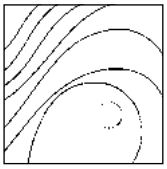
Autogenous Bone Grafts in the Esthetic Zone: Optimizing the Procedure Using Piezosurgery



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Soft and hard tissue defects pose a therapeutic challenge in modern implant dentistry. There are a multitude of surgical techniques available, and it is necessary to match the problem with the solution. This report describes the reconstruction of the alveolar ridge in the esthetic zone with the help of autogenous bone blocks harvested from the chin that were shaped to fit and stabilized at the recipient site. The procedures were performed using Piezosurgery, which made it possible to introduce surgical modifications and had a significant impact on the accuracy of the procedure. An observation period of 2 to 7 years showed positive stable results for treatment in terms of function and esthetics. (Int J Periodontics Restorative Dent 2012;32:e210–e217.)

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The anterior maxilla is one of the most difficult areas for implant treatment because ensuring a positive outcome depends not only on the success of the implants but likewise the esthetics of the implant-supported restorations. Trauma to the alveolar ridge combined with tooth loss, inflammatory processes, and resection procedures results in defects that are difficult to reconstruct in the esthetic zone. Hard and soft tissue defects complicate treatment since they require effective tissue regeneration procedures.[1] They can be performed as single-stage procedures, simultaneously with implantation, or staged prior to implant placement. When selecting patients for such treatment, it is important to consider the type, shape, and size of bone defects and the amount and quality of the soft tissue. Selecting the surgical procedure is guided by the defect shape and size. Two main groups can be distinguished. The first includes guided bone regeneration using biomaterials, autogenous bone particles, and barrier membranes; the second involves

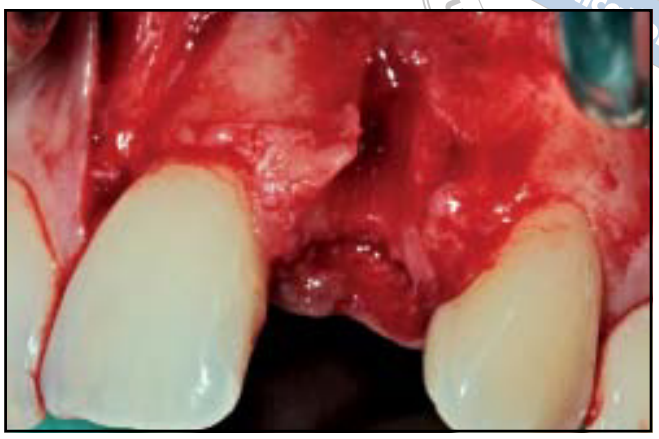


Fig 1 *Bone defect at the site of the maxillary left lateral incisor.*

autogenous bone block grafts.[2–8] A combination of both techniques has also been used: biomaterials and membranes with autogenous bone blocks. Biomaterials have osseoconductive properties with no inductive capacity, and autogenous bone is prone to resorption. Growth factors[9,10] and bone morphogenic proteins enhance bone formation. However, there are few long-term reports that support promising clinical and histologic observations. There are many surgical factors that influence bone formation, including primary wound closure, angiogenesis, space creation, and stability.[11] When assessing the predictability of such treatment, not only should the immediate results of tissue healing be taken into account, but also it must be considered if the implant integration and function, as well as the esthetic results of the peri-implant soft tissue and implant-supported prosthetic crowns, are satisfactory in the long term.

This paper describes a modified bone regeneration procedure using autogenous bone block grafts together with biomaterials and bioresorbable membranes.

Method and materials

A total of 23 procedures were performed in patients between the ages of 24 and 47 with a clinical observation period of 5 to 7 years. Patients qualifying for the procedure exhibited defects in the anterior maxilla with extensive damage to the labial plate of the alveolar ridge so that it was not possible to achieve immediate implant stability. The extent of the defect was a contraindication for guided bone regeneration since it would be difficult to create and maintain the shape of the alveolar ridge during the regeneration process.

The procedure can be divided into the following stages: preparation of the recipient site, bone block harvesting, stabilization of the bone block at the recipient site, contour modification of the bone block after its stabilization, and primary wound closure. The author made important modifications to this procedure, which in long-term observations revealed positive effects of the treatment in terms of function and esthetics. The goal of these modifications was to create a stable biologic space in the defect enclosure for bone formation and minimize the negative effects correlated with autogenous bone block resorption.

