary prosthesis, the inflammation was controlled, and an evident gingival recession was noted at the zenith and mesial papilla aspect of tooth 12 (Figs 11 and 12).

A comprehensive examination of the relationship between the patient's teeth, smile, and face was performed. The facial midline, incisal plane, gingival margin, lip smiling position, and occlusal plane were evaluated by means of photographs and films within the Digital Smile Design (DSD) protocol[20] (Figs 13 and 14). The most important requirements were the gingival margin of the central and lateral right incisor and the papilla loss between them.

The dental team and the patient decided to try to obtain the best esthetic results and the following treatment plan and clinical sequence were suggested:

1. Extracting the implant and reconstructing the hard and soft tissue using a non-invasive regenerative procedure without losing more papillae between the right central and right lateral incisors.
2. Inserting a new guided flapless implant with an immediate provisional restoration.
3. Reducing the grayish aspect of the gingiva in the left central incisor and improving the periodontal biotype.
4. Recovering the gingival harmony with orthodontic extrusion and provisional restorations to improve the clinical outcome.





Figs 11 and 12 Clinical appearance 1 month after scaling and root planing. Notice the gingival recession at tooth 12 and the papilla loss between tooth 12 and implant 11.

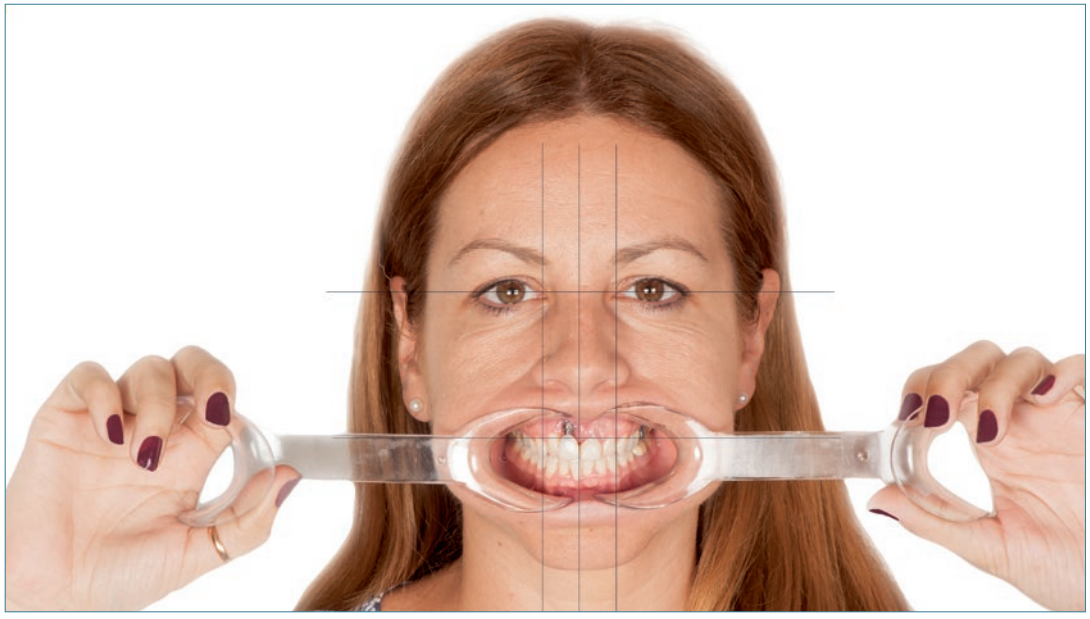


Fig 13 Facial photograph with buccal retractors to determine the horizontal and vertical reference lines.

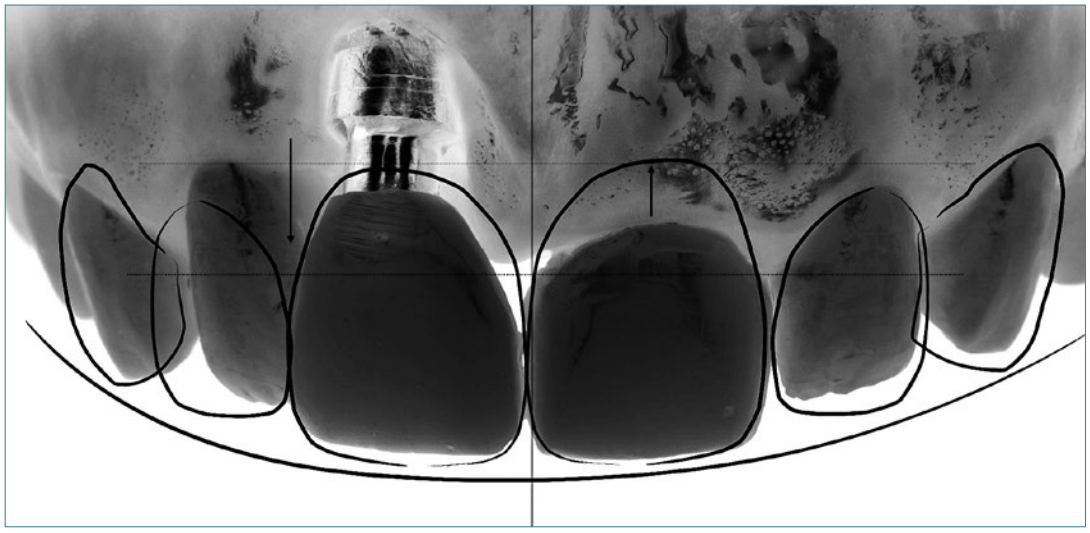


Fig 14 The DSD protocol disclosed a severe discrepancy in gingival architecture between the central and lateral incisors, the total absence of a papilla between tooth 12 and implant 11, and the lack of harmony in the proportions of the central incisors.

5. Mimicking nature with new ceramic restorations.

Phase I: Implant extraction and regenerative procedure (the triple saddle: bone xenograft, resorbable collagen membrane, and CTG)

The implant was then atraumatically extracted using a high anti-torque implant retriever (BTI Biotechnology Institute), and the granulation tissue was carefully debrided. Afterwards, the socket walls were probed to assess the bone loss and confirm the anatomic form of the defect. No buccal bone was present. Due to the labial position of the implant, the palatal bone wall suffered only mild resorption (about 2 mm). The left central incisor presented altered passive eruption that would eventually require crown lengthening. Therefore, the need to regenerate vertically the palatal wall of the edentulous ridge on implant 11 in order to place an implant at an optimal height was eliminated (Fig 15).

After copious irrigation of the socket with saline serum, a full-thickness envelope recipient bed was prepared through the socket entrance without raising a flap by using a blunt microsurgical instrument (Aesculap). The envelope was extended at least 8 mm around the perimeter of the buccal dehiscence, involving the buccal aspect of implant 11 and tooth 21, extending beyond the mucogingival line to ensure that no tension was present (Fig 16). At the palatal level, another full-thickness, 6 mm recipient envelope was prepared (Fig 17). Removal of the sulcus epithelium was carried out using a diamond bur.

Layers of xenograft (Bio-Oss Collagen; Geistlich) were introduced in the envelope and condensed vertically and horizontally until the remaining alveolar ridge between teeth 12 and 21 was completely filled (Fig 18). Since the recipient bed was tension free, a specially prepared collagen membrane (Bio-Gide; Geistlich) could be delicately introduced in the envelope (Fig 19) so that the bone graft was fully covered and at the same time a part of the membrane was introduced at the palatal level between the bone wall and the periosteum (Fig 20). After proving the membrane stability inside the envelope, a CTG from the contralateral side of the palate (Fig 21) was introduced through the socket entrance and placed *ad modum* 'saddle'[17] between the tension-free buccal and palatal mucosa and the membrane using 5-0 mattress sutures (Fig 22). Care was taken to ensure that the CTG did not displace the collagen membrane or the bone graft. The CTG covered the socket entrance and extended subgingivally through the envelope by at least 8 mm to prevent necrosis. Finally, using 6-0 sutures, the exposed part of the CTG was united to the mucosa borders using interrupted sutures to avoid invaginations of epithelium (Fig 23). Figure 24 shows the sequence of treatment. Afterwards, the temporary bridge was placed back on without any contact with the soft tissue ridge.

Postsurgical medication included antibiotic (amoxicillin 500 mg) and anti-inflammatory (ibuprofen 600 mg) three times a day for 7 days. Chlorhexidine rinse was also prescribed 3 times a day for 3 weeks. Healing was uneventful, without signs of necrosis (Fig 25).

Phase II: Complementary saddle CTG for ridge augmentation

Ten months later, the ridge still showed a flat aspect and the right lateral incisor presented a zenith and mesial recession (Figs 26 and 27). A split-thickness envelope was then prepared through a small horizontal incision beyond the apex of the right lateral incisor and through the sulcus of the right lateral incisor and the left central

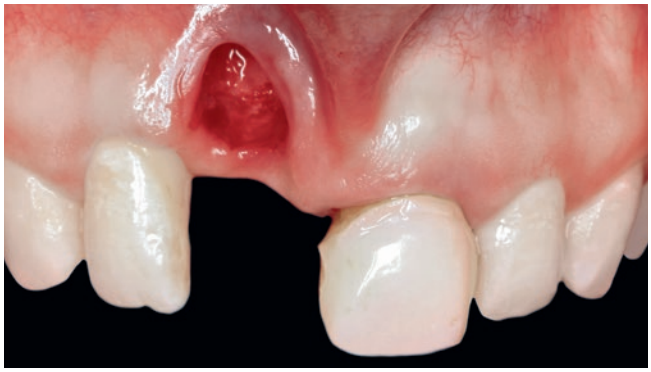


Fig 15 Frontal view of the anterior zone after implant removal. Notice the papilla loss at the mesial level of tooth 12.

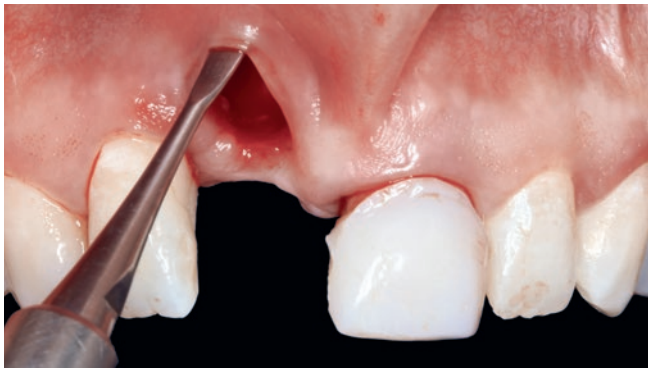


Fig 16 A flapless full-thickness recipient bed envelope is prepared 8 mm around the buccal dehiscence at the area of implant 11.

