Horizontal Ridge Augmentation Before Placing Implants Using a Double-bone, Double Resorbable Membrane Technique: Two Clinical Cases

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Abstract

Guided bone regeneration is a well-established technique used for augmentation of deficient alveolar ridges. There is much evidence in the literature to support the success of this procedure. Multiple techniques have been introduced using various types of membranes and bone grafting materials. However, efficacious regeneration requires both a high level of technical skills and a thorough understanding of major biological principles. This case report is presented to illustrate a reliable approach to successful management of two different alveolar defects.

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Introduction

Implants have become an increasingly important part of restoring function and esthetics in edentulous spans. Although long-term success rates have added to the growing acceptance of dental implants, there are circumstances in which implants are not initially the best option. A horizontal and/or vertical deficiency of bone volume is shown to be the primary reason for avoiding implant treatment.[1]

Infection, trauma, periodontal disease, and tooth loss often cause a less favorable anatomical foundation for ideal implant placement. In these cases, reconstruction of the alveolar bone and soft tissue through a variety of regenerative surgical procedures is necessary. To obtain a functional and esthetic predictable implant-supported restoration.[2,3]

Guided bone regeneration is one of the techniques currently utilized to enhance bone formation in deficient sites. There is much evidence in the literature to support its success.[4,5,6] Multiple techniques have been introduced using various types of membranes and bone grafting materials.[7]

Achieving successful bone regeneration requires an appropriate barrier to exclude infiltration of non-osteogenic soft-tissue cells. Various materials are available as barrier membranes, classified as non-resorbables and resorbables. Good results can be achieved using non-resorbable membranes composed of expanded polytetrafluorethyelene and titanium-reinforced.

However, premature membrane exposure during the healing period, creating less favorable bone formation, can occur, and has been reported.[8]

They also require removal with a second surgical procedure, whereas the resorbable membranes do not. The resorbable membranes, which are made of collagen, achieve excellent tissue response, with less likelihood of premature exposures due to high tissue compatibility.[9]

The purpose of this paper is to present the clinical application of a double- layer technique using a mixture of xenogenic bone substitute and autogenous bone underneath a double layer of non-cross-linked outer and a cross-linked inner bioresorbable collagen membranes. Two cases will be illustrated and discussion of the rationale of this technique will be presented.

Case 1: Guided bone regeneration after a traumatic avulsion

Clinical procedure

A 63-year-old female patient presented with an esthetically compromised situation in the right central incisor area. The history of the present complaint goes back to 2005, when the patient presented acute bone loss and mobility. At that time, it was highly recommended to extract the tooth, before losing more bone and soft tissue. However, the patient refused to undergo the procedure. In 2007, the patient was brushing her teeth when she suffered spontaneous avulsion (Fig 1). She presented active periodontal disease, generalized gingival recessions, absence of the mesial papilla on tooth 12, and a thick gingival biotype. Moreover, there was an evident

Fig 1 Present situation of missing tooth 11 in full smile.

Fig 2 Present situation with lips retracted.

Fig 3 Preoperative close-up view of a large defect, caused by spontaneous avulsion.

Fig 4 Direct occlusal view from the defect.

Fig 5 Preoperative periapical radiograph shows an important loss of attachment in teeth 12 and 21.

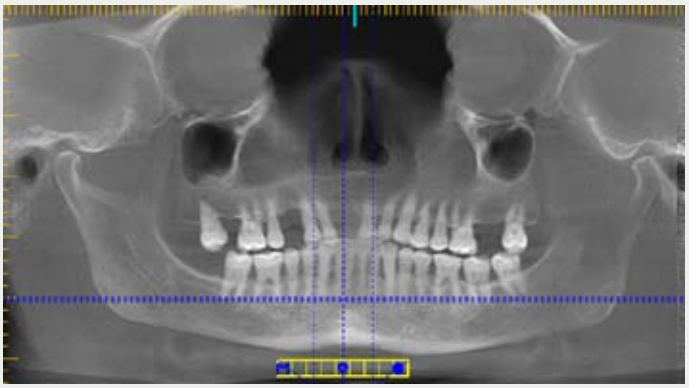

Fig 6 There is a generalized horizontal bone loss and teeth missing.