The procedure was performed with a twice daily antibiotic prophylaxis (375 mg Augmentin, GlaxoSmithKline) that patients took 1 day prior to and 6 days after surgery. Patients were instructed to rinse with 0.1% chlorhexidine solution three times a day for 3 days before and 2 weeks after surgery. Surgery was performed under local anesthesia (4 to 6 mL 4% Ubistesin, 3M ESPE). In the first stage, the size and shape of the defect were assessed after first elevating the mucoperiosteal flap and removing the tooth root together with any inflammatory lesions of a chronic character (Fig 1). Stage two was to harvest the bone block from the chin using Piezosurgery (Mectron) with a saw-shaped insert (OT6, OT7; Mectron).

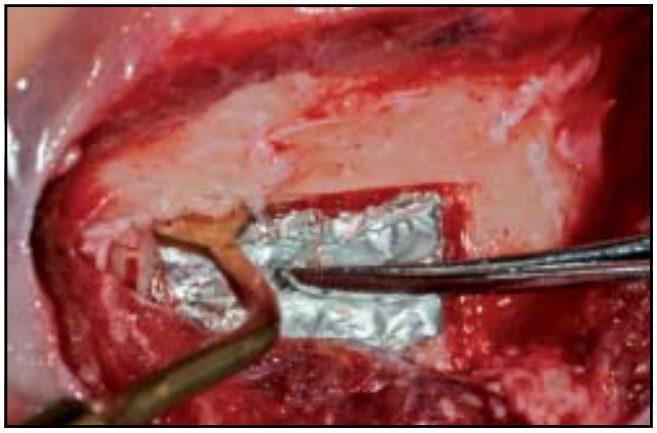


Fig 2 *Bone block harvested from the chin area with the same dimensions as the bone defect and marked with aluminum foil.*

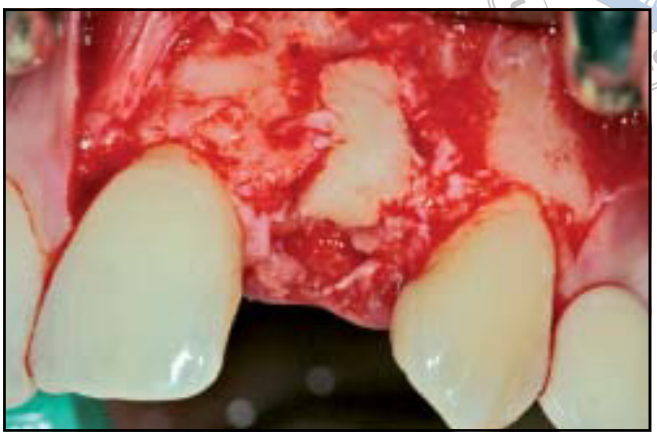


Fig 3 *Stable fixation of the bone block was achieved at the recipient site.*

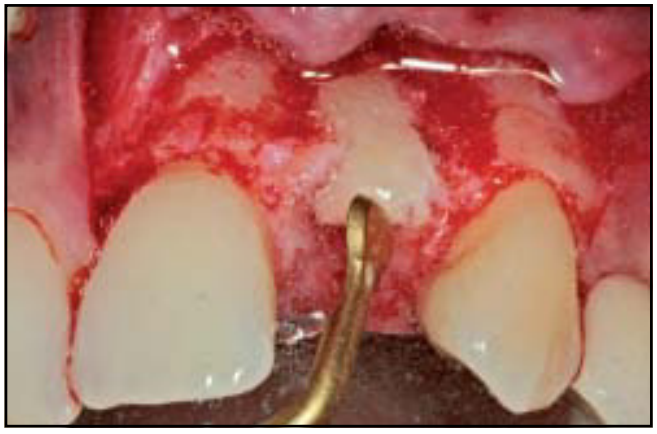


Fig 4 *Shaping of the cortical portion and adjustment of the contours of the bone block to the alveolar ridge after its stabilization in the recipient site.*

