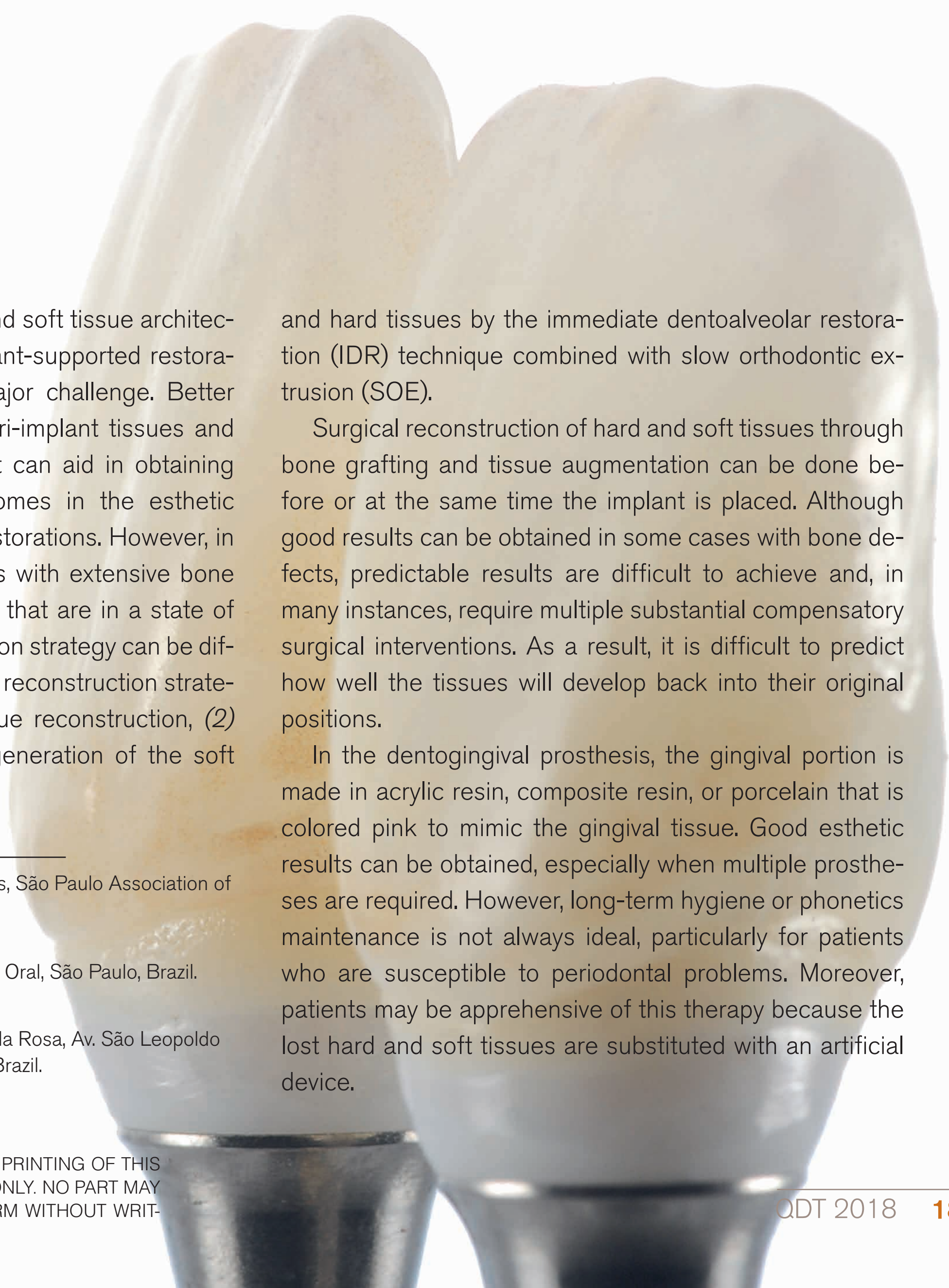
Multidisciplinary Approach Using Slow Orthodontic Extrusion and the Immediate Dentoalveolar Restoration Technique

José Carlos Martins da Rosa, DDS, MSc, PhD[1]
Juliana Romanelli, DDS, MSc[2]
Luis Eduardo Calicchio, DDS[3]



Reconstruction of the bone and soft tissue architecture around teeth with implant-supported restorations continues to be a major challenge. Better understanding of the biology of peri-implant tissues and the limitations of implant treatment can aid in obtaining more predictable restoration outcomes in the esthetic zone, particularly for single-tooth restorations. However, in complex cases, such as for patients with extensive bone and gingival defects and with teeth that are in a state of collapse, selecting the ideal restoration strategy can be difficult. For such complex cases, three reconstruction strategies can be used: *(1)* surgical tissue reconstruction, *(2)* dentogingival prosthesis, or *(3)* regeneration of the soft and hard tissues by the immediate dentoalveolar restoration (IDR) technique combined with slow orthodontic extrusion (SOE).

Surgical reconstruction of hard and soft tissues through bone grafting and tissue augmentation can be done before or at the same time the implant is placed. Although good results can be obtained in some cases with bone defects, predictable results are difficult to achieve and, in many instances, require multiple substantial compensatory surgical interventions. As a result, it is difficult to predict how well the tissues will develop back into their original positions.

In the dentogingival prosthesis, the gingival portion is made in acrylic resin, composite resin, or porcelain that is colored pink to mimic the gingival tissue. Good esthetic results can be obtained, especially when multiple prostheses are required. However, long-term hygiene or phonetics maintenance is not always ideal, particularly for patients who are susceptible to periodontal problems. Moreover, patients may be apprehensive of this therapy because the lost hard and soft tissues are substituted with an artificial device.