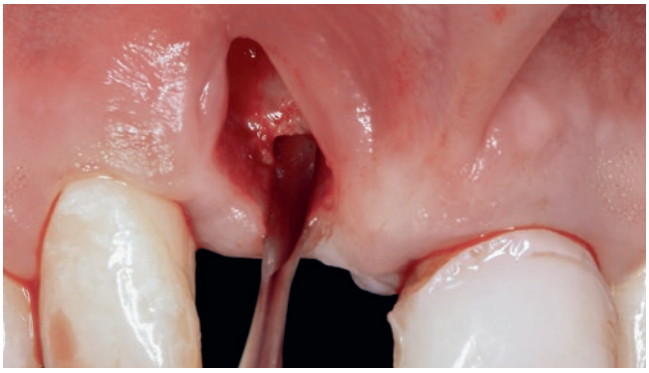


Fig 17 A full-thickness recipient bed envelope is prepared 6-mm deep at the palatal aspect. Notice the height level of the palatal bone wall, which is 4 mm more apical than the ideal soft tissue margin of tooth 21 that presents altered passive eruption.

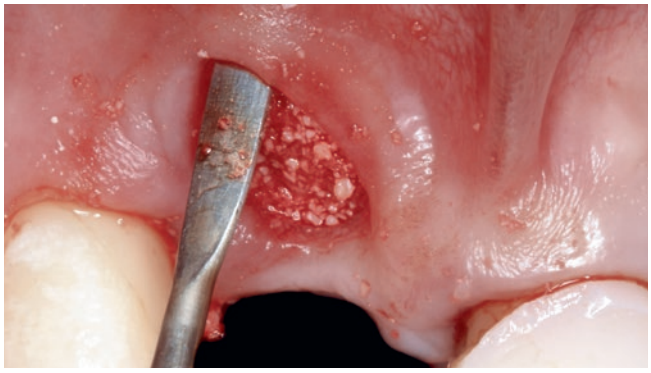


Fig 18 Filling and condensation of the xenograft material occupying the whole buccal aspect of the edentulous alveolar ridge.

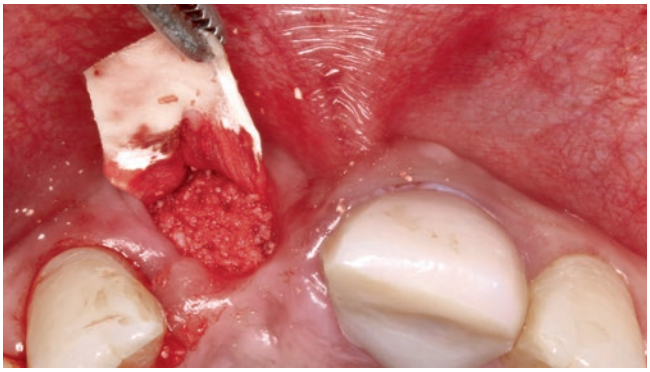


Fig 19 A non-cross-linked resorbable membrane is introduced at the buccal aspect between the mucosa and the xenograft.

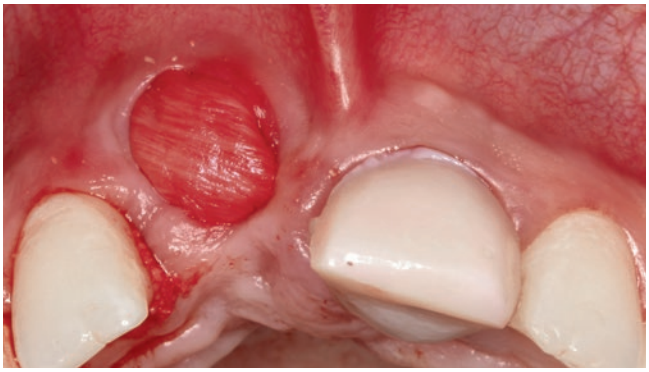


Fig 20 Total coverage of the xenograft by the resorbable membrane at the buccal, crestal, and palatal levels.

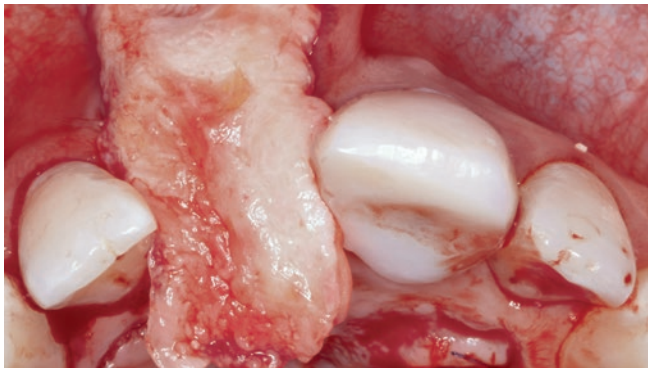


Fig 21 A CTG is harvested from the left side of the palate.

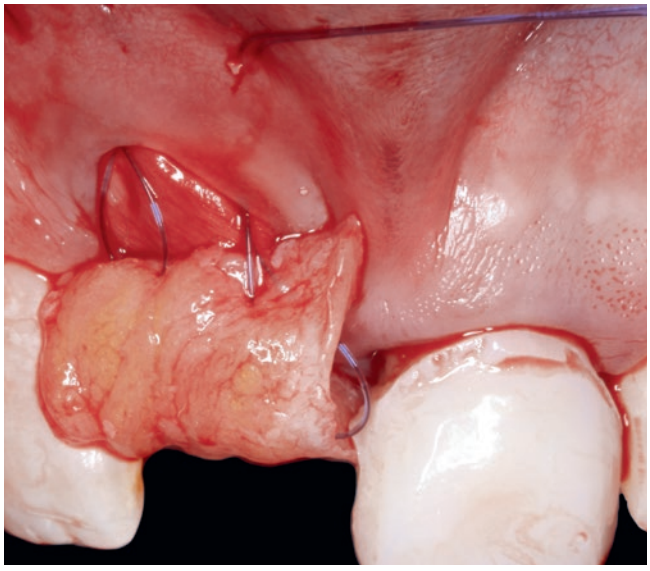


Fig 22 The introduction of the CTG between the membrane and the buccal mucosa using mattress sutures.

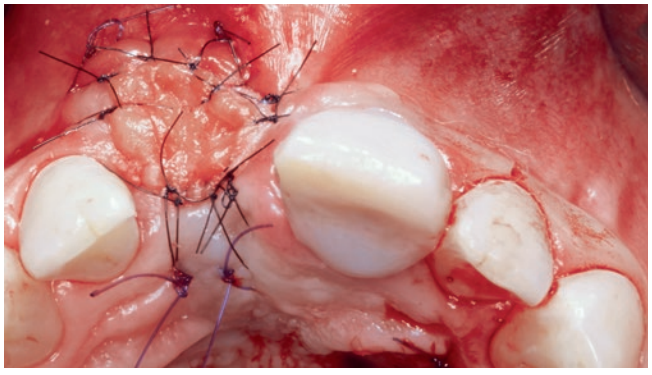


Fig 23 View of the CTG inside the envelope. Notice the extension of the CTG under the envelope preventing necrosis of the exposed part.

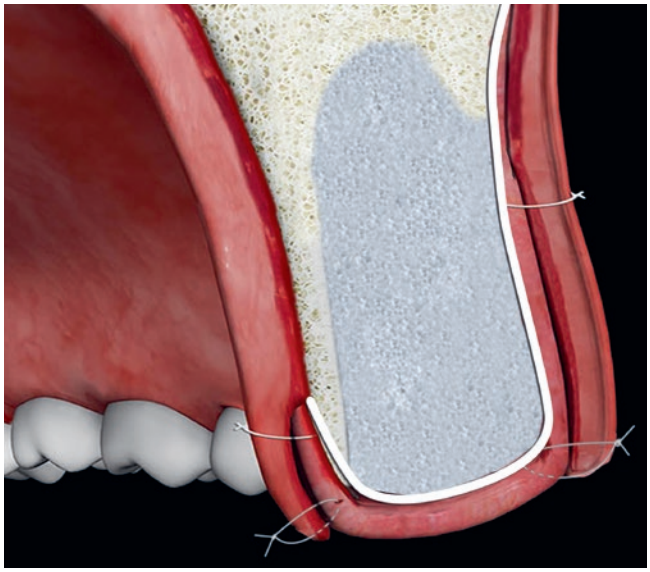


Fig 24 Image depicting the placement of the three components filling the ridge: the triple saddle graft (xenograft, membrane, and CTG).

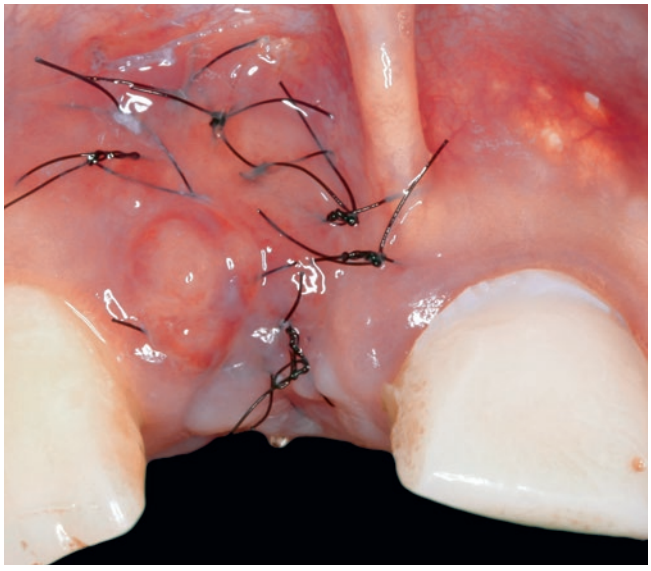
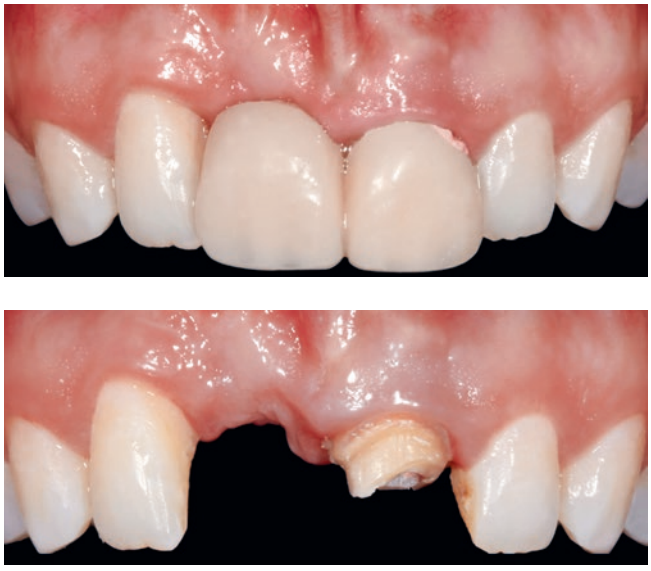


Fig 25 Healing at 2 weeks postoperative.



Figs 26 and 27 Views of the anterior maxillary zone with and without the temporary abutment 10 months after the grafting procedure. Notice the flat profile of the ridge and the zenith, and the mesial gingival recession of tooth 12.