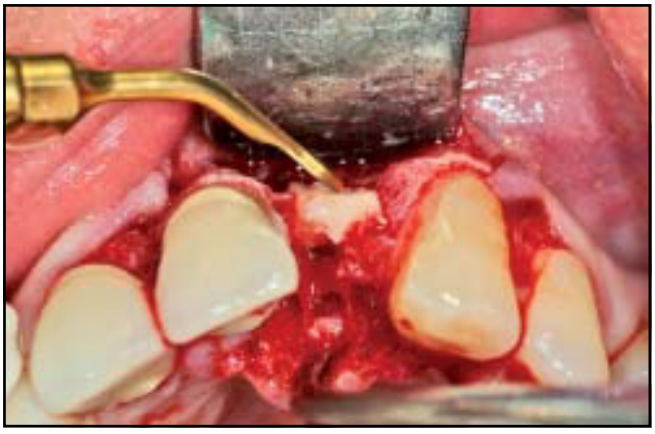
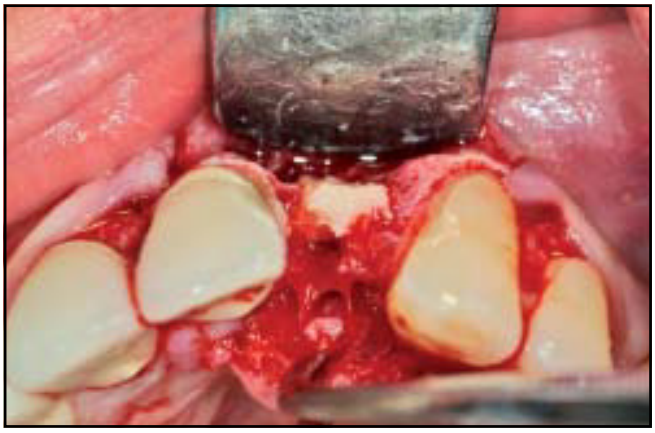
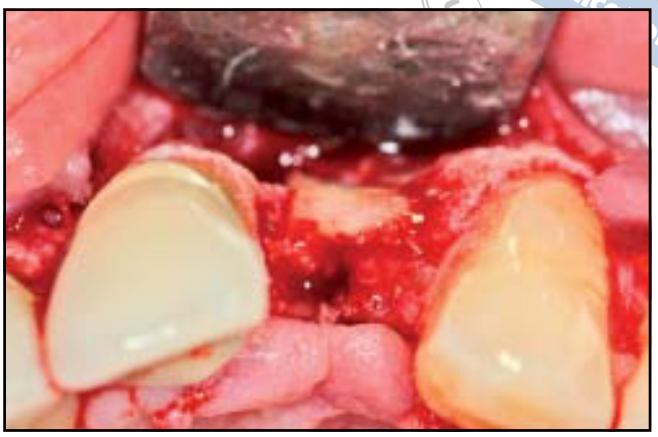


Fig 5 *The bone block was shaped and thinned using the Piezosurgery insert.*

The upper incision line in the bone was 5 mm below the mandibular incisor root apexes so as to minimize periapical injury. The shape and size of the defect were reproduced with the help of a template made from sterile aluminum foil (Fig 2). The bone incision was deep enough to obtain a corticocancellous block with an approximate thickness of 5 to 6 mm. The block was then compared with the geometry of the defect and the bone block itself, and the walls of the defect were prepared with the help of a Piezosurgery device so as to ensure that both elements matched closely in shape and size. The bone block was then wedged between the side walls of the bone defect. In three-wall defects where inlay-type blocks were used, such preparation of the contours ensured stable fixation for the bone block in the defect without the need for additional miniscrews or miniplates (Fig 3).

The next stage consisted of the final preparation and adjustment of the bone block to the contours of the alveolar ridge in the recipient site. Suitable Piezosurgery inserts (OP1, OP3) were used for this purpose (Figs 4 and 5). Effort was made to prepare the bone block in such a way that its external cortical surface represented a continuity





Figs 6a and 6b *Bone block in the recipient site* (left) *before and* (right) *after modification.*

