Implant-prosthetic rehabilitation:

One-stage surgery with post-extraction, hard- and soft-tissue augmentation, periodontal regeneration and immediate fixed prosthesis

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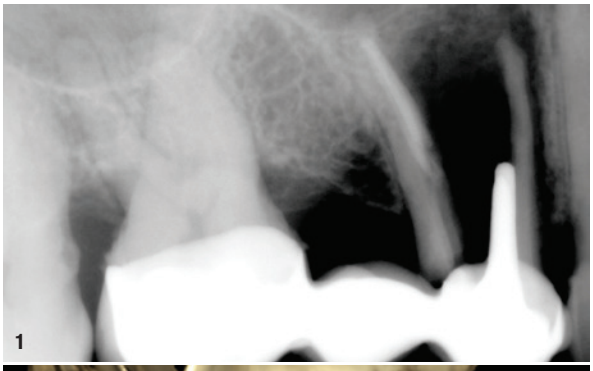
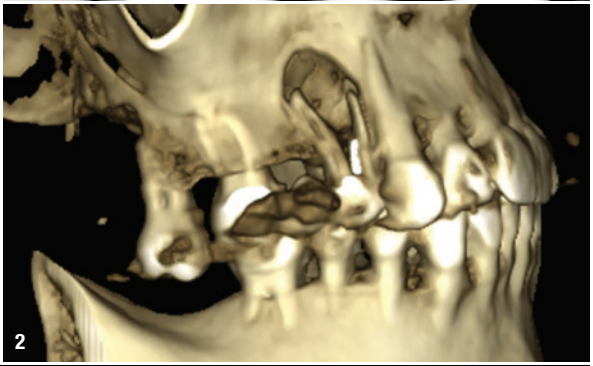
The predictable application of hard- and soft-tissue regenerative techniques has made it possible to pursue the goal of prosthetically guided implant treatment. In cases of severe osteolytic lesions with extensive impairment of the alveolar bone and loss of one or more teeth, the traditional approach to fixed rehabilitation involves planning a multistage surgery. The scientific literature has demonstrated the effectiveness of guided bone regeneration techniques, indicating resorbable devices as the first choice in horizontal regeneration. However, major regenerations involving a significant vertical defect have required the use of non-resorbable devices. Nonetheless, scientific evidence has demonstrated the effectiveness of resorbable devices even for bone regeneration in cases with limited vertical bone. Furthermore, increasing importance is being given to the management of soft tissue, which in some cases can be combined with implant treatment to obtain adequate supra-crestal mucosal thickness. In addition, periodontal regeneration of an infrabony defect can be performed with guided bone regeneration when the surgical sites are adjacent. When possible, the combined





