Chapter 3

Dental Implants Placements with Simultaneous Guided Bone Regeneration

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Abstract

One of the most important prerequisites for achieving and maintaining successful osseointegration is the presence of a sufficient volume of healthy bone at recipient site. This includes not only bone of sufficient height to allow the insertion of an implant of appropriate length but also a ridge of sufficient crest width. When the implants placed in a site with a missing buccal bone wall, this will lead and based in different clinical studies, a greater rate of soft tissue complications and /or a compromised long-term prognosis. To avoid increased rates of implant complications and failures, most of the clinical studies suggested that sites with inadequate bone volume either should considered local contraindications to implant placement or should be locally augmented with an appropriate surgical procedure to regenerate the bone and allow implants placements.

The aim of this chapter is to provide a brief summary and different clinical cases of these surgical procedures and clinical applications for implant placement with simultaneous Guided Bone Regeneration for the bony defect which can be corrected by a staged event, with the implant placed after regeneration takes place or in a one-stage approach which, implants positioning associated with a guided bone regeneration (GBR) technique to minimize the risk complications and to ensure predictable and stable long term results.

Introduction

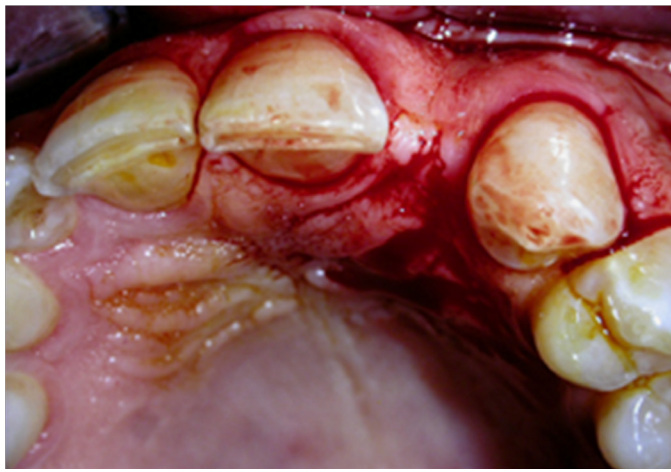
For a dental implant to function optimally, it must be placed in a biologically acceptable and restoratively driven position. Hence, the three-dimensional positioning of the dental implant is crucial to a successful treatment outcome. However, with the loss of teeth, the alveolar bone remodels and decreases in dimensions at varying rates and degrees [1]. Dental Implantology has been considered as one of the most accepted treatment modalities for rehabilitation of missing teeth following trauma. The deficiency of the remaining supporting

bone volume, though, is the primary concern in certain situations for avoiding implant placements [2]. The solution to this problem lies in re-establishing the ridge volume consistent with the prosthetic design and with suitable load-bearing lamellar bone for long-term stability of the implant [3]. These days more implants are placed with simultaneous GBR procedures that use barrier membranes combined with bone graft, bone substitutes, or both. The primary objective of GBR procedure is the achievement of successful bone regeneration in the defect area with high predictability and low risk complication. Secondary objectives are to obtain successful outcomes with the least number of surgical interventions, low morbidity for patients, and reduced healing periods [4]. This chapter will focus on the dental implant placement with simultaneous GBR based on the classifications of the alveolar ridge width and the considerations for implant-driven treatment which includes different literature reviews and surgical cases from my respectable clinics.

Bone Collapse After Tooth Loss

It has been shown that although bone collapse after tooth loss is usually three dimensional (3D), the horizontal deficiency or width loss develops to a larger extent [5,6]. Alveolar width deficiency can represent loss of buccal (labial) cortical or medullary bone, or both (Figures 1 and 2).

Deficiency of the buccal cortex (cortical plate) after tooth extraction can present significant difficulty in implant reconstruction [7,8]. The buccal cortical plate with a thickness, 2 mm next to an implant appears to have a higher risk of subsequent resorption [9]. A variety of implant-driven bone augmentation techniques for the deficient alveolar bone have been proposed [10-12]. Four of these techniques are frequently performed: (1) guided bone regeneration (GBR)/particulate bone grafting [3,4]; (2) onlay (veneer) block bone grafting with intraoral sources, such as chin, ramus, posterior mandible, zygomatic buttress, and maxillary tuberosity [15-17]; (3) ridge split/bone graft procedure [8-20]; and (4) alveolar distraction osteogenesis [21-23]. Most of these techniques are designed to improve horizontal bone loss before or simultaneously with dental implant placement.



(A) : Occlusal view

(B): Labial view

Figure 1: Alveolar width deficiency can represent loss of labial, cortical bone, or both.

(A): Occlusal view

(B): Labial view

Figure 2: Alveolar width deficiency can represent loss of buccal cortex, crtical plate , or both.

Alveolar Ridge Width (Bone defect) Classifications Required Dental Implant Placement with Simultaneous GBR

Buser reported different decision criteria for a simultaneous GBR procedure [4], which help the clinician to aid in the decision-making process:

- The implant must be placed in a correct three-dimensional position from both a functional and an esthetic point of view.

- It must be possible to achieve primary stability in this specific position.