[1]Specialist in Periodontics and Prosthodontics, São Paulo Association of Dental Surgeons, São Paulo, Brazil.
[2]Specialist in Orthodontics, São Paulo, Brazil.
[3]Private Practice, Associate Director of Ateliê Oral, São Paulo, Brazil.

Correspondence to: José Carlos Martins da Rosa, Av. São Leopoldo 680, CEP 95097-350, Caxias do Sul, RS – Brazil.
Email: josecarlos@rosaodontologia.com.br

The multidisciplinary treatment approach using SOE to move the soft and hard tissues coronally combined with the IDR technique has shown particular benefit in cases of asymmetry of the bone and soft tissues in the esthetic zone in unnrestorable teeth. Use of the IDR technique for alveolar reconstruction has led to important improvements in terms of the long-term stability of the soft tissues because the biological properties of the technique favor faster and more effective bone incorporation. This technique has proven efficient in preventing bone resorption and gradual loss of graft volume. Moreover, the technique promotes maintenance of the tissue architecture of the gingiva and papilla.[1–3]

This article presents a clinical case of multidisciplinary treatment involving orthodontics and implant rehabilitation with immediate reconstruction of alveolar bone defects of both maxillary central incisors. The clinical results support the idea that this approach is a viable option for implant-supported rehabilitation.

MULTIDISCIPLINARY TREATMENT FOR COMPLEX CASE

Multidisciplinary treatment needs to be well-coordinated and systematically directed, with excellent communication among all involved specialists. In this complex clinical case, SOE[4] was used initially to improve positioning of the gingival and papilla line in the apicocoronal direction before performing IDR and finalizing the restoration, as described below.

A 32-year-old woman visited the authors' office seeking a solution to trauma-induced loss of bone and gingival tissues in the esthetic area. Initial analysis showed that both maxillary central incisors could not be saved (Figs 1a to 1d). The fact that they were consecutive teeth to be restored by implants made the esthetic prognosis dubious with respect to formation of the interdental papilla.[5] Extensive bone loss in the "U" between the teeth was an aggravating factor that made it difficult to plan surgery with any predictability. Loss extended from the mesial side of the root of the right lateral incisor to the same area on the left lateral incisor, with a lack of papillae between the central and lateral incisors on both sides.

Step 1: Basic Preparation

Basic prophylactic periodontal therapy (three sessions), treatment of caries, and endodontic treatment were performed to prepare the patient and to stabilize the affected teeth. Periodontal and endodontic treatment should always be performed before orthodontic extrusion.

Step 2: Slow Orthodontic Extrusion

Vertical bone and soft tissue volumes can be augmented by coronally repositioning the clinical levels of periodontal insertion through SOE of the involved teeth. Treatment time depends on the amount of apicocoronal movement required. A minimum of 3 months of fixed containment is needed to allow for complete mineralization of the bone and maturation of the anatomical contours of the soft tissues around the compromised teeth.[6] For the SOE concept to be utilized, adjacent pillars need to be present. The teeth to be extruded may have damaged tissues, but there must be sufficient periodontal insertion to allow for gradual movement in the coronal direction.

SOE achieves superior results over other surgical techniques for tissue reconstruction in terms of periodontal tissue and papillae changes and low morbidity.[7,8] The technique enables bone and gingival gains of the appropriate height and thickness in the vertical and horizontal directions. These advantages facilitate implant placement in the ideal three-dimensional (3D) position and correct implant-crown proportion, and they simplify the design and manufacture of the prosthetic crown, thereby allowing for a more predictable outcome. Patients are receptive to this treatment because they know that they will get clinical crowns that are compatible with their natural teeth.

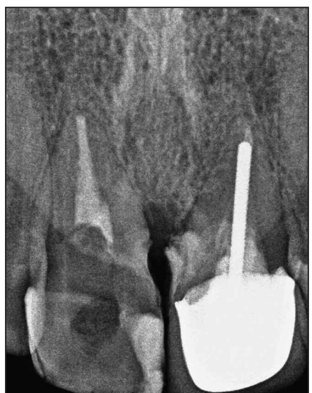
This case involved orthodontic treatment by SOE to facilitate dental extrusion. The traumatically lost alveolar bone was recreated by traction of the unrestorable maxillary central incisors until the inserted bone overcorrected for the loss. To achieve this objective, SOE was performed at a velocity of approximately 1 mm per month. The amount of movement that is needed determines the extrusion time. As this patient required a large amount of traction, a 2-month "rest" period was included in the treatment to allow for maturation of the formed tissue.

An orthodontic device (Equilibrium Mini, Dentaurum) was inserted to achieve an initial basic leveling (Fig 2). SOE was

1a

1b

Figs 1a to 1d Initial photographs and periapical radiograph showing the loss of bone and gingival architecture with significant loss of papilla between the central incisors. The two maxillary central incisors were planned to be extracted.