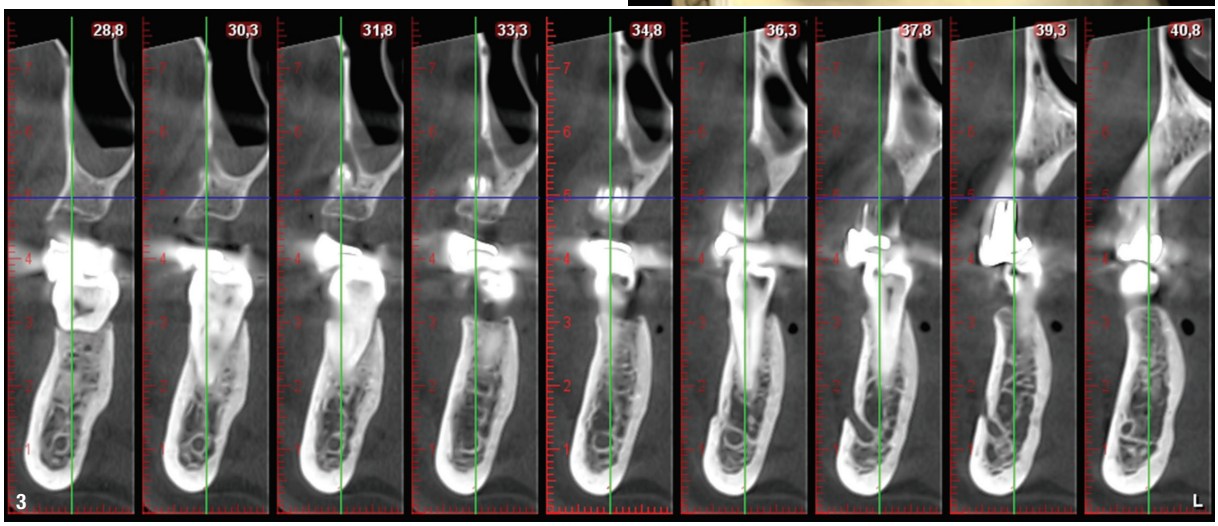


Fig. 1: Pre-op evaluation. Vertical fracture of the root of tooth #14 rehabilitated with a long intra-canal metal pin. **Fig. 2:** Pre-op evaluation. Wide periradicular infrabony injury with vertical bone loss. **Fig. 3:** Pre-op evaluation. Wide periradicular infrabony injury with vertical bone loss.

application of several techniques allows fewer surgeries and optimisation of the healing process.

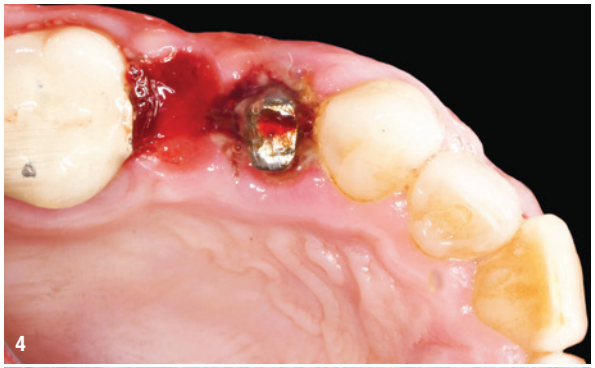
Case presentation

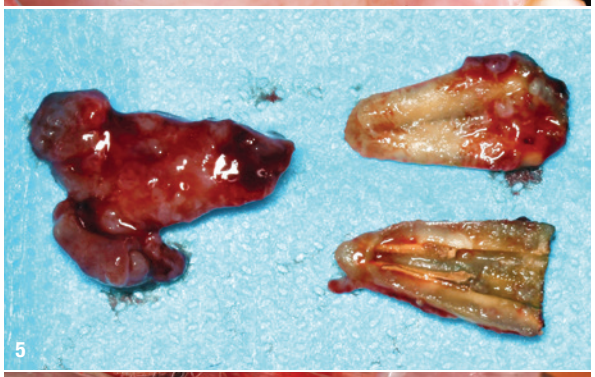
A 49-year-old female patient presented to our clinic in Milan in Italy reporting mobility and pain in the maxillary right quadrant, corresponding to the area of a fixed bridge from tooth #14 to tooth #16—tooth #15 was missing. Based on the general anamnesis, the patient was classified as ASA I, and she was a non-smoker. After a clinical and radiographic check-up, both intra-oral and CBCT, a vertical fracture of the root of tooth #14 rehabilitated with a long intra-canal metal pin was evident (Fig. 1). The compromised root had caused a wide periradicular infrabony injury with vertical bone loss of up to 12.0 mm vestibularly and 3.5 mm palatally (Fig. 2). In site #15, the residual alveolar process measured 7.0 mm high and 7.5 mm wide. In addition, a mixed two- and three-walled infrabony periodontal defect with a probing depth of 5 mm was found mesially around tooth #16 (Fig. 3).