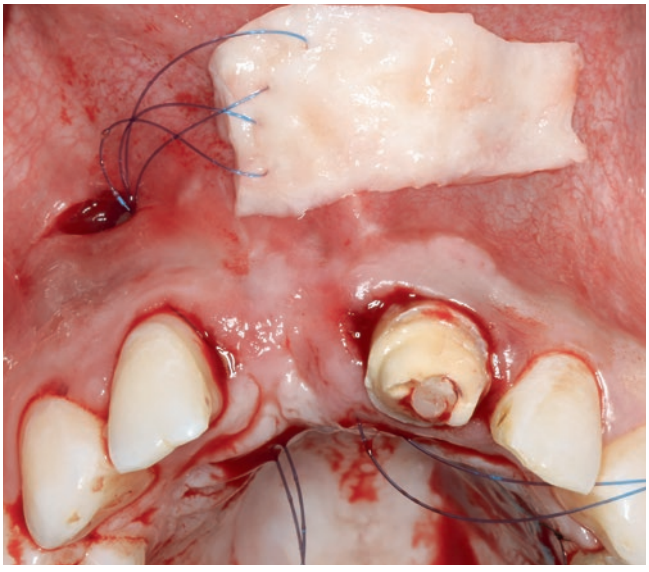


Fig 28 Introduction by mattress sutures of a CTG taken from the left side of the palate through a horizontal incision at the apical level of tooth 12, filling a split-thickness envelope recipient bed that extended through the buccal, crestal, and palatal aspects of the edentulous ridge as well as tooth 12 and 21.

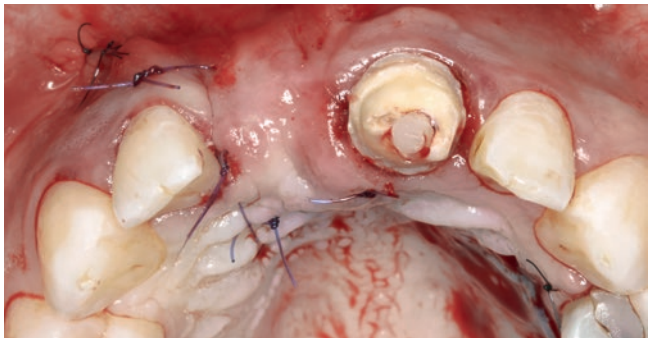


Fig 29 View of the CTG augmented ridge. Notice the sutures at the palatal level and over the buccal aspect of tooth 12 to thicken the soft tissue biotype.

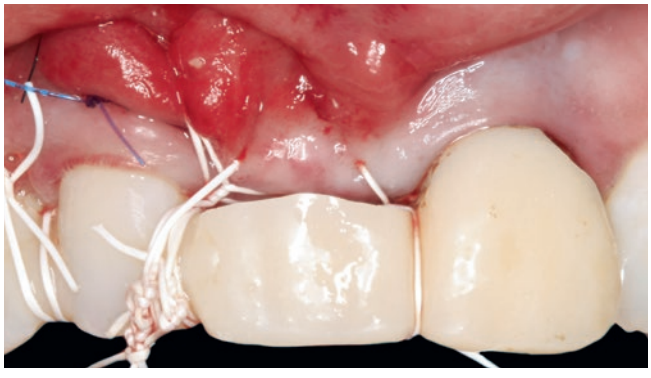


Fig 30 Sling suspensory sutures are used to obtain coronal repositioning of the soft tissue.

incisor. The envelope extended through the buccal and interproximal aspects of the right lateral incisor and the left central incisor, as well as the buccal, supracrestal, and palatal aspects of the edentulous right central incisor ridge, beyond the mucogingival line, in order to prevent any tension so the soft tissue level could be coronally repositioned at the supracrestal and interproximal level.

A CTG was harvested from the contralateral side of the palate from the same place where the previous CTG was obtained and, using resorbable 5-0 mattress sutures, was anchored to the mesial and distal palatal aspect of the edentulous ridge. The sutures were introduced through the apical horizontal incision and pulled inside until the palatal aspect of the edentulous ridge was reached, covering the supracrestal, buccal, and palatal area of the edentulous ridge and extending over the buccal aspect of the right lateral incisor[21] (Figs 28 and 29). After closing the horizontal incision and placing the temporary bridge back on, sling suspensory sutures were placed to ensure the coronal repositioning of the graft and soft tissues (Fig 30).

Phase III: Implant placement and immediate provisionalization

Healing was uneventful. Three months later, vertical soft tissue gain could be seen (Fig 31). An impression was then taken to fabricate a stone cast, and a diagnostic full-contour wax-up was made to replicate the final dental anatomy (Fig 32). A cone beam computed tomography (CBCT) image was taken that showed the complete reconstruction of the alveolar ridge (Figs 33 to 35). A computerized surgical guide was prepared in order to place an implant in the optimal position without raising a flap, maintaining a 2-mm-wide buccal bone wall and a 1-mm-wide palatal bone wall.

Thirteen months after the implant extraction and simultaneous bone and connective tissue graft, drilling through the guide was performed. A good bone quality was noticed (Fig 36). A 3.6 x 11 mm Astra Tech Evolution Dentsply Implant (Mölndal) was placed at an insertion torque of 35 N/cm (Fig 37). The abutment of the left central incisor was reconstructed with a post and core, and a biologically oriented prosthetic technique (BOPT) preparation was performed to improve the periodontal biotype (Fig 38). This new, marginless prosthetic approach with a reduction of the radicular perimeter allows for the improved quality of the biologic width without the necessity of performing soft tissue grafts. The final thick gingival biotype is the result of the transformation of the blood clot into connective tissue in the gap under the subgingival tooth preparation.[22]

A transparent template was fabricated to insert the provisional restorations in a perfect position (Fig 39). At this stage of the restorative phase, a customized slim-screwed acrylic restoration was applied (Fig 40). Both provisional restorations were splinted, and the provisional crown of the left central incisor was relined chairside to establish an ideal fit and proper emergence profile with a 1-mm circumferential subgingival margin.

Composite was added to the implant abutment and light cured to prepare a better soft tissue architecture in the apicocoronal direction (Figs 41 to 43).

Phase IV: Orthodontic extrusion

Three months after implant placement, the temporary restoration showed a symmetric soft tissue level compared with the contralateral central incisor, but the mesial papilla of tooth 12 was in a slightly more apical position compared with the mesial papilla of tooth 22 (Fig 44). An extrusion orthodontic treatment[23] was then carried out to try to achieve vertical papillae gain.[24]

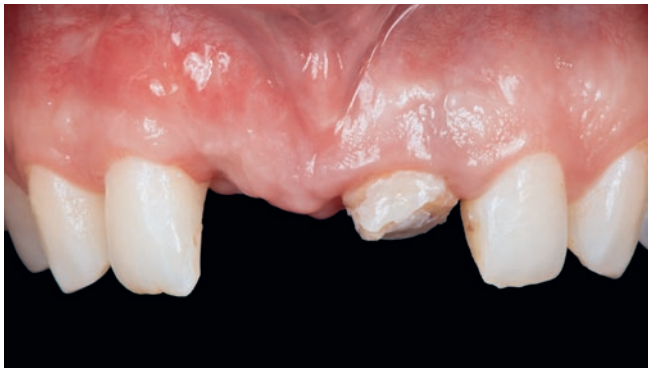


Fig 31 Clinical appearance 3 months after soft tissue graft surgery (13 months after the first graft). This photograph was taken on the day a CBCT image was taken to plan a computer-guided implant placement.

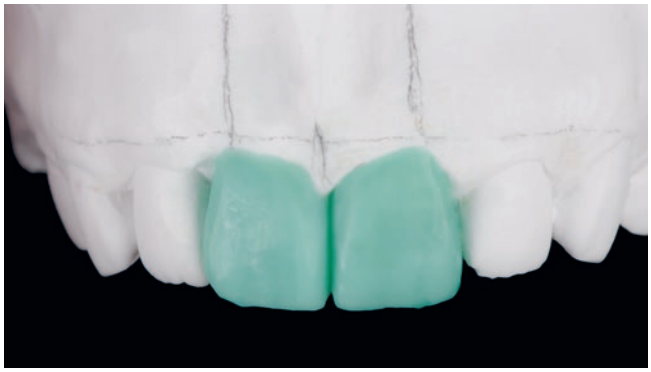
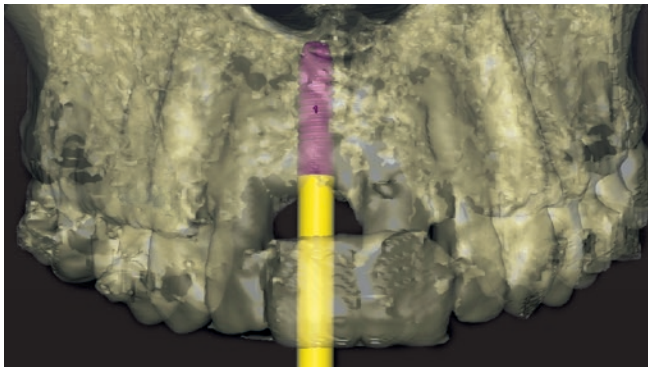
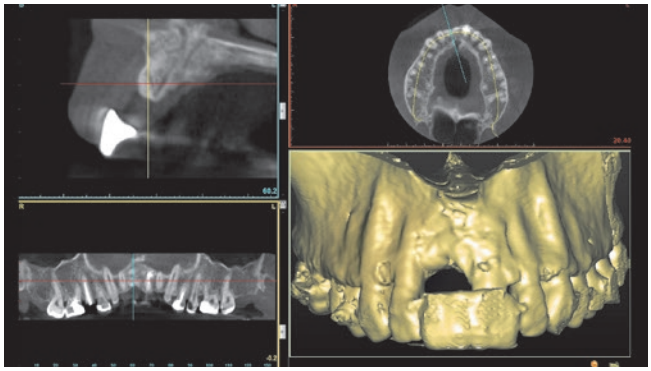


Fig 32 Wax-up following the proportions, shape, and size of the DSD protocol.





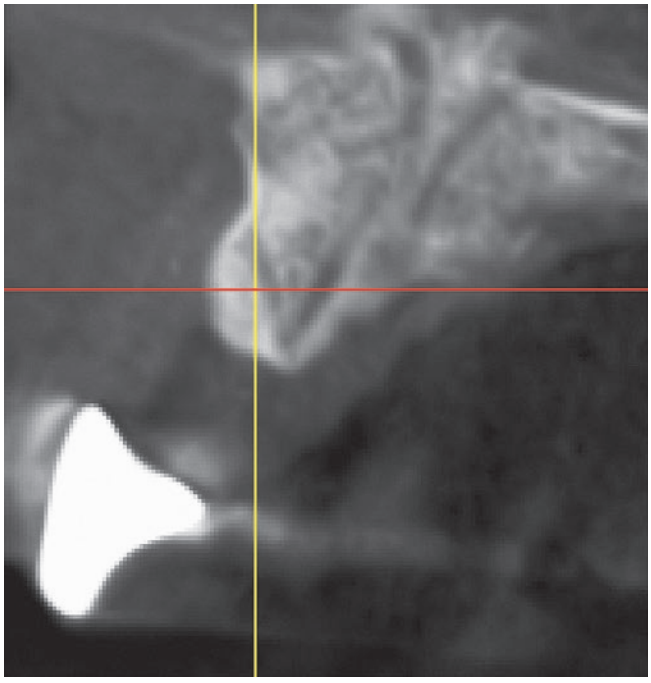


Fig 33 to 35 CBCT images of the planning of the implant placement. Notice the reconstruction of the bone contour and shape at the edentulous ridge.