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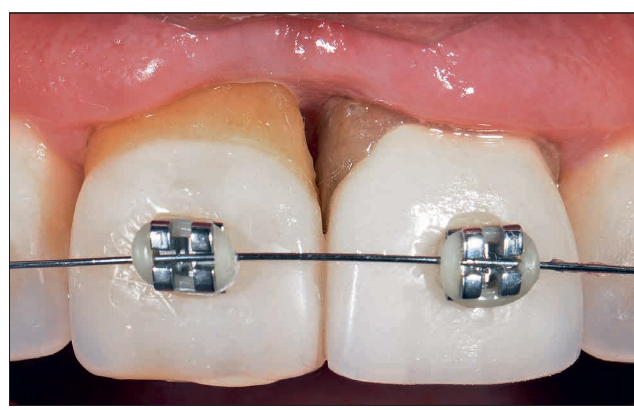
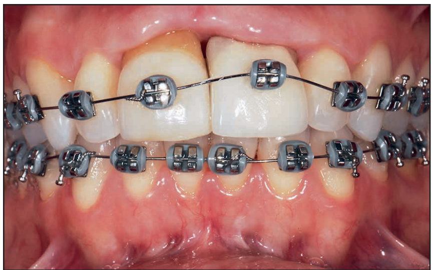


Fig 2 Passive bonding of brackets for initial leveling of teeth.

begun, with the maxillary left central incisor being chosen as the first to be tractioned. The choice of this tooth was random because both teeth required extraction in this case. In cases where only one of the teeth is condemned and needs to be extracted, that tooth should be extruded first, in a continuous way, until it is substituted by the implant. Then, after bone remodeling and accommodation of this procedure by the peri-implant tissue, the adjacent tooth can be tractioned up to the limit of being just maintained in the mouth. In cases where both teeth are to be extracted but one tooth is in a better position of insertion visually and in better periodontal health, the tooth in the poorer situation should be extruded first. This consideration is supported by the fact that the tooth with a greater volume of periodontal insertion and, consequently, irrigation, allows better formation of new bone that is enabled through extrusion of the less-favorable tooth.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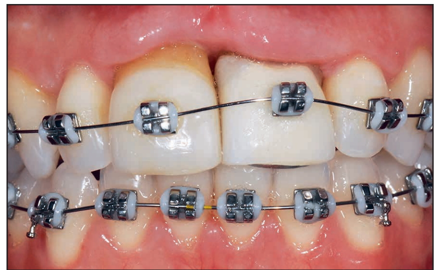
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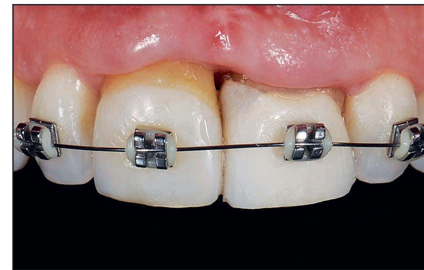
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4a


4b


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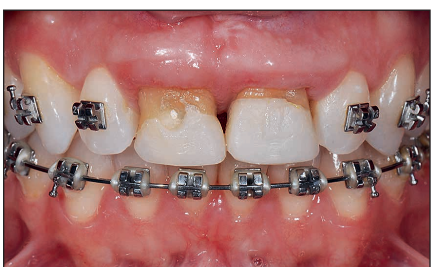
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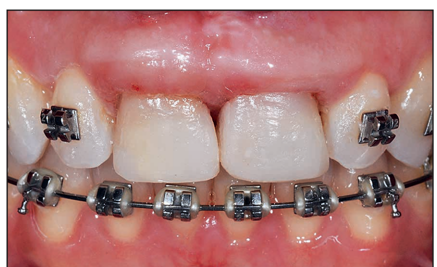

6b


6c

Figs 3a to 3c First phase of the SOE technique, with extrusion of the left central incisor.

Figs 4a and 4b *(a)* After extrusion of the right central, *(b)* the teeth were adjusted to provide a more triangular shape that favors papilla formation.

Fig 5 Remarkable formation of the interproximal gingival tissue in the buccal and palatal aspects, with a greater volume in the palatal due to the greater irrigation in this region.

Figs 6a to 6c *(a)* End of slow orthodontic extrusion. *(b)* Provisional restorations placed on the extruded teeth. *(c)* Bonding of the brackets for the wire to passively enter the stabilization phase with no tooth movement.

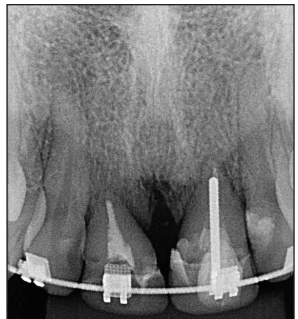
The sequence for the first phase of the technique (Figs 3a to 3c) took 45 days—from the first apical position of the bracket on the left central incisor to the final stipulated movement. The total extruded length was 1.5 mm. Thus, the extrusion velocity, which was fundamental to treatment success, was 1 mm per month. Among the various methods available for performing SOE, the technique involving wires with slight memory was used in this case. Wires were arranged for successive apical repositioning of the bracket.[9] Because of the square shape of the teeth, good formation of the interdental papilla was impossible. The best way to proceed with the planned reconstruction of the papilla was by adjustment between the teeth from an appropriate height to the point of contact between them (Figs 4a and 4b). In this way, the tissue and space that were created through extrusion could be accommodated. The result could be verified within 30 days, during extrusion of the left central incisor. In most cases, the result can be seen first on the palatal and later on the vestibular side. The palatal region has good irrigation, which promotes rapid and extensive growth in this area (Fig 5).

To ensure that there was no interference with the bite during the extrusion maneuver, the incisal and palatal sides of the tooth were preventatively adjusted. During extrusion, it was observed that a portion of the root in the cervical area remained exposed, indicating that there was a sub-

Fig 7a After orthodontic extrusion, the crestal bone between the central incisors was missing.

Fig 7b CBCTs showing the absence of the buccal bone walls in both central incisors.