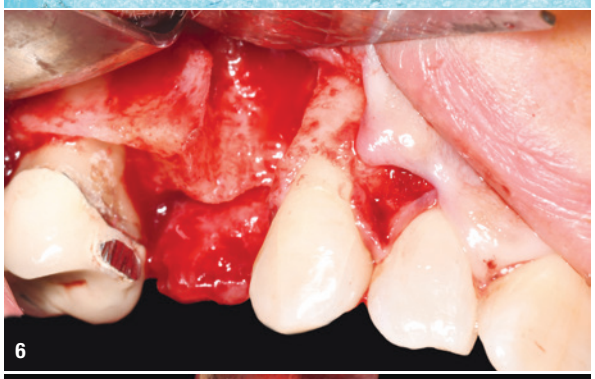
The patient desired a fixed rehabilitation that would not involve healthy teeth or a large number of surgeries. A virtual case resolution project was then created, according to the guidelines of regeneration and guided prosthetic implantology.[1] Based on clinical evidence, the literature and the surgeon's skill, a one-stage surgery was planned that would involve a bone condensation technique using magneto-dynamic technology[2–4] and the use of intramucosal implants with a UTM (ultrathin threaded microsurface) hybrid neck surface (Prama, Sweden & Martina), capable of promoting both soft-tissue integration and osseointegration.[5, 6]

Materials and methods

The week before the operation, the patient underwent a complete oral hygiene session. The day of surgery, it was verified that the full-mouth plaque score was less than 20%, and after that the patient rinsed with 0.2% chlorhexidine digluconate for 1 minute. Local anaesthesia was performed with articaine (40 mg/ml) and adrenaline (0.01 mg/ml). The surgical procedure involved the separation of the pontic in site #15 from the crown of tooth #16 and an atraumatic extraction of the fractured tooth #14 (Figs. 4 & 5). A full-thickness flap was elevated and the extensive osteolytic lesion removed (Figs. 6–8). At site #15, the implant site was prepared with magneto-dynamic osteotomes of circular cross-section and conical shape with increasing diameter (Magnetic Mallet, Meta Ergonomica) and







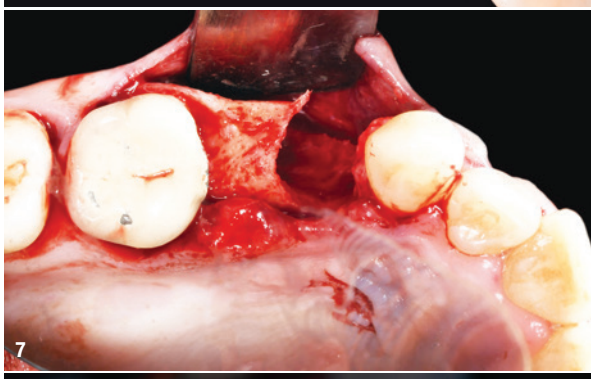


Fig. 4: Separation of the bridge from the pontic in site #15 to the crown of tooth #16. **Fig. 5:** Atraumatic extraction of the fractured tooth. **Fig. 6:** Full-thickness flap elevation, vestibular view. **Fig. 7:** Full-thickness flap elevation, occlusal view. **Fig. 8:** Removal of the extensive osteolytic lesion.