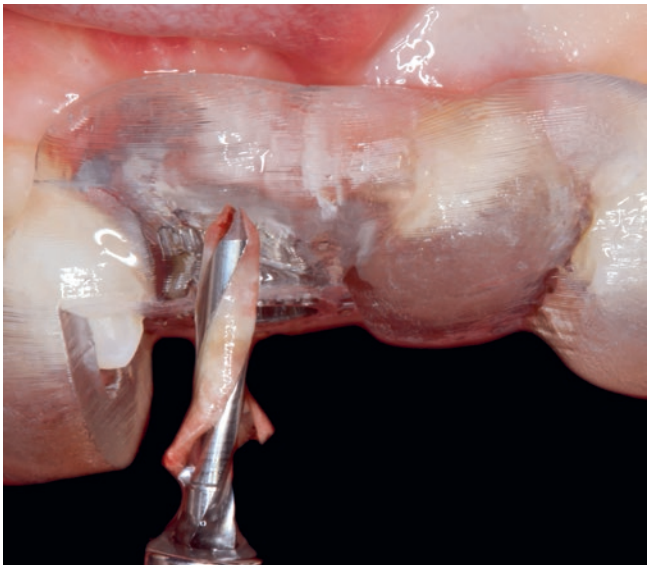


Fig 36 A computer surgical guide was used to place the implant at an optimal 3D position. Notice the slices of bone in the threads of the bur.

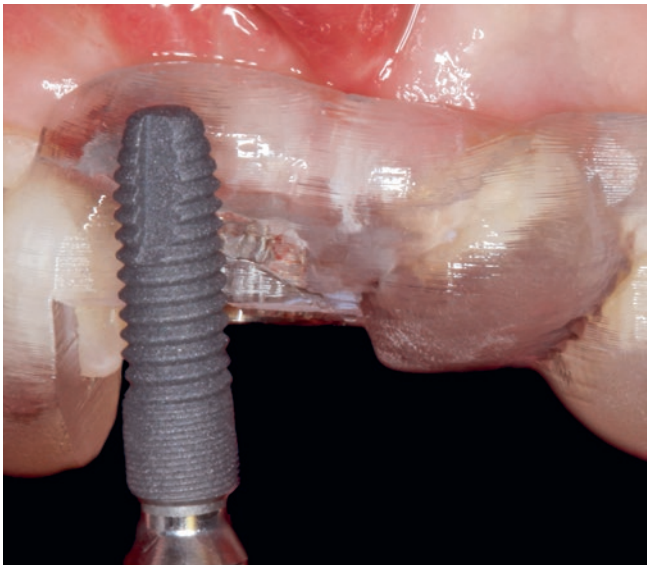


Fig 37 A 3.6 x 13 mm Astra Tech EV implant was placed using a computer surgical guide.

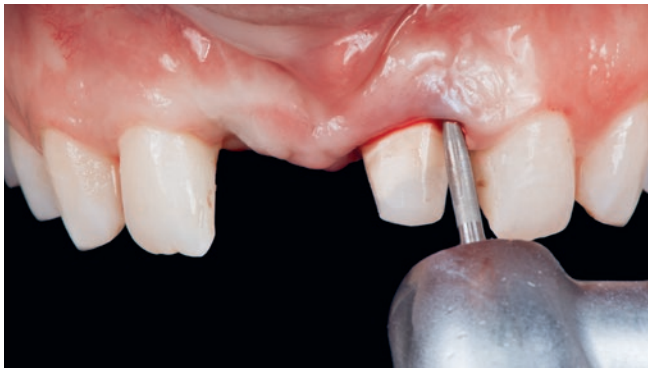


Fig 38 BOPT tooth reduction using a fine diamond bur to try to improve the periodontal biotype.

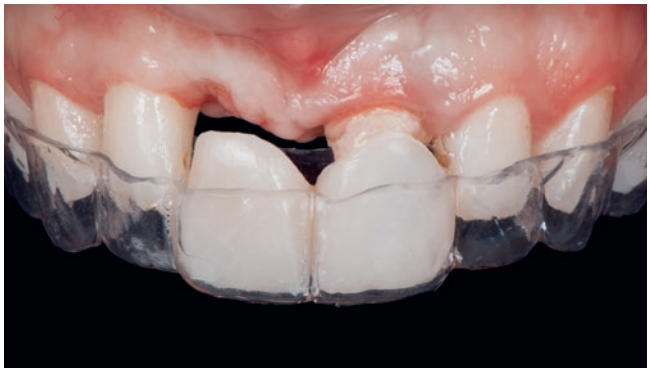


Fig 39 A transparent template helps the dental team to put the acrylic second provisional in the correct position in order to reline it.

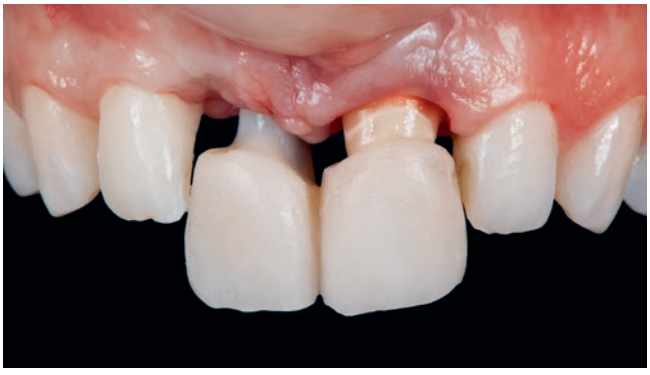


Fig 40 Slim design of the implant restoration and ideal emergence profile of the left central incisor.

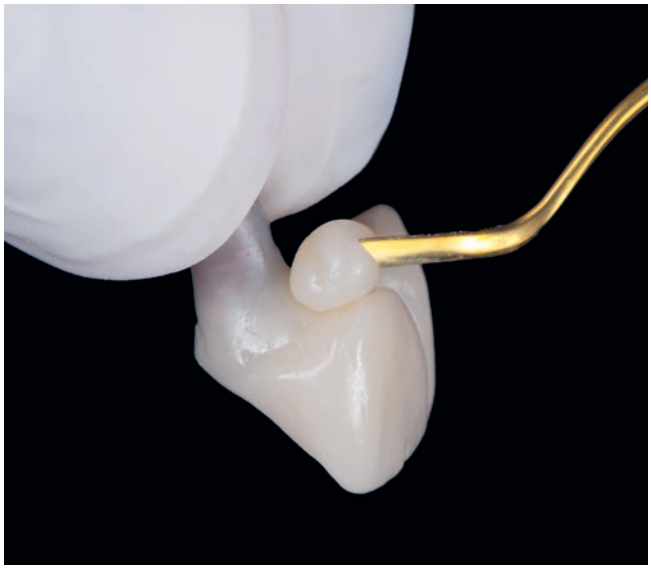


Fig 41 Modification of the critical and subcritical zones with composite.

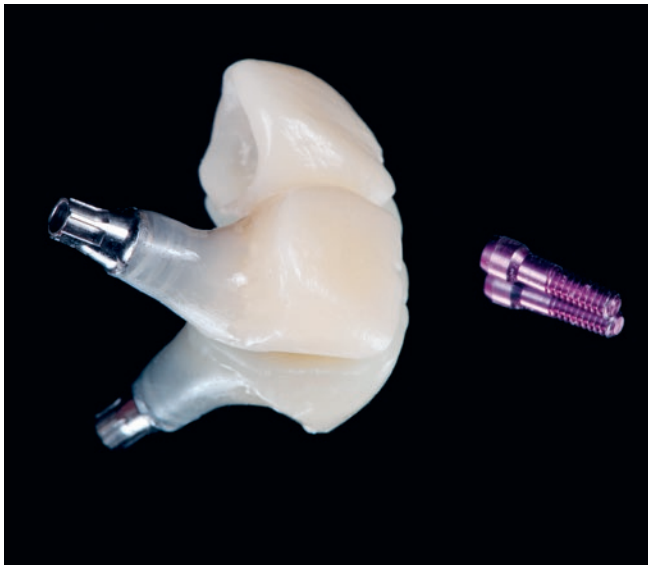


Fig 42 Aspect of the temporary restorations.

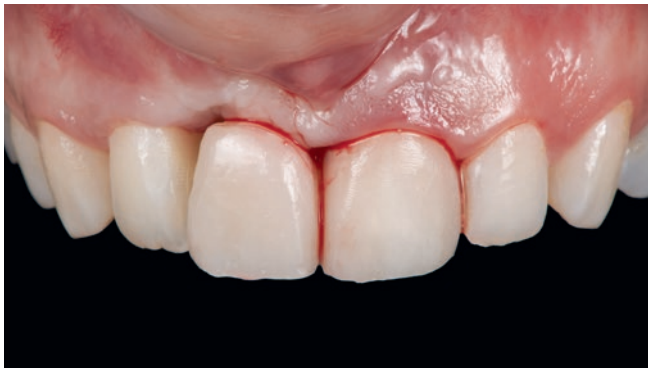


Fig 43 Clinical situation immediately after insertion of the temporary restorations.

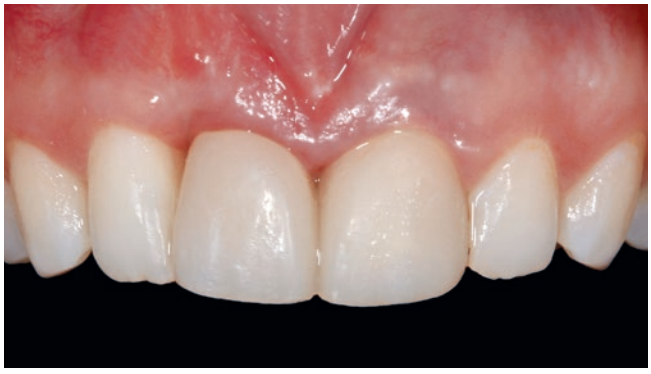


Fig 44 Three months after the implant surgery. Notice the absence of a papilla between the right central and right lateral incisors.

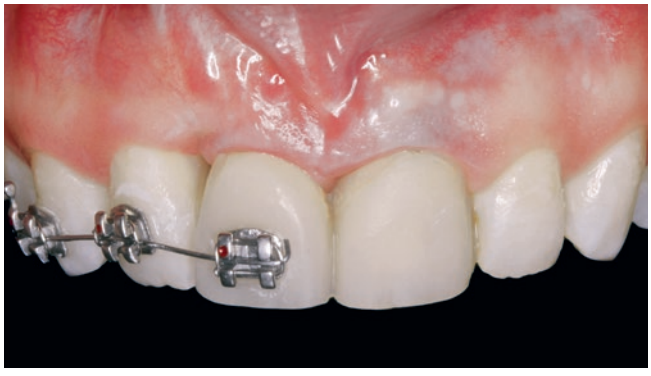


Fig 45 Starting point of the orthodontic treatment to extrude the lateral incisor and gain papillae height.