Figs 7c to 7e The buccal probing depth was approximately 10 mm and 9 mm in the right and left central incisors, respectively.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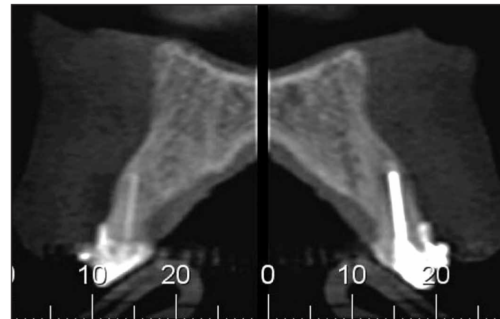


7b


7c


7d


7e

gingival region without periodontal insertion. In some cases, root exposure can indicate rapid orthodontic extrusion, in which heavy force is used and the periodontal ligament is injured.

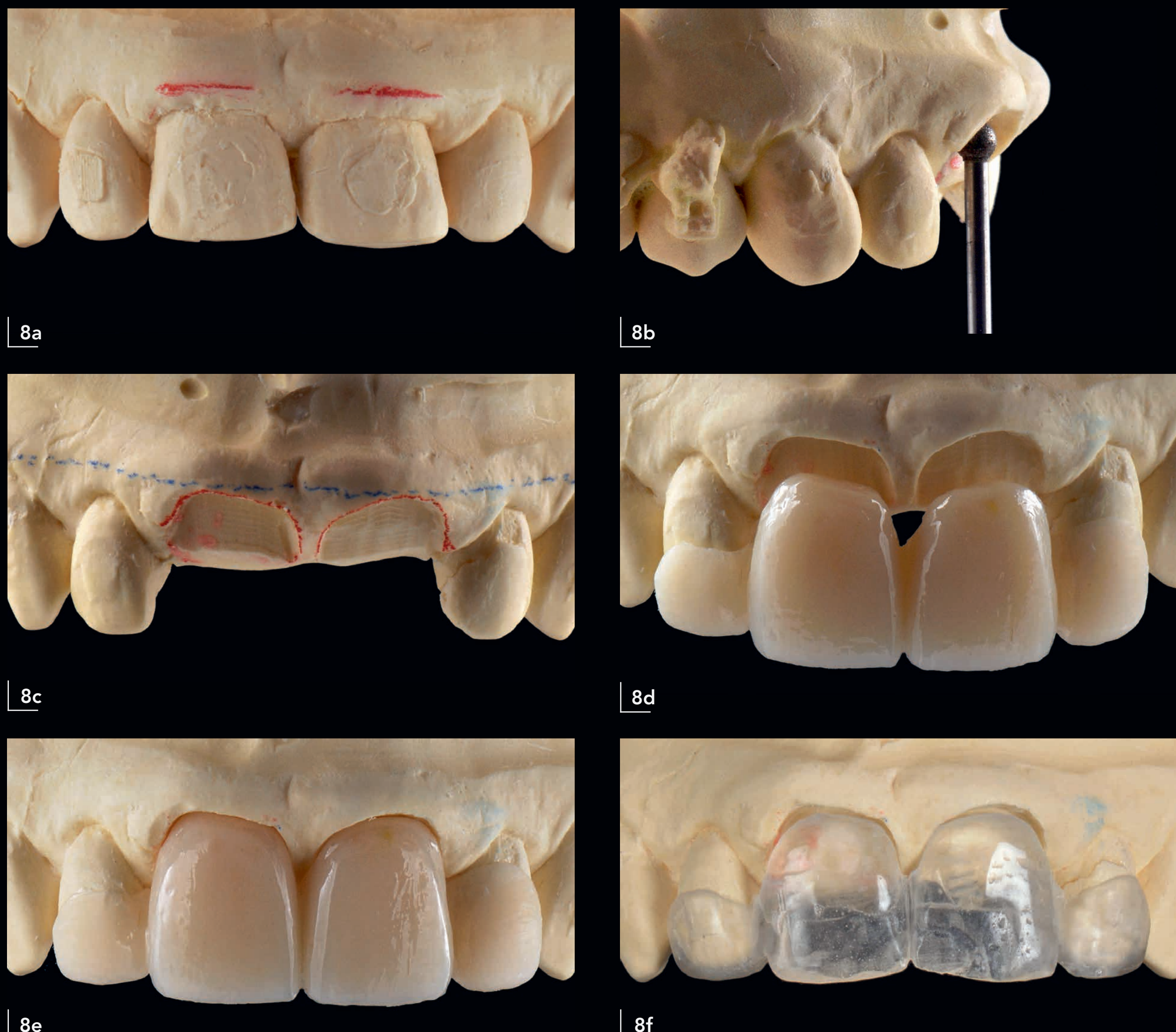
To finalize the SOE process, the brackets were repositioned passively (Figs 6a to 6c) using stiff rectangular wires, so that there was no more movement. At the end of the extrusion process, the teeth had a reasonable amount of mobility. During a 6-month stabilization phase, the patient's elastic bands were changed but there was no tooth movement. The aim of this "rest period" was to allow the newly formed bone to mature. Bone maturation is fundamental to the success of implant treatment. At the end of the stabilization period, 6 months later, the gingival volume was maintained and the teeth were no longer mobile. The patient was evaluated by tomography before implant placement. Evaluation revealed the apex of the roots of the extruded teeth beneath the gingival tissue in the vestibular region.

The case proceeded to the surgical phase. To make the surgical guide and provisional prostheses and to carry out the surgery without interference, the orthodontic brackets were removed from the anterior region, to be replaced after surgery. After osseointegration of the implants and complete maturation of the peri-implant tissues, the absence of periodontal insertion of the mesial cervical thirds of the lateral incisors made the papillae migrate in the apical direction. Therefore, with the orthodontic brackets in the mouth, the lateral incisors were extruded, by approximately 1.5 mm each, to move the interproximal bone crest in the coronal direction. This step supported appropriate formation of papillae in the distal area of the implants.