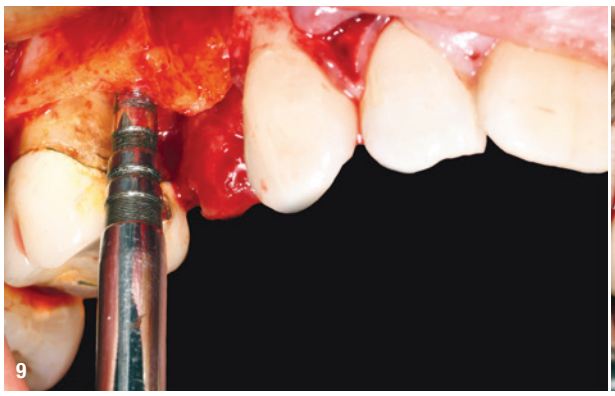
a concomitant crestal sinus lift (vertical gain of 6–10 mm; Fig. 9). The sinus lift technique (PRO SCV Sinus Lift, RESISTA) allowed us to obtain floor deformation and detachment of a bone operculum of about 3 mm in diameter, increasing the height of the infrabony prepared implant site path by at least 2 mm, for better bone–implant contact and primary stability.[7, 8] A fibrin haemostatic sponge was inserted into the sinus prior to implantation to protect the sinus membrane from biomaterial granules, followed by the grafting of a cross-linked collagen and hydroxyapatite matrix (OSSIX Bone, Datum Dental; Fig. 10). The implant site was underprepared to further increase primary stability and implant insertion torque, and the implant was then positioned (Fig. 11).[9] A rigid cross-linked collagen membrane (OsseoGuard, Zimmer Biomet) was fixed palatally with #5/0 resorbable PGA monofilament sutures (Fig. 12). In site #14, bone condensation was performed in the digitally planned implant position with magneto-dynamic osteotomes. The residual bone, apical to the defect, was compacted and shaped together with the maxillary sinus floor, gaining additional vertical bone in the apical direction of 2 mm.[10, 11] An implant with a UTM intramucosal neck of 2.8 mm high was inserted into site #14 about 2.0 mm more apical than the implant inserted into position #15, which had an intramucosal neck of 1.8 mm high, and both were placed to a torque of between 20 and 25 Ncm.

After the implant placement, degranulation of the periodontal defect of the mesial root surface of tooth #16 was performed, followed by scaling, root planing and decontamination with 24% EDTA gel.[12] Simultaneous guided bone regeneration and periodontal regeneration were performed, using a high-porosity porcine-derived carbonate apatite (Zcore, Osteogenics Biomedical) mixed with cross-linked hyaluronic acid (hyaDENT BG, BioScience; Figs. 13 & 14). The membrane was fixed vestibularly with titanium micro-tacks 3.0 mm long and 2.5 mm in diameter (Geistlich Pharma) and, through a hole drilled on the membrane, to the transmucosal healing screw provisionally placed on the implant at site #15 (Figs. 15 & 16). A layer of cross-linked hyaluronic acid was placed on the root of tooth #16 involved in the periodontal defect. After complete fixation of the membrane, a matrix (mucoderm, botiss biomaterials) was perforated and placed around the neck of implant #15 (Fig. 17). The vestibular flap was lengthened by periosteal releasing incision, followed by the brushing technique, and then repositioned coronally. It was closed by first intention with #5/0 PGA monofilament double-layer sutures over the collagen matrix. After removal of the transmucosal screw in site #15, a provisional fixed prosthesis was screwed on to implant #15 and cemented with a metal wing on tooth #13 (Fig. 18).

After six months of healing and conditioning, a control radiograph was performed (Fig. 19), and the provisional prosthesis was removed. The supra-crestal soft tissue appeared to be free of inflammation, and a pink mucosal cone was appreciable above the prosthetic UTM neck connection of the implants (Fig. 20). Single crowns were realised on implants #14 and 15, and the old metal–ceramic crown on tooth #16 was replaced, having been provisionally maintained and separated from the rest of the bridge. After one year, clinically and radiographically, we observed perfect integration of the implants, maturation of the augmented sinus at implant #15 and resolution of the periodontal defect affecting tooth #16 and of the wide bone defect at implant #14 (Figs. 21 & 22).

Discussion

Ridge augmentation techniques are characterised by horizontal, vertical or 3D hard-tissue augmentation. The prerequisites for the success of these techniques concern various parameters. The type of membrane used is primary. It must be able to create an isolated, rigid, fixed space.[13] For this reason, non-resorbable membranes have been regarded as indispensable for larger augmentations with a significant vertical component, whereas some authors have reported cases treated successfully with rigid, slowly resorbable devices, such as cross-linked collagen membranes, for 3D augmentations whose vertical component is reduced.[14, 15] The success of 3D augmentations also requires the presence of other factors considered indispensable, such as supporting structures (tenting