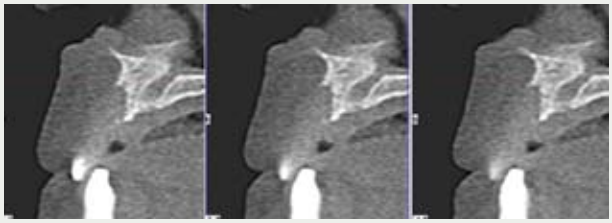

Fig 7 CT scan image (i-CAT Vision, Imaging Sciences Int.) shows a missing buccal bone plate.

lack of keratinized tissue and bone in the affected site presenting a class III Seibert defect (Fig 4). Infrequent dental care was recorded. Radiographically, loss of attachment in the area of teeth 12 and 21 was evident, several teeth were missing, and generalized horizontal and vertical bone loss was present (Figs 5–6). A CT scan image (i-CAT Vision, Imaging Sciences Int., Hatfield, PA, USA) shows a missing buccal bone plate in the area of tooth 11 (Fig 7).

Various alternatives were proposed and explained to the patient. However, some strong contraindications came up when screening the clinical findings. Based on clinical criteria and the patient's desires, after having explained the advantages and disadvantages of removable partial dentures, fixed partial prostheses, GBR procedures, and implants, a treatment plan was chosen.[10,11,12,13] (Please refer to the discussion for more detailed information.)

Treatment plan

As it was a priority to restore esthetics to the patient, the natural tooth 11 was sectioned and the crown was bonded to teeth 12 and 21 (Fig 8). At this time, a bone sounding was performed and the measurements recorded (Figs 9 and 10). A treatment plan was developed.

The treatment plan sequence was as follows:

- Impressions were taken to obtain a stone model for the waxup in order to simulate the ideal 3D position of the implant.14 Moreover, this analysis helped in the reconstruction of the missing bone (Fig 11).
- A complete periodontal evaluation and an appropriate periodontal treatment were mandatory in this case, prior to surgery. The patient was placed on a very strict hygiene maintenance program.15
- A full-thickness flap was reflected. All the granulation and soft tissue over the defect was removed (Figs 12 and 13). The buccal bone plate was perforated to obtain the stem cells. A first layer of autogenous bone, which was harvested from the surroundings with a bonescraper (Divisione Medicale Meta, Reggio Emilia, Italy), was placed to completely cover the defect. A second layer of Bio-Oss® spongiosa granules 0.25–1 mm (Geistlich Pharma AG, Wolhusen, Switzerland) was placed on top of the first layer (Fig 15). The first cross-linked resorbable membrane (Ossix™ Plus, OraPharma Inc., Langhorne, PA, USA) was trimmed and adapted to cover the bone graft (Fig 16). A second non-cross-linked resorbable collagen membrane (Bio-Gide®, Geistlich Pharma AG) was placed covering all the defect (Fig 17). It is important to place this barrier the opposite way to how the company recommends.

Fig 8 The natural crown of tooth 11 was bonded to 12 and 21.

Fig 9 Bone sounding shows from the point of the papilla to the bone peak 4 mm of periodontal attachment.

Fig 10 Bone sounding shows a lost periodontal attachment of about 7 mm.

Fig 11 Waxup.

Fig 12 A full-thickness flap was reflecting. Notice the horizontal and vertical bone loss.

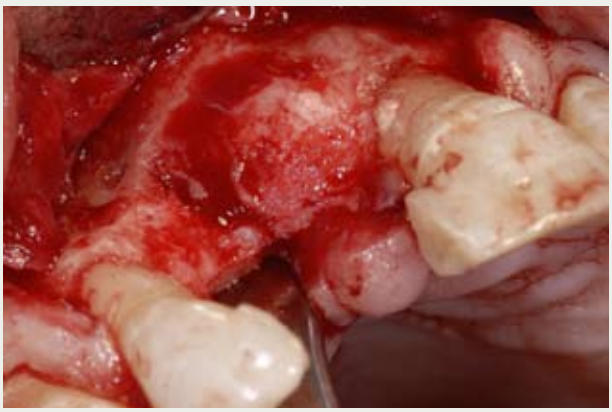

Fig 13 The granulation tissue was removed from the defect.

Fig 14 The defect is completely covered with autogenous bone.

Fig 15 Second layer of deproteinized bovine bone material (Bio-Oss, Geistlich Pharma AG).