Step 3: Immediate Dentoalveolar Restoration

This step involves a surgical and prosthetic protocol for bone and soft tissue reconstruction to keep the gingival architecture stable. The IDR technique allows for implant placement in the compromised socket after extraction, reconstruction of the socket using the maxillary tuberosity as the donor area, and immediate provisionalization in a single procedure.[1,2,10,11] The IDR approach has many benefits: it is a minimally invasive technique, avoids the need for complex grafting surgeries of the bone and/or gingival tissue, and reduces morbidity by harvesting a graft from the maxillary tuberosity.[1,2]

After the slow orthodontic forced eruption was completed and the positioning of the coronal gingival architecture improved, the IDR technique was applied. Both central incisors still presented total loss of the buccal walls and crestal bone deformity after orthodontic treatment; however, a good amount of available bone was present beyond the root apex (Figs 7a to 7e). The surgical guide and pro-



Figs 8a to 8c Correct emergence profile built over stone cast in both central incisors.
Figs 8d to 8f Construction of the *(d and e)* provisional prosthesis and *(f)* surgical guide.

visional prosthesis were manufactured on a stone cast, which defined the ideal anatomical contour of the gingival margin of the central incisors (Figs 8a to 8f).

Considering the esthetic and functional demands, a treatment plan was developed including the following steps: atraumatic extraction of the teeth (Figs 9a and 9b); curettage of the sockets; immediate placement of implants in the correct 3D position, while achieving primary stability and leaving a gap of approximately 3 mm in the labial aspect (Figs 10a to 10g); construction of a provisional prosthesis with the ideal emergence profile; reconstruction of the alveolar bone defects by using the IDR technique, as described elsewhere[1–3,10,11]; and use of corticocancellous bone grafts harvested from the maxillary tuberosity (Figs 11a to 11c) to restore the lost socket walls and crestal bone between the central incisors. Buccal bone defects were restored with corticocancellous bone harvested from the maxillary tuberosity. The graft was shaped to the defect, while maintaining a biological distance of 2 to 3 mm to the gingival margin. Residual gaps were filled with can-

Fig 9a The hopeless right central incisor was extracted using a minimally invasive procedure that favored preservation of the remaining bone walls.

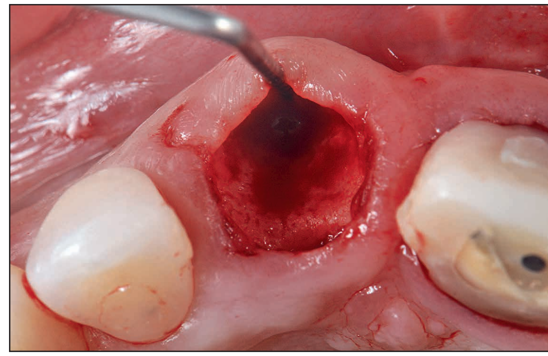
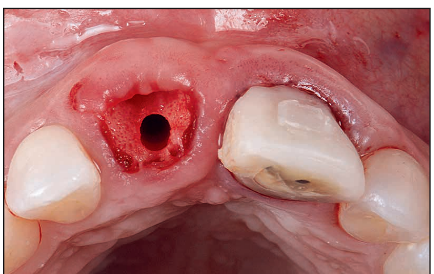
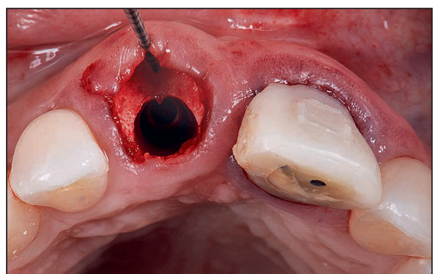


Fig 9b Clinical evaluation with a periodontal probe confirmed the extension of buccal bone defect.



10a



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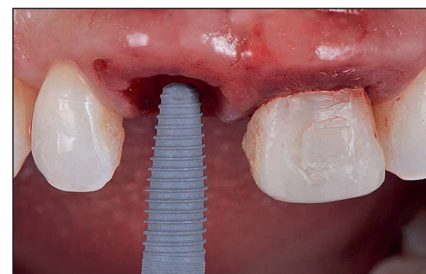

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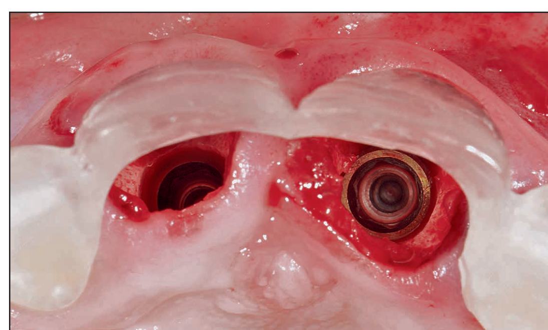

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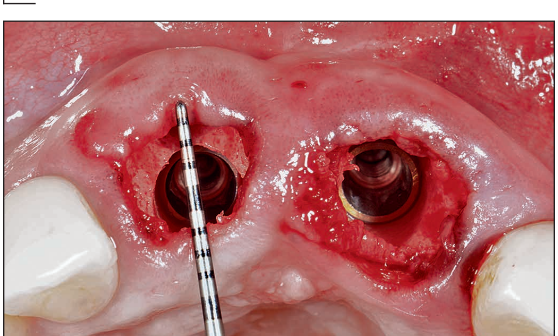