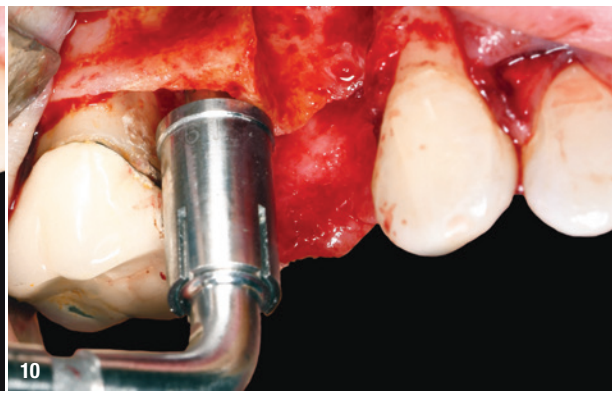


Fig. 9: Preparation of the implant site in region 15 with bone condensing osteotomes. **Fig. 10:** Crestal sinus lift in site #15.

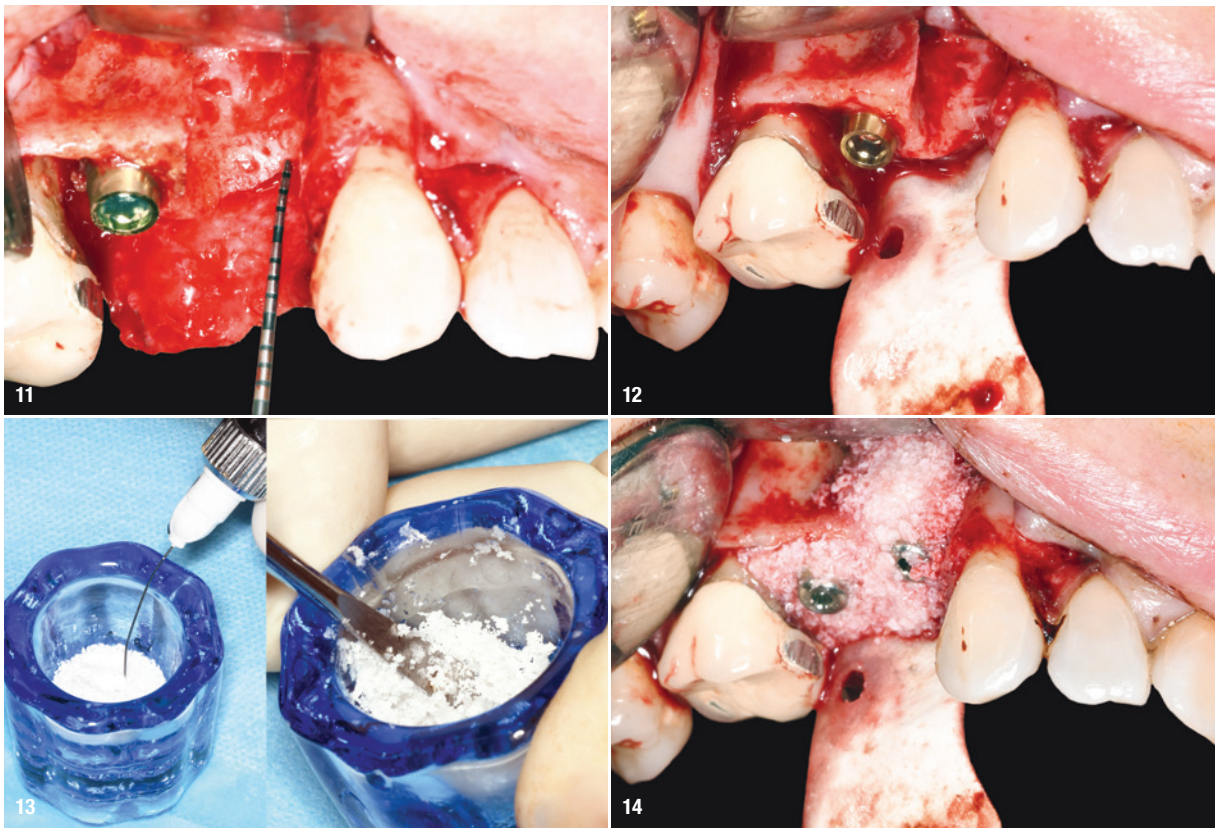


Fig. 11: Implant inserted into site #15. **Fig. 12:** Palatal fixation of the rigid cross-linked collagen membrane with sutures. **Fig. 13:** Preparation of a mix of high-porosity porcine-derived carbonate apatite with cross-linked hyaluronic acid for grafting. **Fig. 14:** Implant inserted into region 14 and both sites grafted.