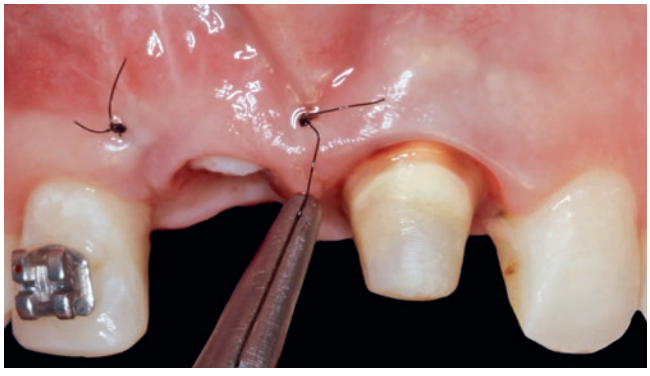


Fig 46 New CTG from the tuberosity to increase the buccal soft tissue volume.

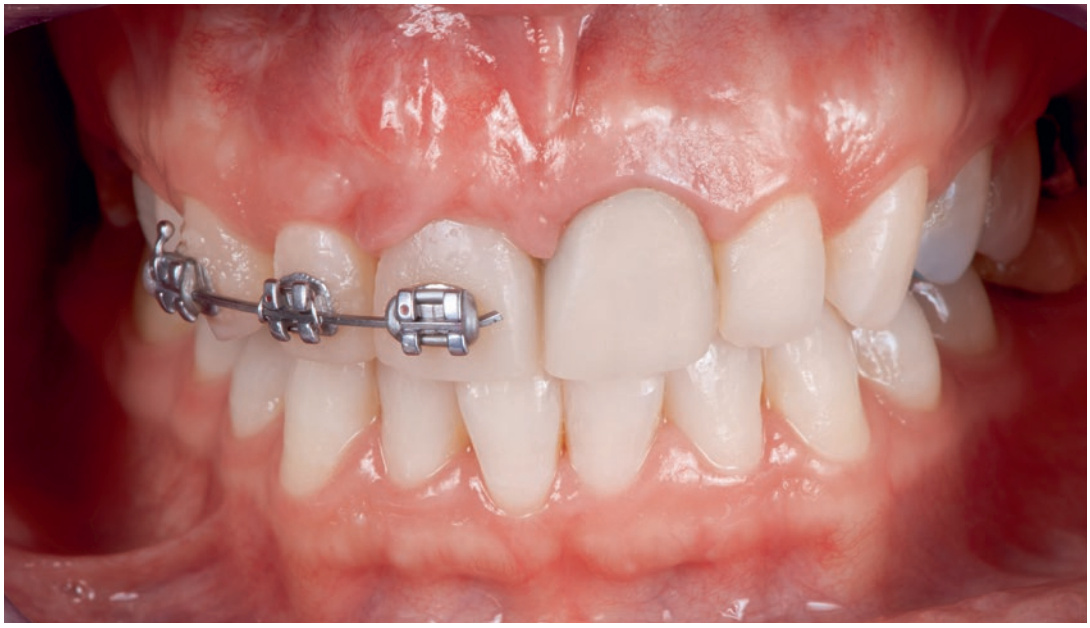
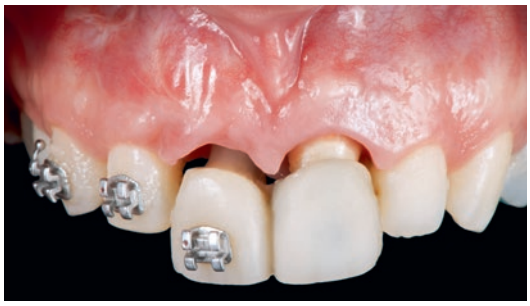
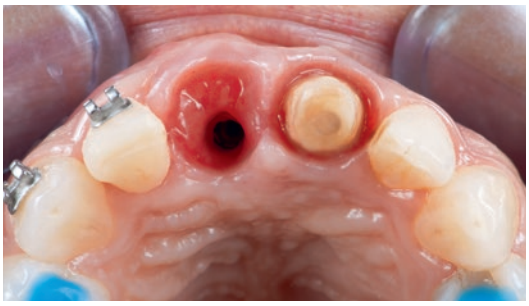


Fig 47 Aspect of the anterior zone 4 months after the extrusion of tooth 12 was completed. Notice the improvement of soft tissue levels at tooth 12.





Figs 48 and 49 Emergence profile after removing the restorations.

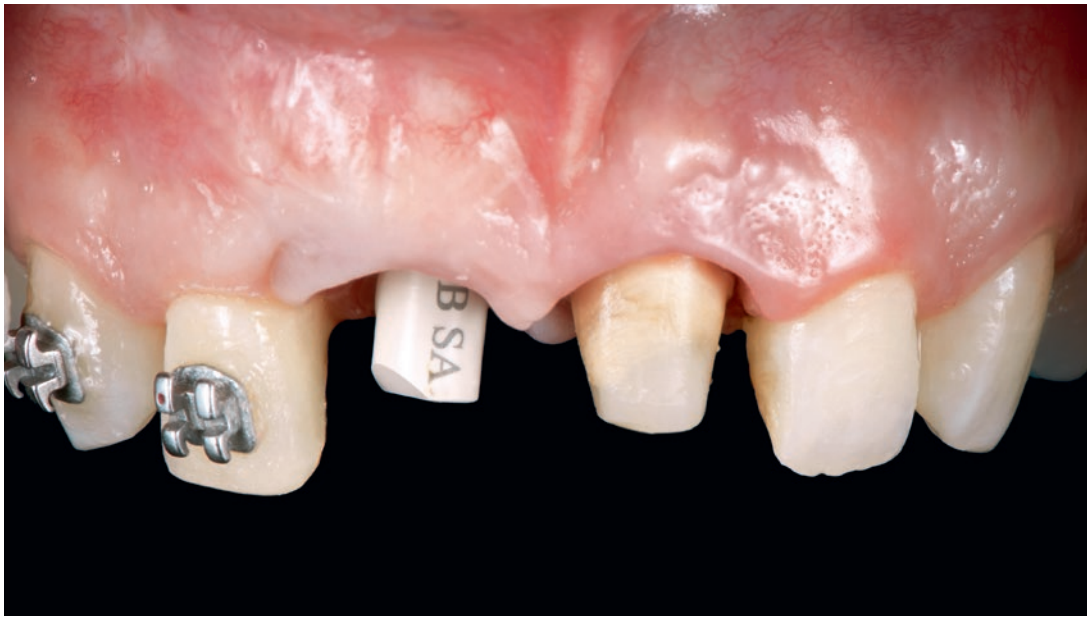


Fig 50 Scan body in place.

Orthodontic extrusion was performed on tooth 12[25] using the implant-supported crown at position 11 and tooth 13 as anchorage (Fig 45) at a rate of extrusion of 0.5 mm per month.[26,27] After 6 months, when the papillae level was symmetrical to the papillae between teeth 21 and 22, the extrusion treatment was terminated, the lateral incisor was grinded at incisal level, and the appliances were left in position for 4 months to stabilize the soft tissue.[28] Following the end of the orthodontic treatment, another CTG from the tuberosity was placed at the buccal level of implant 11 to improve the emergence profile (Fig 46).

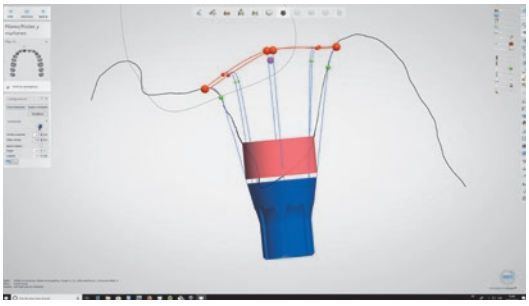


Fig 51 Digital reproduction in a sagittal view of the implant emergence profile.

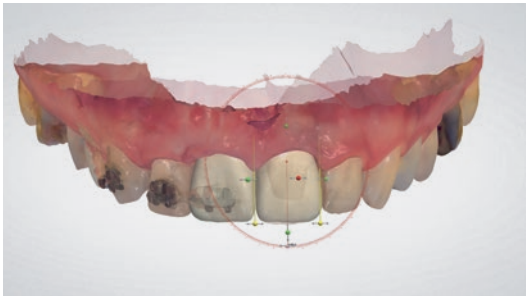


Fig 52 Digital wax-up.

Phase V: Prosthetic stage – second provisionals and final ceramic restorations

Thirteen months after implant placement, the soft tissue situation around the restoration in terms of volume, vestibular support, and interproximal level was more favorable. However, the gingival margin level of the labial aspect required additional modifications to achieve a correct zenith and the same height as the left central incisor.

The interproximal papilla between the implant and the right lateral incisor needed additional pressure to control and improve the scalloped aspect (Figs 47 to 49).

A digital impression was made with a Trios 3 scanner (3Shape) (Fig 50) and a digital protocol was taken to manufacture a new provisional restoration, adapting new parameters to modify the critical and subcritical contour (Figs 51 and 52).

A digital impression model was printed, and polymethyl methacrylate (PMMA) milled restorations were manufactured. The splinted new provisional restorations were placed, and the appliances were maintained in the mouth for stability (Fig 53).

After 3 months of tissue maturation, an esthetic reevaluation demonstrated a better result (Fig 54), and a digital final impression was taken.

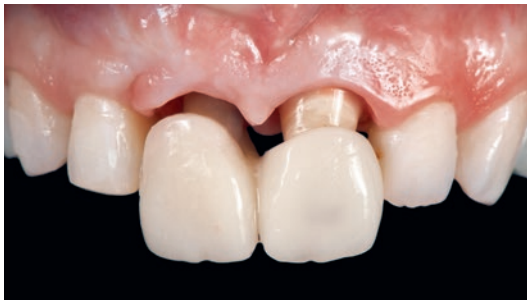


Fig 53 Insertion of the second provisional restorations.