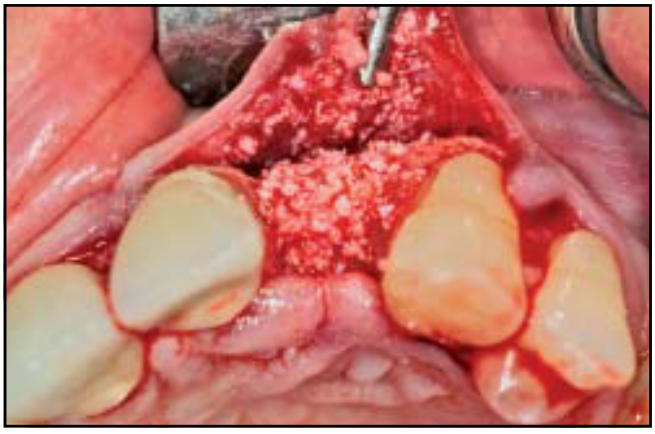


Fig 7 *Bone block and ridge defect filled and covered with Bio-Oss particles.*

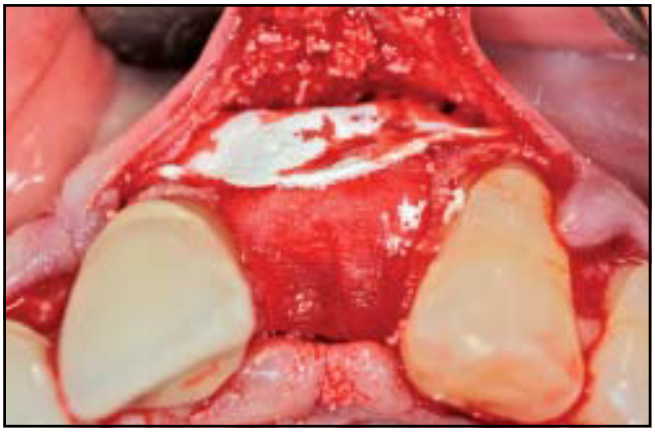


Fig 8 *Autogenous bone block and Bio-Oss particulate were covered with a Bio-Gide membrane.*

of the walls of the alveolar ridge. The thickness of the cortical layer of the bone block was simultaneously reduced (Figs 6a and 6b). The purpose of this procedure was to reduce both necrosis in the cortical portion of the block and graft resorption by facilitating revascularization of the thinner layer of the cortical bone. In clinical observation, a thickness of 2 to 3 mm for the cortical portion was sufficient to maintain the mechanical properties of the grafted block and sustain its stability in the regenerated defect. The gap that appeared between the block and base of the defect was filled with cancellous bone chips harvested from the bottom of the donor site and with spongious bone substitute particles (Bio-Oss, Geistlich). The bone block was covered with an external layer of Bio-Oss as a slow-resorbing material whose function was to compensate for the resorption of the autogenous bone (Fig 7). The regenerated area was secured with a Bio-Gide collagen membrane (Geistlich) to achieve better regenerative effects (Fig 8). The membrane was stabilized with titanium pins and horizontal or cross mattress sutures. After periosteal releasing incisions were made and flap extension was accomplished, the wound was closed

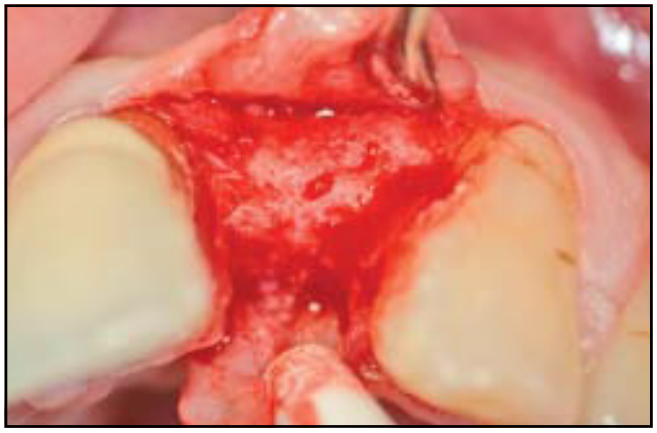


Fig 9 *The bone block was incorporated in the defect 4 months after regenerative surgery.*

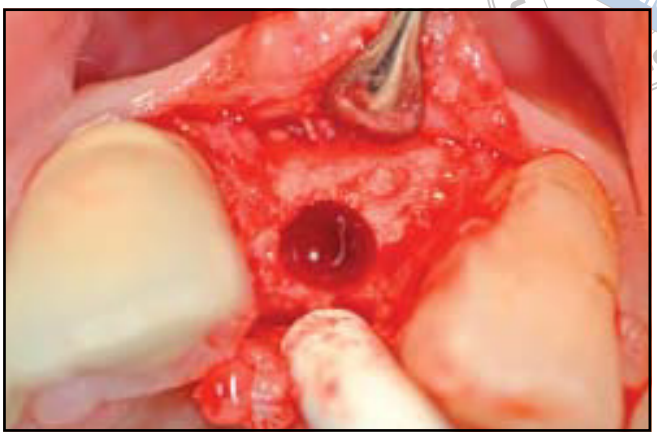


Fig 10 *Ridge morphology in the regenerated area prior to implant placement.*

tightly without pressure, and primary closure was achieved. The bone defect created during bone block harvesting in the donor site was filled with Bio-Oss particles and secured with a Bio-Gide membrane. Patients were given 800 mg of ibuprofen every 8 hours for pain management. Sutures were removed after 7 days. Veneers or acrylic/composite resin crowns were used as provisional restorations and were attached to neighboring teeth with the help of glass-fiber splints.