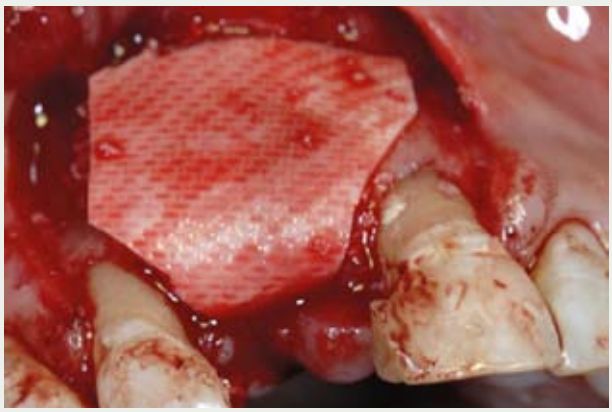

Fig 16 The first membrane, a cross-linked bioresorbable membrane (Ossix Plus), was trimmed and adapted to cover the bone graft.

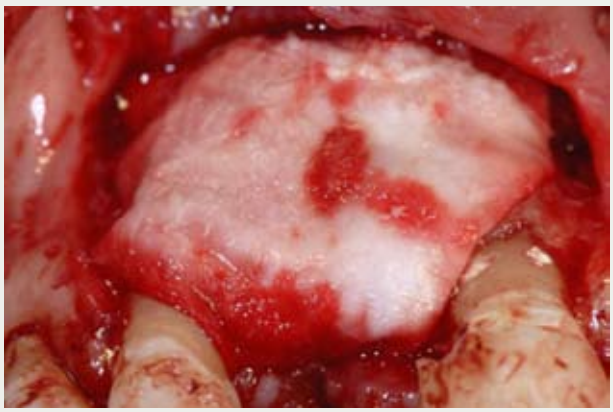

Fig 17 A second, non-cross-linked resorbable collagen membrane (Bio-Gide) was placed covering all the defect.

Fig 18 Prolene 6-0 suture (Ethicon) holding the membranes in place.

Hurzeler et al reported successful results when placing the membrane upside-down; the rough surface created an interlock with the soft tissue, avoiding early or late wound dehiscences.6 To fix the membranes and avoid any kind of movement of them, a Prolene 6-0 suture (Ethicon, Johnson & Johnson, Langhorne, PA, USA) was placed (Fig 18). A new 15C surgical blade (Hu-Friedy, N. Rockwell, Chicago, IL, USA) was used to release the periosteum and avoid any tension. The flap was precisely re-adapted and sutured with Gore-Tex® CV5 (W.L. Gore & Associates, Inc., Flagstaff, AZ, USA) and Prolene 6-0 (Ethicon) (Fig 19). Finally, the crown of the natural tooth was bonded back.

- Amoxicilin 750 mg (Clamoxil 750 mg, Normon S.A., Madrid, Spain) was prescribed three times per day during 1 week. In order to reduce swelling caused by the surgical procedure, Ibuprofen 600 mg was prescribed. The patient was instructed to rinse twice daily for 15 days with 0.2% chlorhexidine digluconate solution. Time when sutures were removed.
- Postoperative healing was uneventful and the membranes remained completely covered. Eight months later, an implant (Brånemark MK III, Nobel Biocare AB, Goteborg, Sweden), 3.75 mm x 11.5 mm, was inserted in the newly formed bone. It was important to establish an adequate 3D position.6 (Figs 19–20).
- Four months later, a little incision was made to uncover the implant and connect an impression pin. A deliv-

Fig 19 After periostal releasing, the flap was repositioned and sutured.

Fig 20 Postoperative healing was uneventful and the membranes remained completely covered.

Fig 21 An implant, 3.75 mm x 11.5 mm (Brånemark Mk III), was inserted.

Fig 22 A small incision was made to uncover the implant, and an impression pin was attached to the fixture head.

Fig 23 A final custom zirconium abutment and an all-ceramic crown (Procera) were delivered. The contour of tooth 21 was improved with composite to close the diastema and help with the papilla formation between 11 and 21.

Fig 24 Occlusal view of the final crown and the improved contour of the buccal bone.

Fig 25 The final natural result fulfilled patient expectations.

ery of a final zirconium abutment and an all-ceramic crown (Procera™, Nobel Biocare AB) fulfilled the patient's expectations. To improve the formation of the papilla between teeth 11 and 21, the contour of 21 was reshaped with composite (Renamel Microfill, Cosmendent® Inc., Chicago, IL, USA) to close the diastema (Figs 22, 23, 24, and 25).