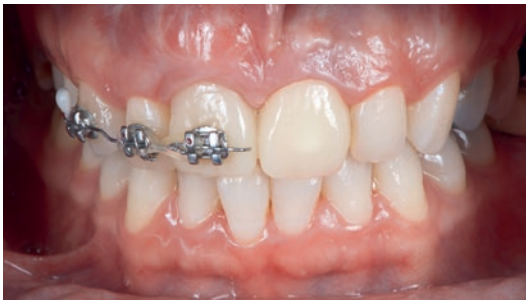
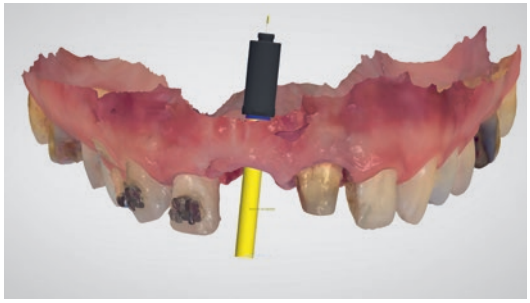
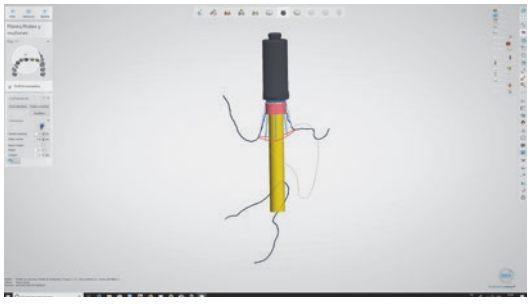
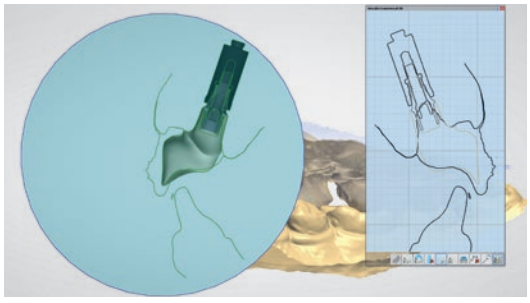


Fig 54 Clinical aspect after 2 months with the new provisional restorations in place.







Figs 55 to 57 Different aspects of the digital workflow in the laboratory.

A 3D-printed alveolar model was created from the preparation scan using 3Shape Model Builder (3Shape), and the dental technician designed a zirconia hybrid abutment with a metal interface for the implant and a zirconia coping for the left central incisor crown (Figs 55 to 57). After milling the zirconia implant abutment and the tooth coping (Fig 58), the ceramist layered the veneering porcelain onto the crown coping and the implant abutment to match both restorations through a precise and meticulous build-up protocol of different porcelain masses (ZI-CT Creation; Willi Geller).

A bisque bake try-in phase provided additional information about details such as final value, cervical color, and anatomical details. The width and final squared size had to be modified, and additional slight pressure was needed on the facial aspect of the implant restoration to match the scallop of the left central incisor.

In the laboratory, the contour in the critical zone was redefined and slightly changed in the printed model and the ceramic was adjusted to it (Figs 59 and 60). After correcting these details, the prosthetic work was complete (Fig 61).

The final restorations were tried-in; first the implant restorations to evaluate the final pressure, then the tooth crown to establish the correct contact points in terms of pressure and extension. The final esthetic was then evaluated with the patient (Fig 62). Before placing the final restorations, a conservative modification was made with com-

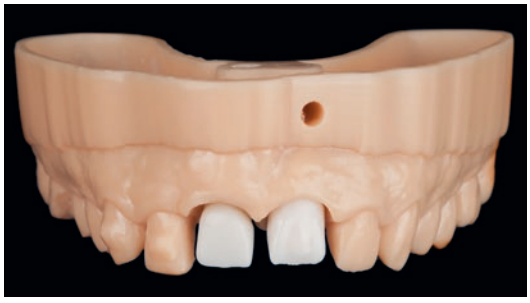
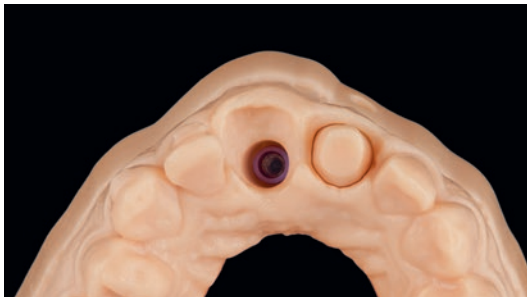
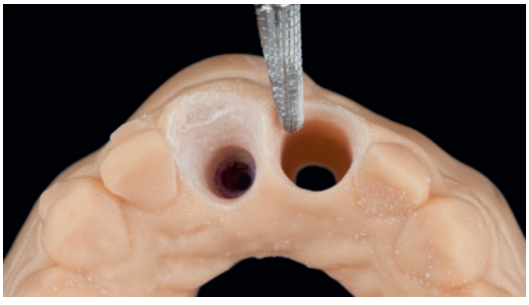


Fig 58 Final hybrid zirconia abutment and zirconia coping on the printed model.





Figs 59 and 60 The sulcular design is defined and remodeled delicately with a laboratory bur to create an identical contour in the critical zone.

posite (IPS Empress Direct; Ivoclar Vivadent) in the right lateral incisor to fill and improve the mesial papillae space and the distal diastema resulting from the effect of extrusion and the diminished diameter in the cervical area of the lateral incisor. A curved matrix (Palodent; Dentsply) helped the dental team to achieve an adequate proximal anatomy (Fig 63).

The implant restoration was screwed into the mouth with a torque of 30 Ncm before the ceramic crown placement. Then, the zirconia crown was cemented with glass-ionomer cement (Fuji II; GC) (Fig 64).

One year after the delivery of the final crowns, the clinical periimplant and periodontal status was healthy, and the restorations showed adequate emergency profiles (Figs 65 to 68). A periapical radiograph disclosed an optimal periimplant bone level (Fig 69), and the patient expressed complete satisfaction with the esthetic outcome (Figs 70 and 71).

Discussion

Surgical stages

The authors believe that the regenerative treatment of a severe vertical bone loss around a malpositioned anterior implant is irrational because, in these kinds of cases, reosseointegration is not predictable,[29] and raising a flap could potentially cause further soft tissue recession and therefore an even bigger esthetic failure. Moreover, even in the event of achieving bone regeneration, the inadequate environment (implant situated too labially and too deeply) can compromise the stability of the regenerated bone.

The esthetic solution of the remaining edentulous ridge after implant extraction is a very difficult issue, since there is often a combined soft and hard tissue deficit affecting not only the edentulous ridge but also, to a lesser degree, the adjacent teeth.

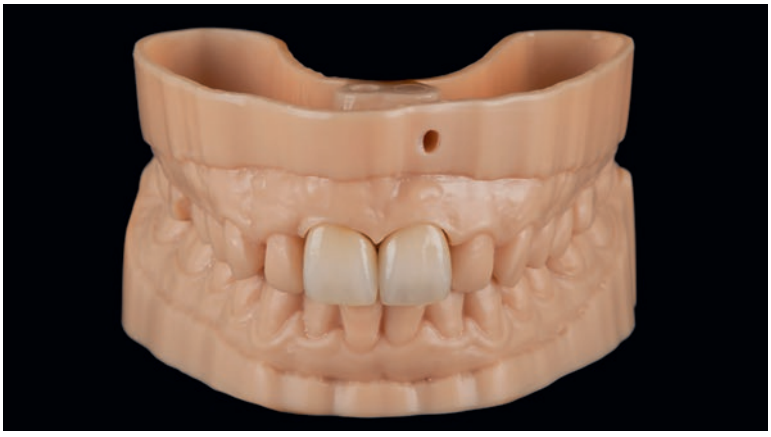


Fig 61 Final ceramic restorations.

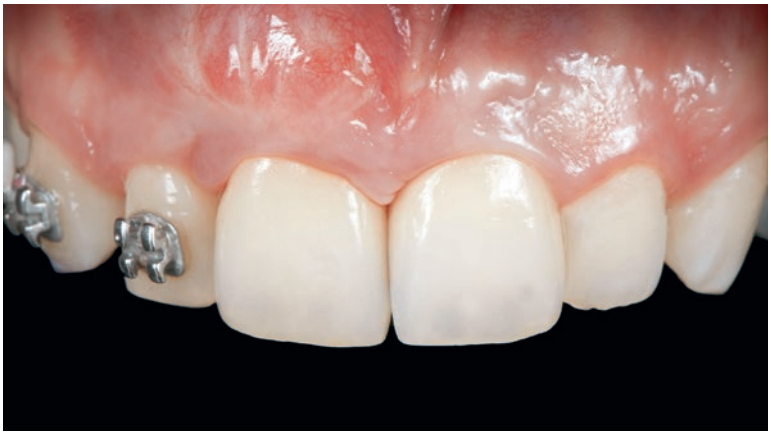


Fig 62 Initial aspect of the restorations before cementation.

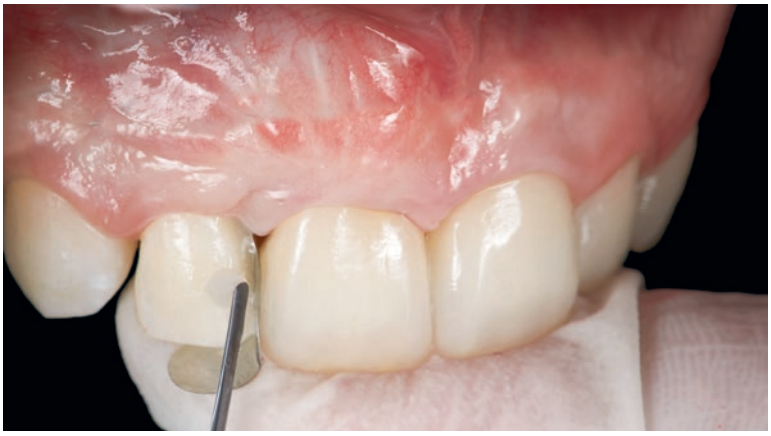


Fig 63 Composite restoration to improve the papillae support and increase the cervical diameter of the right lateral incisor. The sectional matrix allows for the achievement of a correct proximal anatomy at the cervical third of the tooth.

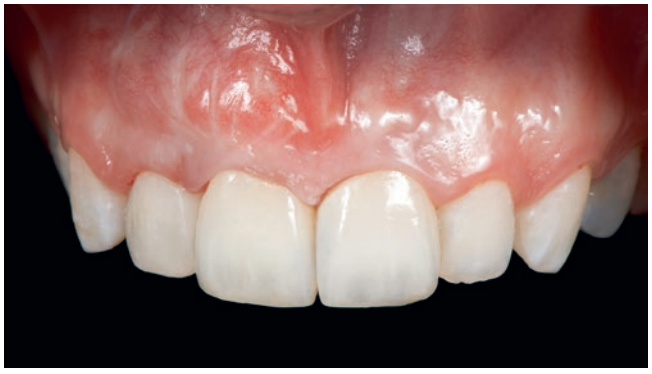
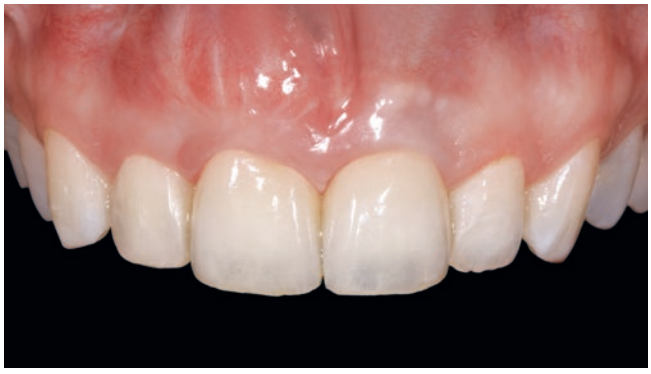


Fig 64 Initial aspect of the final work immediately after cementation.