The healing process was uneventful, with no wound dehiscence observed. Local parasthesia in the chin was observed in two patients. However, it ceased 4 to 6 weeks after surgery. No other complications associated with a second surgical site were noted.

Results

Implants were placed 4 months later, after the shape of the regenerated region and the possibility of placing the implant in the proper position were assessed. The state of the soft tissue was satisfactory with regard to both the shape and width of the zone of the attached gingiva (≥ 5 mm).

Access to the surgical field was achieved through a midcrestal incision without any vertical incisions. The result of bone block healing was observed, with no border or difference noticeable between the grafted bone block and the surrounding host bone tissue of the recipient site (Fig 9). No separation was observed in the visible layer of the compact cortical region of the graft above the surface of the alveolar ridge, as was noted in bone block graft procedures performed without the modifications described previously. Drilling into the osseous bed for the implant revealed the correct morphology with a corticocancellous layer and good blood supply, which indicated that the bone graft had been properly revascularized and incorporated (Fig 10). Necrosis of the cortical bone was not observed in any patient. The implant was placed after achieving correct primary stability using 35 to 45 Ncm of torque. No breaking up or fragmentation of the cortical portion of the graft was observed during implant placement, which occurred in some patients undergoing procedures without modification. This was ad-

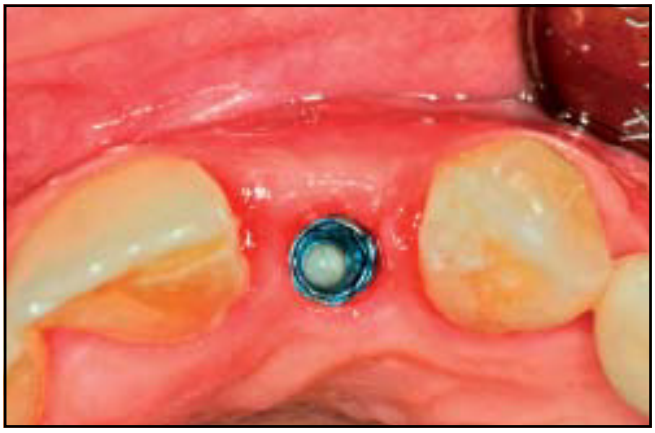


Fig 11 *Clinical view of the soft tissue and shape of the alveolar ridge after regeneration and implant placement.*

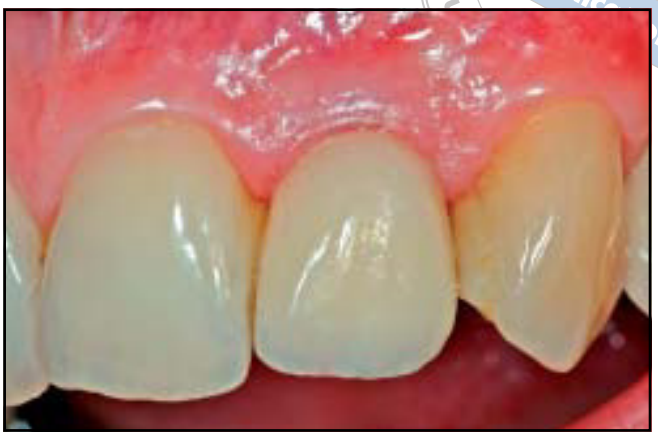


Fig 12 *Definitive implant-supported all-ceramic crown 7 years postsurgery.*

ditional clinical proof that the bone block graft had been incorporated properly.