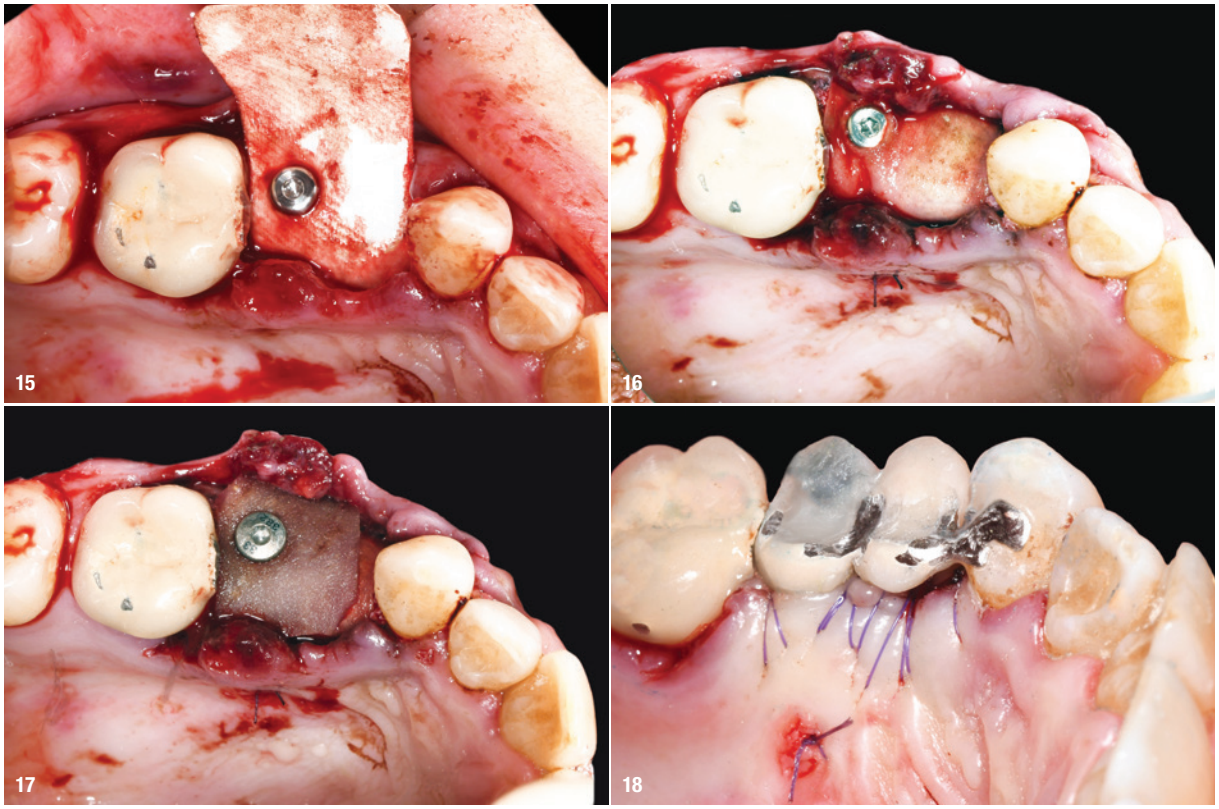


Fig. 15: Membrane fixed with the transmucosal healing screw provisionally placed on the implant in #15. **Fig. 16:** Membrane vestibularly fixed with titanium micro-tacks. **Fig. 17:** Porcine-derived acellular dermal matrix placed over the membrane and around the neck of implant #15. **Fig. 18:** Suturing and fixation of a provisional fixed prosthesis screwed on to implant #15 and cemented on to tooth #13 with a metal wing.