Figs 65 to 67 Final aspect 1 year after placement of the final restorations. Notice the stable soft tissue conditions.

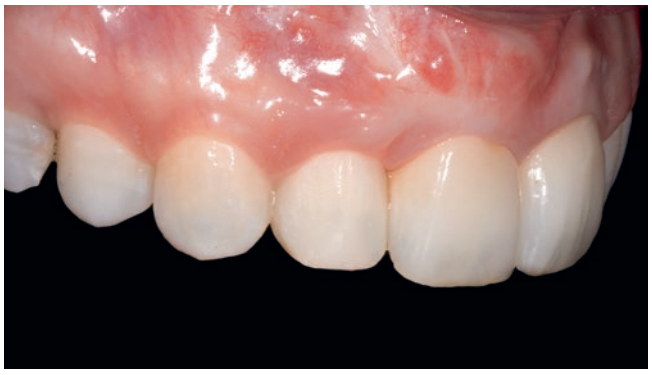


Fig 66

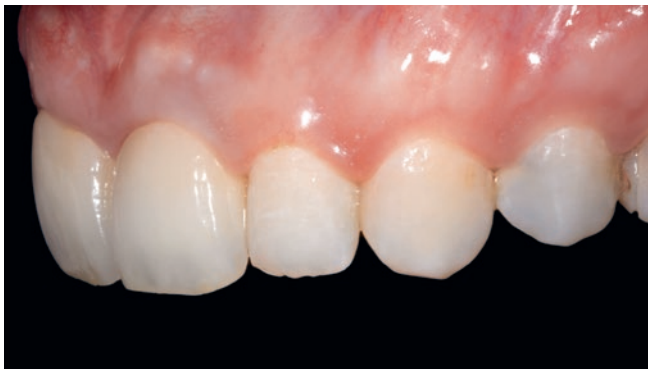


Fig 67

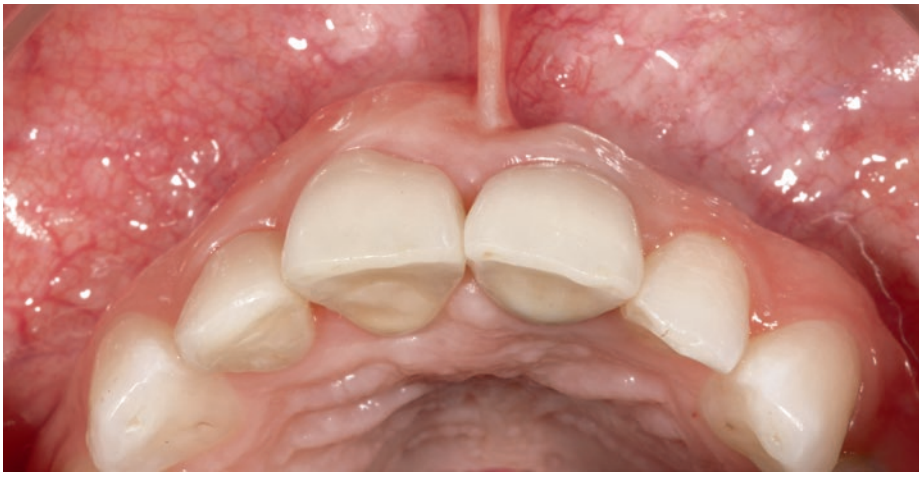


Fig 68 Occlusal view. Notice the difference in volume between the grafted area at the implant level and the volume in the left central incisor zone.

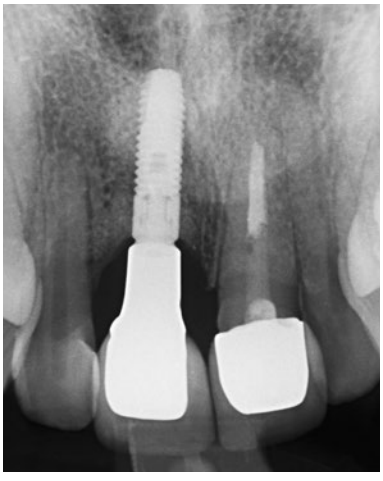


Fig 69 Periapical radiograph 1 year after completion of the restoration.

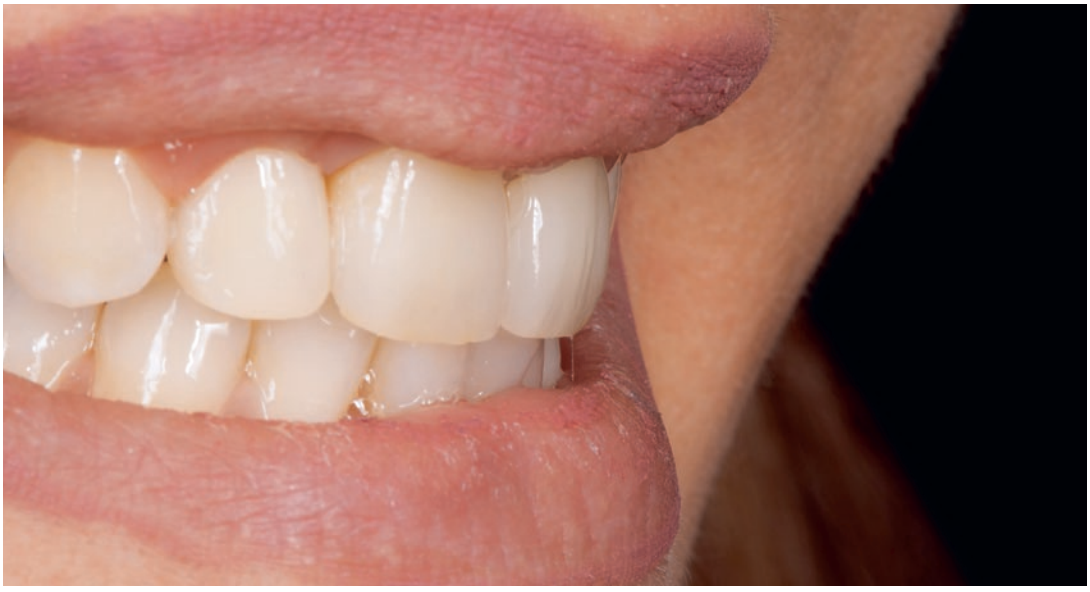


Fig 70 Right papilla aspect from a lateral point of view.

Fig 71 Facial aspect after the new definitive restorations.

Conventional fixed prosthetic treatment using tooth 21 as an abutment and implant 11 as a cantilever could be a valid treatment alternative in such cases, especially if the patient is a smoker. This approach was ruled out as a permanent restoration to prevent overload on tooth 21.

Before the explantation, the amount of bone was assessed by CBCT. Analysis by 3D images disclosed that, due to the excessive labial inclination of the implant, the palatal bone wall was only mildly resorbed. Since the implant did not have a buccal bone wall, there was a mesial, distal, and palatal circumferential defect.

In this article, a minimally invasive regenerative technique based on immediate reconstruction after implant extraction using biomaterials and a CTG was presented. To the best of the authors' knowledge, this protocol applied simultaneously to an implant extraction has not been described before. This approach was chosen because it has a low rate of morbidity and the patient could wear a fixed temporary restoration during the entire treatment period. The protocol fulfills the principles of GBR (isolation of a bone graft by a barrier membrane),[18] and the saddle CTG allows for further horizontal and vertical soft tissue gain for alveolar ridge reconstruction.[17]

Other treatment alternatives could have been chosen after performing implant extraction such as a simultaneous implant placement GBR procedure some months later,[13] a two-stage delayed GBR ridge augmentation procedure,[30] or even bone regeneration using autogenous bone blocks. However, these approaches were ruled out due to increased morbidity and the potential for further recessions due to the raising of flaps.[31] Another interesting surgical approach to treat single-tooth gaps with adjacent papilla loss was proposed by Chu et al,[32] who proposed making papilla-sparing incisions. However, this approach was discarded as the vertical incisions result in scarring.

Other approaches aiming to maintain the implant based on the repositioning of the malpositioned fixture by displacement of the implant and its surrounding bone[33] or distraction osteogenesis[34] were ruled out due to the presence of periimplantitis; thus, even if the treatment was successful, there would still be an infectious bone loss around the implant.

There was a long healing period of 13 months. This was due to the extension of the bone deficit and the goal to reconstruct the edentulous alveolar ridge not only on the strictly buccal aspect of the cavity resulting from the extracted implant, but also on the whole buccal aspect of the edentulous ridge from mesial of tooth 12 to mesial of tooth 21, recreating the bone contour so a new implant could be placed totally surrounded by new regenerated mature bone. Another reason for such a long healing period was that only inorganic bovine hydroxilapatite mixed with collagen was used as a bone graft. The extended healing period thus permitted new bone replacement of the graft, as could be seen by the slices of bone attached to the drill during the implant preparation (see Fig 49). De Risi et al[35] state that a healing period of 4 months is long enough when performing intact socket preservation. In the present case, the defect had not only a buccal wall absence but also soft tissue recession, which made a longer healing period necessary.

A non-cross-linked resorbable collagen membrane was used. Compared with cross-linked membranes, this kind of membrane is more fragile and therefore more difficult to extend inside an envelope recipient without wrinkles in order to cover the whole bone graft. However, the reason for using this membrane despite its difficult management is that non-cross-linked membranes are more hydrophilic, allowing more blood cells

and nutrients to pass through. This permits revitalization even of the exposed part of the CTG and therefore prevents necrosis of the soft tissue graft, which might occur with the use of a cross-linked membrane.[36,37]

The implant was placed using a flapless computer-guided surgery to prevent possible further gingival recession that could have occurred if a flap had been raised.[38,39]

There is a lack of predictability of surgical procedures to reconstruct the interproximal papilla between a tooth and an implant.[40] For this reason, in order to shorten the distance between the contact point and the interproximal bone peak mesial of tooth 12[41] to increase the papilla height, a slow orthodontic extrusion was performed 3 months after loading that lasted for a period of 6 months (at a rate of extrusion of 0.5 mm per month), improving the soft tissue esthetic.[23,24,26] The orthodontic treatment was performed after implant loading in order to use the implant as a pure anchorage without the involvement of the natural teeth.

A third and final CTG was performed to improve the soft tissue biotype because the emergence profile was inadequate and it probably would not have been possible to achieve an optimal result by only pressuring the subcritical contour of the temporary restoration.[42] Since this last CTG was taken from the tuberosity and was very fibrous, more long-term stability can be expected.

Prosthetic stages

The prosthetic work was planned with a digital workflow. Digital impression procedures may be a good approach in order to improve the accuracy of implant-supported restorations. However, this technology requires better soft tissue management, a dry working field, and a high learning curve.[43] However, there are enormous advantages of a digital workflow in the implant field today, being the 3D visualization, the virtual assessments of the implant prosthetic space, the depth of the restoration interface, and the emergence profile configuration before proceeding with the laboratory steps. In the present case, the digital workflow gave the dental team the opportunity to stage the scanning in different moments, modify the shape of the abutment, and reproduce and remodel the concave subcritical contour or maintain the initial design.