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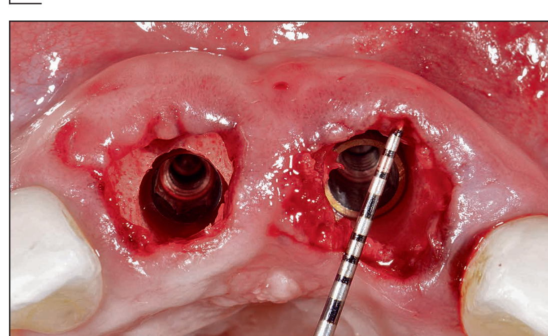


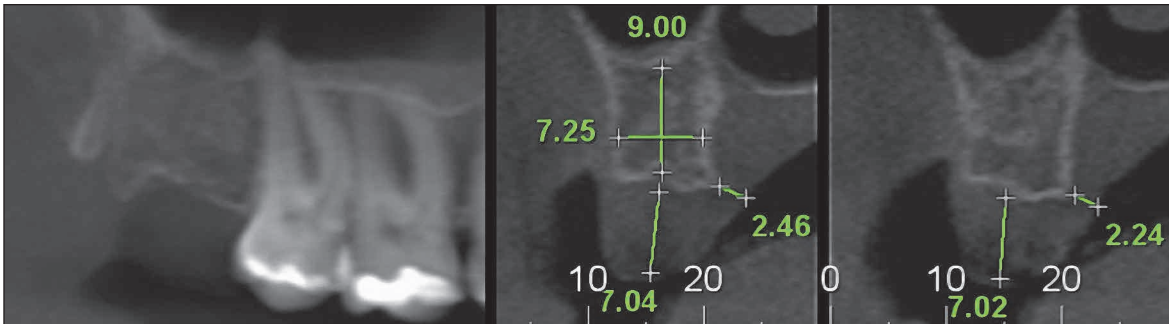
10g

Figs 10a and 10b Site preparation of the palatal wall of the right central incisor.

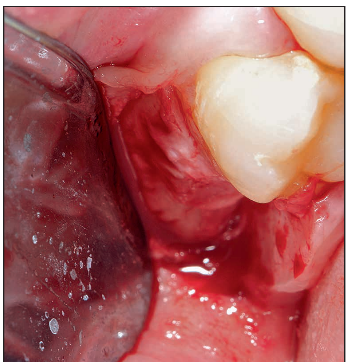
Fig 10c The implant was anchored in the remaining apical bone and at the palatal wall.

Figs 10d and 10e Surgical guide in position.

Figs 10f and 10g Evaluation of the gap and dimension of bone to be restored on the labial aspect of both central incisor sites.



11a



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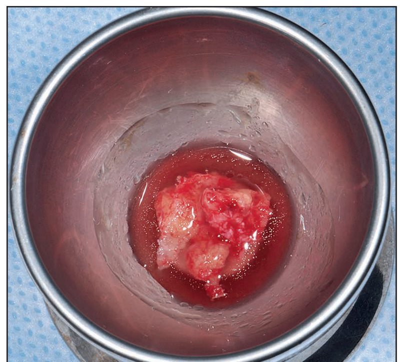
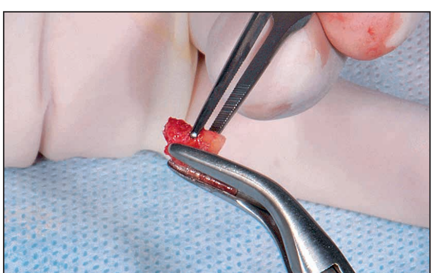


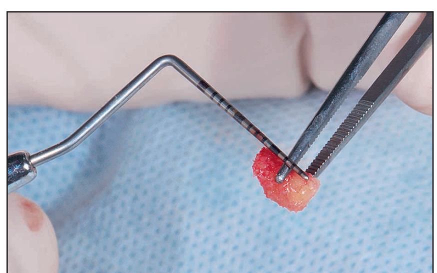
11c

Fig 11a CBCT images show the amount of bone height and width available in the right tuberosity.

Figs 11b and 11c Corticocancellous graft harvested from the maxillary tuberosity.



12a



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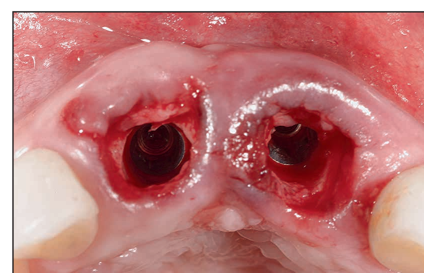

12c

Figs 12a and 12b Reshaping of the graft according to defect configuration using a rongeur.

Fig 12c Corticocancellous graft was inserted to restore the buccal wall, and particulate bone was compacted to completely fill the gaps between the marrow portion of the graft and the implant in both central incisor sites. Particulate bone graft was also carefully inserted and compacted underneath gingival papilla between the central incisors to restore crestal bone.

13a

13b

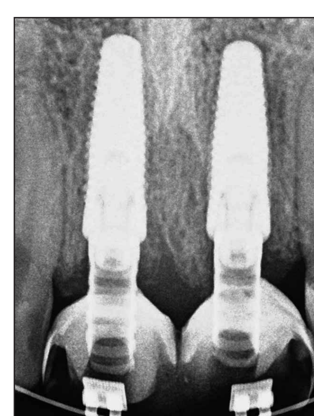

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Fig 13a Provisional prosthesis was inserted with an adequate emergence profile to allow space for the correct accommodation of the tissues.