- A final periapical radiograph was taken to check the fit of the abutment, crown, and composite restoration.

Case 2: Guided bone regeneration after a traumatic extraction

A 43-year-old female patient presented complaining about the appearance of two porcelain fused-to-metal crowns in teeth 13 and 12 (Fig 27). Also, she was unhappy about the presence of a black space underneath the interdental contact between teeth 12 and 11, and the facio-lingual bone depression existing under the pontic area of 12 (Fig 28). Clinical evaluations demonstrated a healthy patient, a non-smoker, with a failing crown in 13 and a pontic replacing tooth 12, which was extracted 10 years ago due to extensive caries. Periodontal evaluation showed a thin gingival biotype, localized gingivitis in the area of tooth 13, and a class I Seibert bone defect. Radiographically, caries was observed in the anterior tooth section.

The final treatment approach was decided from among different alternatives. Based on the patient's desires, a removable partial denture was not taken into consideration. The advantages and disadvantages of a fixed partial prosthesis were explained for this specific case. Also, complex procedures, such as GBR, implant, and an all-ceramic crown, were mentioned in detail[14,15,16,17,18] (please refer to the discussion for more detailed information).

A treatment plan was developed, which consisted of periodontal therapy and maintenance, GBR in the area of tooth 12, an implant, and an all-ceramic crown. Also, an improvement to her smile was planned, consisting of eight ceramic crows from 15 to 25. A waxup

Fig 26 Postoperative radiograph demonstrating integration of the implant, and fit of the abutment, crown, and composite.

Fig 27 The patient complains about the crowns in 13 and 12.

Fig 28 Full anterior view showing that it was not only the failing bridge that was to blame for this patient's esthetic problems.

Fig 29 Crowns were removed. A class I Seibert bone defect is present.

was mandatory in this case as well as a surgical stent (Figs 31, 32, and 33).

A CT scan (i-CAT vision, Imaging Sciences Int.) was taken to evaluate the amount of bone graft necessary to place an implant (Fig 34). The surgical procedure followed the same steps described in Case 1 (Figs 35–40). No complications were present in any of the surgical procedures (Figs 41 and 42). After 12 months of treatment, 10 all-ceramic

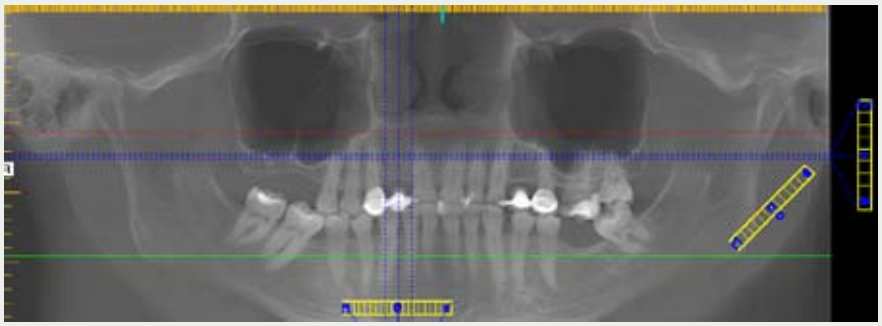

Fig 30 Panoramic radiograph shows the area of the defect and some leaking composites.

Fig 31 A CT scan (i-CAT Vision, Imaging Sciences Int.) was taken to evaluate the amount of bone available to place an implant.

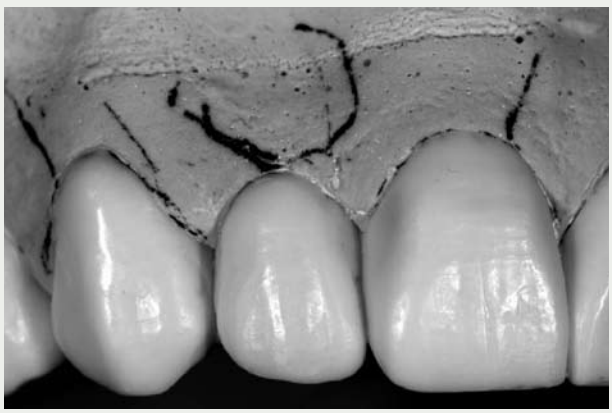

Fig 32 Close-up of the waxup.