The printed 'Geller models' helped the dental technician to customize the final details of the contours more easily and layer the ceramic in a very clean way.

With provisional restorations, PMMA-milled restorations are a very good alternative to handmade acrylic provisional options. They have the advantage of a superior hardness and longevity because they are manufactured from solid blocks free of porosities.[44] With definitive ceramic restorations, the selection of the implant abutment material and the framework structures are always a challenge for the clinician and the dental technician, with each material having its advantages and disadvantages.[45]

In the present case, due to the soft tissue thickness, it was decided to use a zirconia abutment with a titanium base because there was more than 2 mm of tissue thickness. The use of a hybrid abutment has the mechanical advantages of the metal portion and the metal-to-metal contact on the head of the implant. It also has the advantage of zirconia interacting with the soft tissue.[46] However, the design of the provisional abutment was very concave and very slim at the base, and the diameter of the head of the implant was only 3.6 mm. Due to the narrowness of the abutment emergence near the connection area, the zirconia abutment wall thickness was limited to 0.6 mm of zirconia. It was decided to use this because the patient was not parafunctional, and the risk of restoration failure was not very high.

The selection of the framework for the left central incisor was determined for the implant restoration. Therefore, the dental technician decided on a zirconia restoration to achieve the same optical result through the same ceramic layering process.

References

1. Grunder U, Gracis S, Capelli M. Influence of the 3-D bone-to-implant relationship on esthetics. Int J Periodontics Restorative Dent 2005;25:113–119.
2. Wöhrle PS. Single tooth replacement in the aesthetic zone with immediate provisionalization: fourteen consecutive case reports. Pract Periodontics Aesthet Dent 1998;10:1107–1114.
3. Su C-Y, Fu J-H, Wang H-L. The role of implant position on long-term success. Clinical Advances in Periodontics 2014;4:187–193.
4. Chen ST, Buser D. Esthetic complications due to implant malpositions: Etiology, prevention, and treatment. Dental Implant Complications, 2015:209–232.
5. Moráguez OD, Vailati F, Belser UC. Malpositioned implants in the anterior maxilla: a novel restorative approach to reestablish peri-implant tissue health and acceptable esthetics. Part I. Case presentation and treatment options. Int J Esthet Dent 2015;10:368–373.
6. Jemt T, Lekholm U. Single implants and buccal bone grafts in the anterior maxilla: Measurements of buccal crestal contours in a 6-year prospective clinical study. Clin Implant Dent Relat Res 2005;7:127–135.
7. Saghiri MA, Asatourian A, Garcia-Godoy F, Sheibani N. The role of angiogenesis in implant dentistry part II: The effect of bone-grafting and barrier membrane materials on angiogenesis. Med Oral Patol Oral Cir Bucal 2016;21:e526–e537.
8. Milinkovic I, Cordaro L. Are there specific indications for the different alveolar bone augmentation procedures for implant placement? A systematic review. Int J Oral Maxillofac Surg 2014;43:606–625.
9. Chappuis V, Cavusoglu Y, Buser D, von Arx T. Lateral ridge augmentation using autogenous block grafts and guided bone regeneration: A 10-year prospective case series study. Clin Implant Dent Relat Res 2017;19:85–96.
10. Troeltzsch M, Troeltzsch M, Kauffmann P, et al. Clinical efficacy of grafting materials in alveolar ridge augmentation: A systematic review. J Craniomaxillofac Surg 2016;44:1618–1629.
11. Smeets R, Henningsen A, Jung O, Heiland M, Hammächer C, Stein JM. Definition, etiology, prevention and treatment of peri-iplantitis – a review. Head Face Med 2014;10:34.
12. Stacchi C, Chen S, Raghoebar G, et al. Malpositioned osseointegrated implants relocated with segmental osteotomies: A retrospective analysis of a multicenter cases series with 1- to 15-year follow-up. Clin Implant Dent Relat Res 2013;15:836–846.
13. Buser D, Chen ST, Weber HP, Belser UC. Early implant placement following single-tooth extraction in the esthetic zone: biologic rationale and surgical procedures. Int J Periodontics Restorative Dent 2008;28:441–451.
14. Rocchieta I, Ferrantino L, Simion M. Vertical ridge augmentation in the esthetic zone. Periodontol 2000 2018;77:241–255.
15. Cosyn J, De Rouck T. Aesthetic outcome of single-tooth implant restorations following early implant placement and guided bone regeneration: crown and soft tissue dimensions compared with contralateral teeth. Clin Oral Implants Res 2009;20:1063–1069.
16. Stimmelmayr M, Allen EP, Reichert T, Iglhaut G. Use of a combination epithelized-subepithelial connective tissue graft for closure and soft tissue augmentation of an extraction site following ridge preservation or implant placement: description of a technique. Int J Periodontics Restorative Dent 2010;30:375–381.
17. González D, Cabello G, Olmos G, Niñoles CL. The saddle connective tissue graft: a periodontal plastic surgery technique to obtain soft tissue coronal gain on immediate implants. A case report. Int J Esthet Dent 2015;10:444–455.
18. Dahlin C, Gottlow J, Linde A, Nyman S. Healing of maxillary and mandibular bone defects using a membrane technique. An experimental study in monkeys. Scand J Plast Reconstr Surg Hand Surg 1990;24:13–19.
19. Langer B, Langer L. Subepithelial connective tissue graft technique for root coverage. J Periodontol 1985;56:715–720.
20. Coachman C, Calamita M. Digital smile design: a tool for treatment planning and communication in esthetic dentistry. QDT 2012;103–111.
21. Zuhr O, Rebele SF, Cheung SL, Hürzeler MB; Research Group on Oral Soft Tissue Biology and Wound Healing. Surgery without papilla incision: tunneling flap procedures in plastic periodontal and implant surgery. Periodontol 2000 2018;77:123–149.
22. Loi I, Di Felice A. Biologically oriented preparation technique (BOPT): a new approach for prosthetic restoration of periodontically healthy teeth. Eur J Esthet Dent 2013;8:10–23.
23. Bach N, Baylard JF, Voyer R. Orthodontic extrusion: periodontal considerations and applications. J Can Dent Assoc 2004;70:775–780.
24. Lin CD, Chang SS, Liou CS, Dong DR, Fu E. Management of interdental papillae loss with forced eruption, immediate implantation, and root-form pontic. J Periodontol 2006;77:135–141.
25. Mantzikos T, Shamus I. Forced eruption and implant site development: an osteophysiologic response. Am J Orthod Dentofacial Orthop 1999;115:583–591.
26. Salama H, Salama M. The role of orthodontic extrusive remodeling in the enhancement of soft and hard tissue profiles prior to implant placement: a systematic approach to the management of extraction site defects. Int J Periodontics Restorative Dent 1993;13:312–333.

27. Salama H, Salama M, Kelly J. The orthodontic-periodontal connection in implant site development. Pract Periodontics Aesthet Dent 1996;8:923–932.
28. Nozawa T, Sugiyama T, Yamaguchi S, et al. Buccal and coronal bone augmentation using forced eruption and buccal root torque: a case report. Int J Periodontics Restorative Dent 2003;23:585–591.
29. Smeets R, Henningsen A, Jung O, Heiland M, Hammächer C, Stein JM. Definition, etiology, prevention and treatment of peri-implantitis – a review. Head Face Med 2014;10:34.
30. Zitzmann NU, Naef R, Schärer P. Resorbable versus non-resorbable membranes in combination with BioOss for guided bone regeneration. Int J Oral Maxillofac Implants 1997;12:844–852.
31. Khoury F, Hanser T. Mandibular bone block harvesting from the retromolar region: a 10-year prospective clinical study. Int J Oral Maxillofac Implants 2015;30:688–697.
32. Chu S, Hochman M. Tarnow D. Loss of the interdental papilla. Inside Dentistry 2014;10(special issue 1).
33. Osterne RLV, Nogueira RLM, Abreu RT, Cavalcante RB, Medeiros ÉA, Mello MJR. A retrospective study of an alternative technique for implant repositioning in the maxillary esthetic region. Clin Implant Dent Relat Res 2018;20:915–922.
34. Odoncuoglu BF, Alaaddinoglu EE, Oguz Y, Uckan S, Erkut S. Repositioning a prosthetically unfavorable implant by vertical distraction osteogenesis. J Oral Maxillofac Surg 2011;69:1628–1632.
35. De Risi V, Clementine M, Vittorini G, Manocci A, De Sanctis M. Alveolar ridge preservation techniques: a systematic review and meta-analysis of histological and histomorphometrical data. Clin Oral Implants Res 2015;26:50–68.
36. Rothamel D, Schwarz F, Sager M, Herten M, Sculean A, Becker J. Biodegradation of differently cross-linked collagen membranes: an experimental study in the rat. Clin Oral Implants Res 2005;16:369–378.
37. Schwarz F, Rothamel D, Herten M, Sager M, Becker J. Angiogenesis pattern of native and cross-linked collagen membranes: an immunohistochemical study in the rat. Clin Oral Implants Res 2006;17:403–409.
38. Raes S, Eghbali A, Chappuis V, Raes F, De Bruyn H, Cosyn J. A long-term prospective cohort study on immediately restored single tooth implants inserted in extraction sockets and healed ridges: CBCT analyses, soft tissue alterations, aesthetic ratings, and patient-reported outcomes. Clin Implant Dent Relat Res 2018;20:522–530.
39. Arora H, Ivanovski S. Immediate and early implant placement in single-tooth gaps in the anterior maxilla: A prospective study on ridge dimensional, clinical, and aesthetic changes. Clin Oral Implants Res 2018;29:1143–1154.
40. Praddep AR, Karthikeyan BV. Peri-implant papilla reconstruction: realities and limitations. J Periodontol 2006;77:535–544.
41. Rocuzzo M, Rocuzzo A, Ramanuskaite A. Papilla height in relation to the distance between bone crest and interproximal contact point at single-tooth implants: A systematic review. Clin Oral Implants Res 2018;29(suppl 1):50–61.
42. Su H, González-Martín O, Weisgold A, Lee E. Considerations of implant abutment and crown contour: critical and subcritical contour. Int J Periodontics Restorative Dent 2010;30:335–343.
43. Joda T, Bragger U, Zitzmann NU. CAD/CAM implant crowns in a digital workflow: Five-year follow-up of a prospective clinical trial. Clin Implant Dent Relat Res 2019;21:169–174.
44. Abdullah AO, Pollington S, Liu Y. Comparison between direct chairside and digitally fabricated temporary crowns. Dent Mater J 2018;37:957–963.
45. Gamborena I, Blatz MB. Evolution – Contemporary Protocols for Anterior Single-Tooth Implants. Chicago: Quintessence, 2015.
46. Clavijo V, Blasi A. Decision-making process for restoring single implants. Quint Dent Technol 2017:66–88.