Fig 13b Periapical radiograph shows the bone compacted in the crestal area.

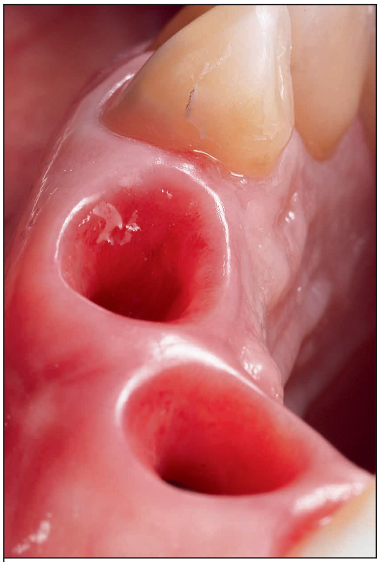
Fig 14 Periapical radiograph 6 months postoperatively shows the crestal bone completely remodeled.

Fig 15 Mock-up in position. The soft tissue had healed and maintained an appropriate position.

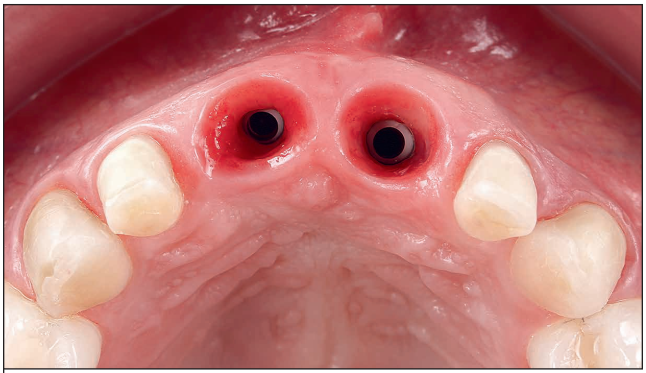
Fig 16a Peri-implant soft tissue healed.

Fig 16b Occlusal view of final teeth preparation shows that the anatomical contour of the soft tissue was maintained.

15



16a



16b

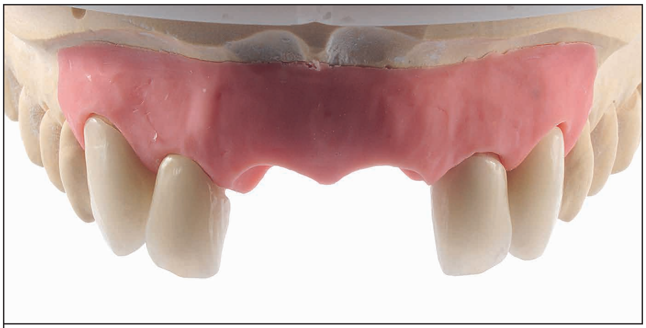
cellous bone harvested from the same donor area, while maintaining the reconstructed bone walls and surrounding soft tissue. Crestal bone damage between the central incisors was carefully curetted and filled with particulate cancellous bone while preserving the papilla integrity (Figs 12a to 12c). The provisional prosthesis was positioned immediately and out of occlusion. A periapical radiograph verified the reconstructed bone in the crestal area (Figs 13a and 13b).

After 6 months, radiography verified that the crestal bone was completely restored between the implants (Fig 14). The definitive restoration could now be accomplished.

Step 4: Final Restoration

Prosthetic rehabilitation involved the construction of customized zirconia abutments and individual metal-free leucite-reinforced crowns, leading to satisfactory esthetic results. After completing the IDR phase, new anatomical documentation was obtained, including new photographs of the patient's face and intraoral areas and new videos for esthetic reevaluation. Ceramic veneers were needed on the lateral incisors and canines, with crowns over the implants on the central incisors, to obtain suitable shape and size distributions. Readjustment of the smile was confirmed with a bis-acryl resin mock-up (Fig 15). After the dentist and patient approved the new smile contour, tooth preparations were initiated. Rubber wheels for ceramic were used to polish the preparations (Figs 16a and 16b).

Impressions of the implants and prepared teeth were made using the double-impression technique. On the prepared natural teeth, cords 000 and 0 (Ultrapak, Ultradent) were used. An important element is customizing the impression transfer caps; in this case, the authors opted for a closed-tray impression technique. To customize the transfer caps, provisional crowns were fitted for the central incisors, which already had their correct emergence profiles for future restorations defined in the analogs. With the addition of silicone, an impression was taken of the unit up to the cervical area of the provisional crowns. After the impression material hardened, the crowns were removed and the analogs left inside the mold. The caps were screwed onto the analogs and, using acrylic resin (Pattern Resin, GC), transfer of the whole emergence profile was completed. Customized transfers were fitted in the mouth, and



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18a

periapical radiographs were used to check their correct adaptation with the implant. The two-step impression was then performed, first with the addition of heavy-body followed by light-body silicone (Honigum and Silagum, DMG).

In the laboratory, veneer restorations for the lateral incisors and canines were digitally manufactured using Empress CAD ceramic (D'sign, Ivoclar Vivadent) (Fig 17). Abutments for the central incisor implants were made with zirconia, which was chosen for its biological and biomechanical properties. Lithium disilicate ceramic (e.max, Ivoclar Vivadent) was applied over the zirconia abutments on the cervical and middle thirds to gain fluorescence and adhesion. The e.max is an acid-sensitive material, favoring the cementation of future full crowns made with Empress CAD ceramic (D'sign). The cervical anatomical contour of the abutments followed a concave design in the transmucosal region, as described by Rompen et al,[12] to minimize gingival recession (Figs 18a to 18c).