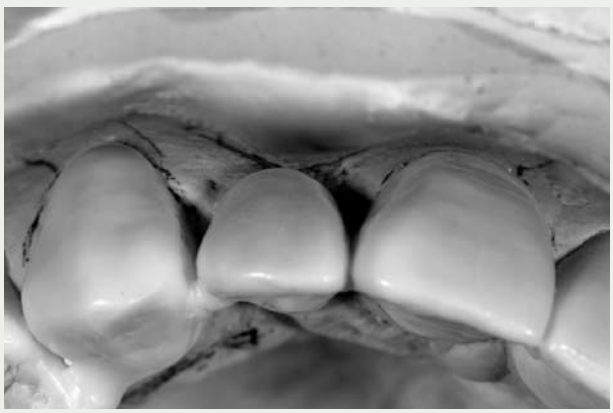

Fig 33 Close-up occlusal view of the waxup. Notice the class I Seibert defect.

Fig 34 A full-thickness flap was raised, showing an evident lack of bone horizontally.

Fig 35 A surgical stent made from the waxup illustrating the amount of bone to reconstruct.

Fig 36 Some bone perforations are made to obtain stem cells.

Fig 37 First layer of autogenous bone and DBBM (Bio-Oss, Geistlich Pharma AG) on top (double-bone).

Fig 38 First collagen membrane in place (Ossix Plus,OraPharma Inc.). Another non-cross-linked collagen membrane (Bio-Gide, Geistlich Pharma AG) would be placed on top to cover the graft (double-membrane).

Fig 39 Final suturing with e-PTFE monofilament suture (Gore-Tex, W.L. Gore & Associates, Inc.).

Fig 40 Picture taken 14 days after surgery. The suture was removed.

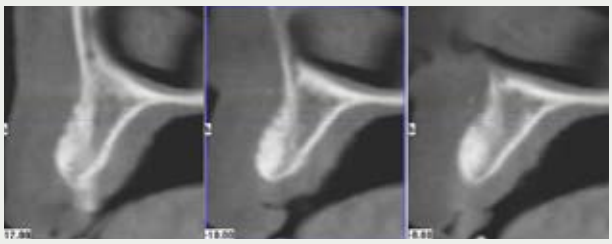

Fig 41 A CT scan (i-CAT vision, Imaging Sciences Int.) was taken 7 months after the GBR procedure to evaluate the new bone available, before placing the implant.

Fig 42 An implant (Nobel Active NP, Nobel Biocare AB) was placed 7 months after GBR. Four months later, the implant was uncovered and an impression was taken.

crowns (Procera, Nobel Biocare AB) were cemented over natural teeth and a zirconium abutment (Figs 43, 44, and 45).

Discussion

Although an alternative form of treatment could have been employed to treat these two cases, the double-bone, double-membrane technique presented has demonstrated predictable and successful treatment outcomes.[9]

The main principle of using a first layer of autogenous bone on top of the defect was to provide the recipient site with live osteoblasts and progenitor stem cells that proliferate and bridge the gap between the graft and the treated site. The second layer was deproteinized bovine bone mineral. This osteoconductive bone mineral matrix will adequately support the collagen membrane. Also, it will enhance the regeneration process by serving as a matrix for angiogenesis and osteogenesis.

The rationale of using two different membranes was determined from the time of biodegradation and the affinity for the soft tissues. Scientific evidence suggests that, for bone regeneration procedures, a long-lasting barrier effect is desirable.[19] The cross-linked membrane went directly on top of the bone graft. Friedmann et al have found qualitative bone regeneration comparable to the standard e-PTFE non-resorbable membrane. When combined with the same mineral, it was reported that collagen layers could still be observed over a six-month period.[20] Finally, a non-cross-linked collagen barrier membrane,

placed with the rough surface against the flap, totally covered the site being grafted (outer layer). The scientific evidence shows that soft tissue consists, for the most part, of collagen. Therefore, healing of the gingiva works best with natural collagen. As soon as natural collagen structures are altered chemically (e.g. cross-linking), the tolerability of the membrane is affected negatively. Tal et al found that cross-linked membranes were associated with a higher incidence of tissue perforations.[21]

Therefore, the principle of this technique is to combine the biological and mechanical properties of both barriers using a Bio-Gide membrane (Bio-Gide, Geistlich Pharma) with optimal behavior towards soft tissue and a long-lasting Ossix Plus membrane (Ossix Plus, OraPharma) for the deproteinized bovine bone material. The function of the outer layer is to maintain primary wound closure, and of the inner to regenerate bone tissue. However, histological data and long-term evaluations are still needed to prove the presented concept.