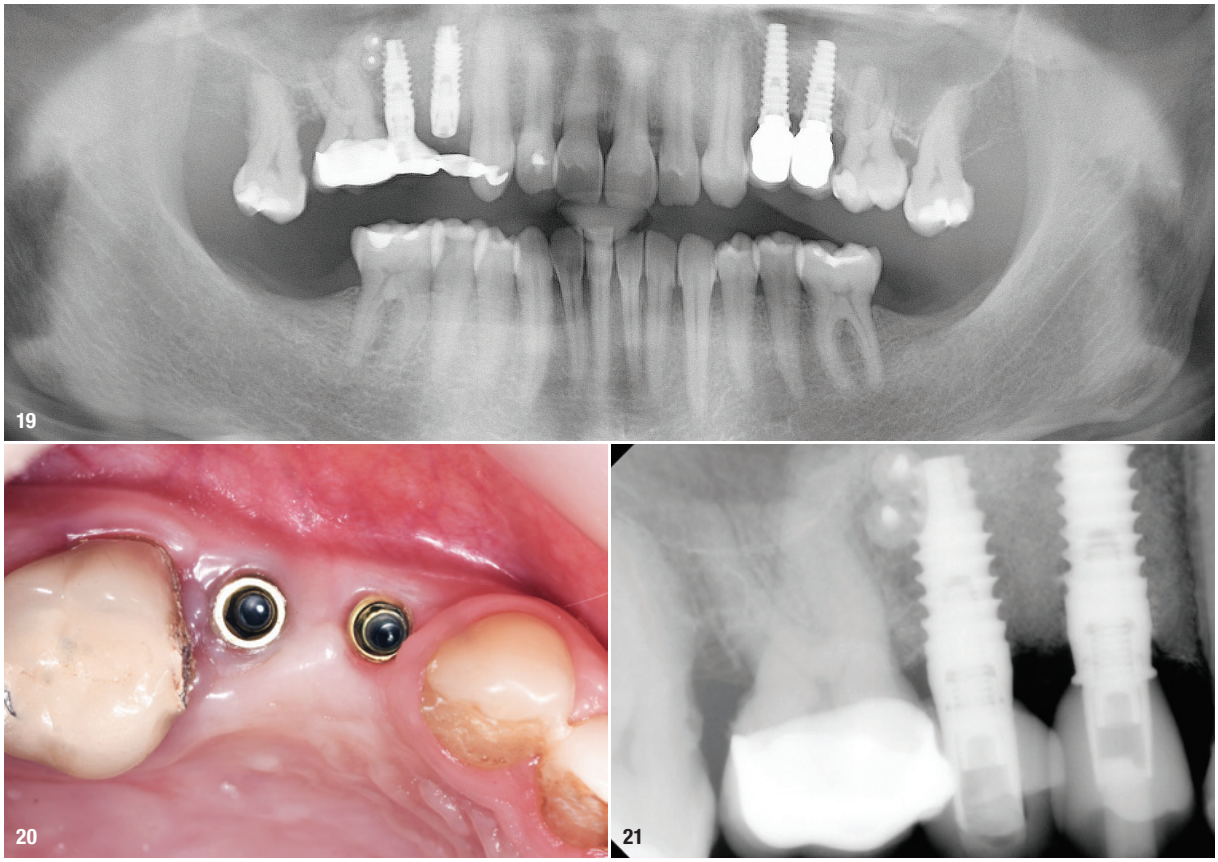


Fig. 19: Post-op radiographic check after six months. **Fig. 20:** Supra-crestal soft tissue at six months after removal of the provisional fixed prosthesis. **Fig. 21:** Post-op radiographic check at one year.