During the osseointegration period, the same provisional crowns or veneers were used. After 4 months, the implant was exposed. During this procedure, the pedicle flap was moved from the palatal region in six patients for soft tissue augmentation on the buccal aspect of the alveolar ridge at the implant site. There was no need to perform additional procedures using a connective tissue graft from the palate because the regenerated bone structures offered sufficient support for the soft tissue to ensure a satisfactory esthetic effect. No implant was lost. After the implant was exposed, a new provisional acrylic resin crown was screwed onto the implant to ensure final modeling of the soft tissue and interdental papillae around the future definitive implant-supported ceramic crown. After 4 to 6 months of soft tissue conditioning, the correct contours of the gingival margins were achieved, and the space between the crowns and neighboring teeth had been filled with gingival papillae (Fig 11). The thickness, width of the attached gingiva (≥ 5 mm), color, and texture of soft tissue papilla presence were assessed by the surgeon and patient to be satisfactory. The complete ceramic crown was cemented on the implant abutment. Patients were followed up with after 6 months and yearly thereafter after the prosthetic phase. The implant-supported prosthetic crowns performed their function properly. No pathologies of the soft tissue were observed in the area surrounding the implants and prosthetic crowns. Radiographs were taken every year postsurgically and revealed a normal pattern of remodeling up to the first implant thread. No major bone loss around the implants was noted throughout the observation. All of the esthetic parameters for peri-implant soft tissue remained stable in observations over a period of 5 to 7 years (Fig 12).

Discussion

It is difficult to maintain the contour of regenerated areas requiring vertical and horizontal augmentation since they are susceptible to

pressure from the flap closure and removable provisional restorations. The use of nonresorbable titanium-reinforced barrier membranes, foil, or titanium mesh involves the risk of wound dehiscence[12] and subsequent extensive resorption of the regenerated bone tissue. Collagen barrier membranes have difficulty maintaining the contours of the regenerative site since they have low rigidity and shape memory and are subject to biologic degradation over the course of regeneration before the regenerated alveolar bone achieves shape stability.

The surgical procedure described in this paper uses corticocancellous block grafts. A definite advantage of autogenous tissue is the biologic compatibility of the graft material. In these blocks, the cortical portion was used as the appropriate scaffold for supporting soft tissue and maintaining the stability of the contours of the regenerated site.

One of the most serious problems associated with the use of bone blocks is their resorption at the recipient site. The literature shows variations of this resorption from 25% to 60%.[13–16] The donor site from which the autogenous bone is harvested is another important factor. These sites include intraoral (most commonly from the chin and retromolar area) and extracoronal locations (iliac crest, fibula, and ribs). Autogenous bone harvested from intraoral sites with the same embryologic origins undergoes less resorption compared with extraoral areas.[17] Moreover, the architecture of bone grafted from the chin into a recipient site possesses characteristics similar to the dense, hard bone tissue of the mandible and thus may maintain the stable contours of the regenerated area.[17]

On one hand, the cortical layer of the bone graft undergoes resorption at a slower rate than the cancellous portion.[18] On the other, the cancellous portion acts as a carrier for osteogenic cells in the recipient site, which facilitates the revascularization process and graft healing.[19]

The healing and incorporation of autogenous bone block grafts, ie, the phenomenon known as "creeping substitution," is described by Burchardt[20] as a biologic reconstructive process involving the gradual replacement of necrotic tissue with new vital bone tissue.

A purely cortical bone block is less likely to undergo revascularization than a corticocancellous block.[20] In connection with this, the nutrition of this part of the bone block is poor. Necrosis of the grafted tissue may occur as the cortical bone blocks heal.

The aim of the surgical method described was to create the best possible conditions for bone block incorporation. The bone block has to be properly stabilized in the site. The precise block harvesting and shaping using the Piezosurgery device allowed for a perfect match and stabilization of the transplanted bone block in the defect enclosure.

The most important characteristic of the cortical component is its mechanical property of maintaining contours. However, the thicker this layer is, the worse the conditions appear to be for revascularization.[20] The use of a Piezosurgery insert tip for precision shaping and thinning of the cortical layer after bone block stabilization was intended to create the best possible conditions for graft incorporation. The thin cortical layer of the transplanted block (2 to 3 mm) was replaced with new vital bone tissue after 4 months and maintained the contour of the regenerated site. Autogenous bone blocks, used as the biologic scaffold, served to reconstruct the buccal wall of the defect. The use of bone substitutes to fill the space between the bone blocks and defect walls, as well as an external layer to cover the graft material, together with resorbable collagen membranes was intended to compensate for resorption of the autogenous bone.[21] Simultaneously, the biomaterial layer acted as additional support and volume for the soft tissue after the regeneration process. The bone block served as a stable, biologic base for the biomaterial.

The use of Piezosurgery to prepare the osseous bed and make a precise incision in the bone tissue facilitates the healing process and reduces the inflammatory reaction while the graft is healing.[22–25] This modified technique with the use of Piezosurgery reduced the surgical time and impacted the final result. The modified version of this method made it possible to achieve better clinical outcomes in terms of function and tissue esthetics over long-term observations.

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