These cases could have been solved through alternative methods. In Case 1, however, the patient presented chronic periodontal disease. That was an important factor in deciding the appropriate treatment option. An RPD was not taken into consideration; in this case, the retention was going to be achieved through clasps, which might cause plaque formation on the buccal surface. Besides, the unesthetically, unharmonious appearance of the teeth is unavoidable if clasps are placed in visible frontal areas.[10,11] A zirconia oxide ceramic bridge would involve at least two teeth as abutments (12 and 21). Mechanically,

Fig 43 Final zirconia abutment and all-ceramic crown (Procera, Nobel Biocare AB) on the implant replacing tooth 12.

Fig 44 All-ceramic crowns (Procera, Nobel Biocare AB) were placed from 15 to 25.

Fig 45 Postoperative radiograph demonstrating integration of the graft and implant in the maxillary treatment site.

these teeth had been affected by periodontal disease. Therefore, long-term prognosis of this type of rehabilitation would be unpredictable.[12] To consider GBR, implant placement, and restoration with a ceramic crown, a complete evaluation was accomplished and a periodontal therapy was mandatory prior to the GBR surgery. One month after this procedure a re-evaluation was done. No signs of active periodontal disease were present. A very strict maintenance program was designed to avoid any relapse of the disease condition.[13] Only then was the surgery programmed. In Case 2, the dilemma was to make a fixed partial bridge or an implant restored with a ceramic crown in the area of tooth 12, despite the fact that a full upper rehabilitation had been planned. The main problem arose when a class 1 Seibert defect was detected following the analysis of the facio-lingual ridge profile. An ovate pontic was considered. Nevertheless, some contraindications to this treatment were observed. A thorough assessment of the edentulous ridge is compulsory in order to determine the extent of the deficiency in the hard and soft tissues relative to the desired tooth position.[22] In order to create the illusion of the pontic emerging from the ridge, a sufficient amount of tissue must be present. If not, a preprosthetic surgical augmentation procedure is indicated,[16] as presented in this case. Therefore, a GBR procedure was chosen to obtain an adequate amount of bone volume and to reconstruct the bone defect.

According to the scientific evidence, the presence and level of interdental papillae is highly influenced by the level of the interdental bone crest on the adjacent teeth. The papilla can be predictably re-established or maintained if the distance between the interdental bone peak and the apical aspect of the contact area between the teeth is 5 mm or less.[15,13] Extrapolating these findings to Case 1, where the periodontal attachment had been damaged by the periodontal disease, papilla formation between teeth 12 and 11 was considered an impossible task, due to the absence of papillae and interproximal bone lost from the beginning of the treatment. However, papilla formation between teeth 11 and 21 was predictable. It was important to maintain an adequate interproximal distance between the implant and the adjacent tooth. In addition, the prosthetic improvement of the distance from the contact point to the interdental bone at tooth 21, and the presence of a very thick biotype, were the key factors to optimize the result.[17] Case 2 presented a different challenge. However, a favorable outcome in this case was supported by the literature. Clinical findings, like thick biotype, absence of periodontal disease, and correct periodontal attachment in the adjacent teeth, increased the possibilities for success.[14,15,17,18]

Conclusion

Guided bone regeneration is a proven technique. The primary disadvantage with GBR techniques using non-resorbable membranes is the requirement of a second invasive surgical procedure to retrieve the membrane. In addition, non-resorbable membranes often require premature removal secondary to overlying soft tissue dehiscence and wound

infection. Also, the complexity of this technique makes it a unique procedure for very skillful operators. The combined therapy of a slowly resorbable collagen membrane (Ossix Plus) and a highly soft-tissue-compatible membrane (Bio-Gide), as well as an underlying mixture of a biocompatible, osteoinductive natural bone mineral material and autogenous bone, with all its properties, allows GBR to occur. To obtain reliable results, many important factors have to be considered prior to the surgical and prosthetic phase. The double-bone, double-membrane technique has achieved the major principles of GBR. Two illustrative cases have been presented.

Acknowledgments

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AUTHOR QUERIES:

1. The notes have been renumbered. Author please check carefully that the superscript numbers in the text relate accurately to the endnotes.

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Please note that Figs 2, 3, 14, 21, 26, 29, and 30 are not referred to in the text. Author to please check all figure numbers carefully against the images.