screws, implants themselves, etc.), fixing devices (sutures, pins, micro-screws, etc.) and grafting materials, which, in addition to being osteoconductive, require a component that improves the supply of autologous growth factors.[16] For this last characteristic, the gold standard is still the autograft, but recently, biological agents such as the cross-linked hyaluronic acid used in this case report have been making gains, being capable of improving the formation and support of the clot, as well as enhancing the supply of autologous growth factors.[17–19]

The philosophy of the intramucosal implant involves the positioning of the rough, sandblasted and etched portion strictly intraosseously and the UTM neck in a hybrid manner between the hard and soft tissue. The different UTM neck heights of 1.8 and 2.8 mm therefore allow the implant to be placed at different depths using the different lengths available on the market.[5, 6, 20, 21] This is particularly useful in implant treatments associated with regenerative techniques, where tissue healing and remodelling cause postoperative shrinkage during the healing phase that is not entirely predictable.[22] Magneto-dynamic technology also allows implant sites to be prepared using bone condensation techniques, improving the primary stability of implants even when placed into areas with very small volumes of native bone.[23, 24]

Soft-tissue management is also an aspect now considered indispensable in oral regenerative techniques. The thickness of the peri-implant supra-crestal soft tissue, the amount of keratinised gingiva and the maintenance or restoration of a proper mucogingival line are of primary importance. The technique of choice in restoring adequate quality to supra-crestal soft tissue remains autologous connective tissue grafting, traditionally performed in association with major bone regeneration as free gingival graft, but recently alternative solutions favouring connective tissue grafting as the augmentation technique are becoming more established.[25] It appears that a deep connective tissue graft not only reduces the contraction typical of free gingival grafts, but over time improves the quantity of the soft tissue through creeping attachment. When an improvement in soft-tissue quality is not essential, but an increase is sufficient, biological substitutes have proved to be a viable alternative in order to reduce the invasiveness of treatment. Indeed, the literature reports increases of 1.0–1.5 mm in thickness achievable with biological substitutes based on porcine-derived dermal matrix grafted at partial thickness or subperiosteally.[26, 27]

Conclusion

The use of a rigid, cross-linked, bone-fixed and -supported resorbable membrane is effective in correcting defects

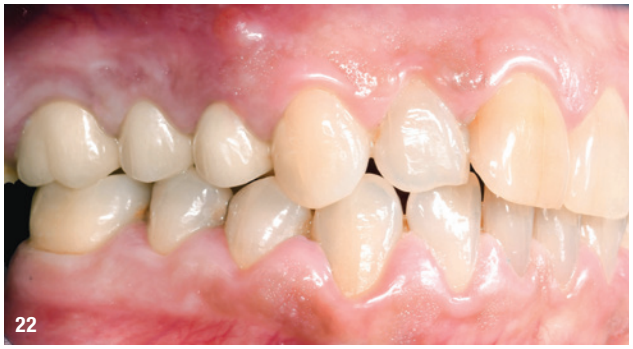


Fig. 22: Post-op clinical check at one year.

with a small vertical component. Bone condensation makes it possible to increase primary stability even in the case of limited residual bone volume. The UTM neck facilitates the fixing of a collagen matrix, allowing the maturation of hard and soft tissue. The application of a regenerative surgical protocol for the management of an intrabony periodontal defect adjacent to the site to be regenerated is effective. The application of a minimally invasive approach with the possibility of exploiting surgical access to an edentulous site to manage the periodontal regeneration of an adjacent natural tooth makes the clinical outcome even more successful. Combining multiple techniques with few surgeries allows optimisation of the healing processes as well as reduction of the overall treatment time, in addition to lower invasiveness of the therapy.[28]

Literature

about the author

Dr Stefano Scavia completed his DDS in 2003 at the University of Milan in Italy and in 2008 obtained a second-level master's degree in implantology and oral surgery. He lectures in this master's programme at the School of Medicine and Surgery of the University of Milano-Bicocca and the elective course in minimally invasive surgery as part of its dentistry degree programme. Dr Scavia founded the Minimal Invasive Dental Academy in Milan and is a certified member of the Italian Academy of Osseointegration and a member and speaker of the National Association of Italian Dentists.

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