Color, shape, and contact points of the restorations were checked and approved (Figs 19a to 19c). Ceramics were conditioned outside the mouth using 10% hydrofluoric acid for 90 seconds. According to Peumans et al,[13] acid conditioning creates microretentions on the restoration surface, increasing adhesion with resin cement. The restorations were cleaned with 35% phosphoric acid (scrubbing the surface for 10 seconds), followed by abundant washing and drying. They were placed in an ultrasonic bath with distilled water for 5 minutes to remove residual acid and then were dried. Silane was applied for 1 minute, and the restorations were dried at 100°C for 1 minute.

18b

18c


19a


19b


19c


20a


20b

Fig 17 Empress CAD veneers on model.

Fig 18a Zirconia abutments on model.

Fig 18b Customized zirconia abutments.

Fig 18c Final customized zirconia abutments and final crowns.

Fig 19a Checking adaptation of zirconia abutments. The cervical anatomical contour of the abutments accommodated the soft tissue volume on the labial and proximal aspects.

Figs 19b and 19c Checking contact points of the crowns.

Figs 20a and 20b Cementation of crowns with resin cement.

Cementation of the restorations was performed using rubber dam isolation (Figs 20a and 20b). The dental surfaces were cleaned with pumice stone and water, rinsed abundantly with water, and surface dried. The teeth preparations were conditioned with 35% phosphoric acid for 15 seconds. The surface was again washed with abundant water and dried. Three to four layers of adhesive (Single-Bond, 3M) were applied, according to the manufacturer's recommendation. Without polymerizing the adhesive, resin cement (Variolink, Ivoclar Vivadent) was applied to the interior of the veneers and they were placed in the mouth for correct adaptation in the prepared areas. Excess cement was removed with cotton balls, dental floss, and delicate brushes, while carefully stabilizing the restoration in position. Restorations were light cured for 3 seconds. The remaining cement was removed using the blade of a #12D scalpel and strips of serrated metal (Komet). The restorations were light cured for 60 seconds on each side.

Customized lithium disilicate abutments were conditioned outside the mouth with 10% hydrofluoric acid for 20 seconds. The protocol for ceramic conditioning was followed in the same way as described above. Abutments were placed on the implants and torqued to 35 N. Crown cementation followed the same steps and involved the same materials as the veneers.

Occlusal adjustment was performed with carbon paper to correctly distribute the occlusal contacts during protrusive and excursive movements. Final impressions were made in silicone to obtain the rigid occlusal protector. The digital ceramic restorations recreated the correct emergence profile and shape of natural teeth (Figs 21a to 21d) and provided ideal soft tissue support (Figs 22a and 22b). The patient was followed up for 3 years. Clinical and radiographic images taken from the 3-year follow-up appointment demonstrate that the conditions and levels of bone and gingival architecture remained stable (Figs 23a to 23c).


21a


21b


21c


21d

Figs 21a to 21d Final result after cementation of crowns. Dental technician: Wagner Nhoncance.

22a

22b

Fig 22a Occlusal gingival contour showing stability of the soft tissue.

Fig 22b Emergence profile of the final crowns.

23a

23b

23c

Figs 23a and 23b Clinical photographs at 3-year follow-up show harmony between lips, crowns, and gingival architecture.

Fig 23c Radiograph at 3-year follow-up shows stability of the crestal bone between the implants and bone stability between the implants and neighboring teeth.

BENEFITS OF USING THIS MULTIDISCIPLINARY APPROACH

1. *Less invasive surgery:* This type of treatment prioritizes preservation instead of complex reconstruction involving soft and hard tissue grafts. Surgical morbidity for patients is reduced by avoiding invasive procedures. Thus, satisfactory esthetic results can be achieved with more predictability.
2. *Ease of making the prosthetic crown:* The manufacturing technique for the restorations is simplified because the prosthetic restoration essentially restores the clinical crown. By contrast, dentogingival prostheses are complicated to use and are often rejected by patients.
3. *Biomechanical aspects:* The crown-implant proportion is optimized, and complex prosthetic reconstructions involving cantilevers of the dentogingival prosthesis are avoided.
4. *Simplified oral hygiene and maintenance:* An appropriately designed prosthesis with single crowns of ideal shapes and contours makes maintenance and oral hygiene procedures easier, with clear long-term benefits in terms of maintaining peri-implant tissue health.
5. *Phonetics:* In patients with advanced bone and papillary loss, reconstituting an ideal relationship between the teeth and soft tissues avoids the phonetic complications that can be caused by large spaces in implant-supported fixed prostheses.
6. *Biological restoration:* In contrast with more complicated graft procedures, the approach of using SOE with IDR achieves an ideal biological restoration of the soft and hard tissues.
7. *Tissue stability:* This approach reduces risks of resorption and gradual loss of the graft volume, complications that are seen with most surgical techniques used for grafts involving large reconstructions in esthetic areas.

CONCLUSION

An excellent functional, biological, and esthetic result was maintained after 3 years of follow-up, with vertical and horizontal bone stability. In addition, the soft tissue architecture was maintained in terms of the esthetic stability of the contours of the gingival and papillary margins. For patients affected by trauma and major tissue loss, as in the case described, a multidisciplinary approach involving SOE of the compromised teeth and IDR can offer an excellent method for esthetic rehabilitation, particularly in the vertical augmentation and regeneration of bone and soft tissues. This approach can improve the results of implant-supported restorations. Meticulous surgical and prosthetic treatment, excellent hygiene control, and careful maintenance are essential.

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