- The peri-implant bone defect must have a favorable defect morphology to allow predictable bone regeneration of the defect area.

Park et al in their random controlled trial which included 22 patients wanted to check the importance of using a barrier when GBR is carried to cover exposed threads of dental implants [24]. Patients were divided into 3 groups; In group 1, the allograft was covered with a collagen membrane. In group 2, the allograft was protected with an acellular dermal matrix. In group 3, no membrane was used. Six months later, a 48 % loss of the graft was observed in group 1 in comparison with a 42 % loss in group 2 and a 66% loss in group 3. Based on this study as well as on others papers (Donos and Chen et al) [25,26], we can suggest that the application of an occlusive membrane minimizes the resorption rate of the graft.

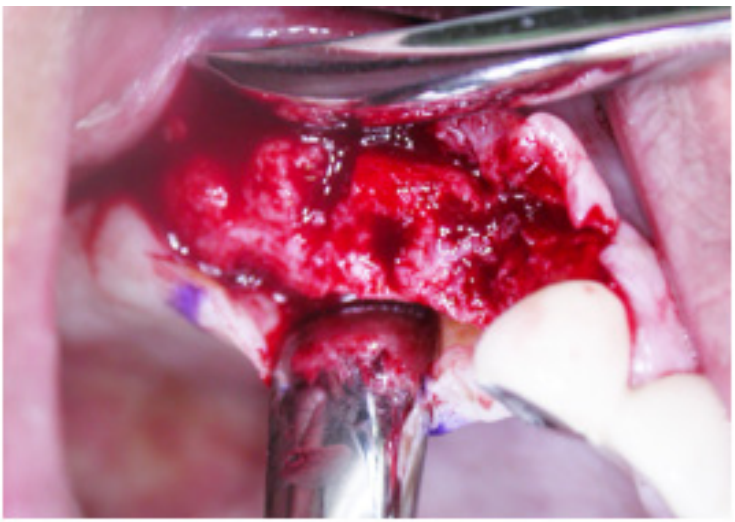
The main indication of GBR use as simultaneous approach is to treat dehiscence- and fenestration-type defects. The majority of studies used combinations of bone grafts and barrier membranes to promote bone regeneration in peri implant defects.

Surgical Procedures and Clinical Applications for Implant Placement with Simultaneous GBR

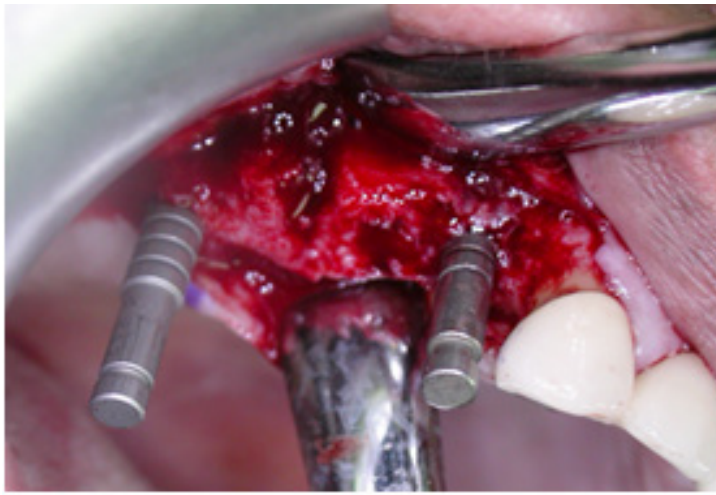
All reports to date describe in one way or another four categories of defects [27].

Extraction Wounds

The discrepancy of these problems and their related treatment schedules requires a determined privilege to establish our expected procedures. It must be considered that some problems are reliant upon bone regeneration at the time of implant placement (simultaneous) (Figure 3), and others are best served by staged events separated by enough time to allow bone maturation (Figure 4) [28,29].

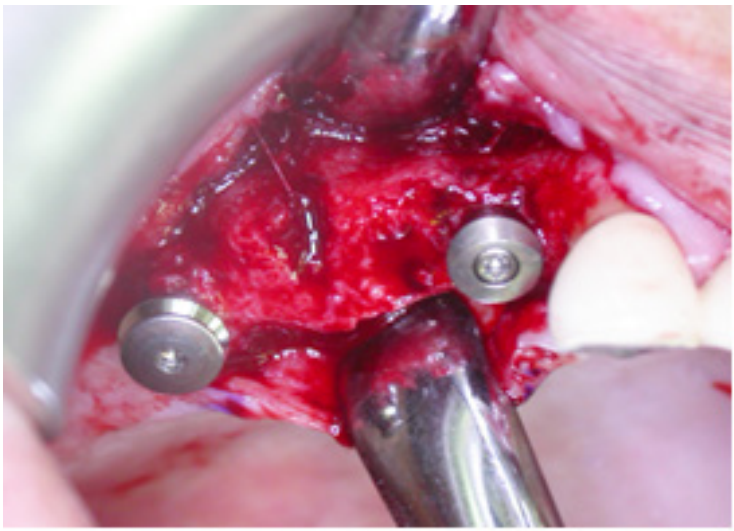


(A): After tooth extraction

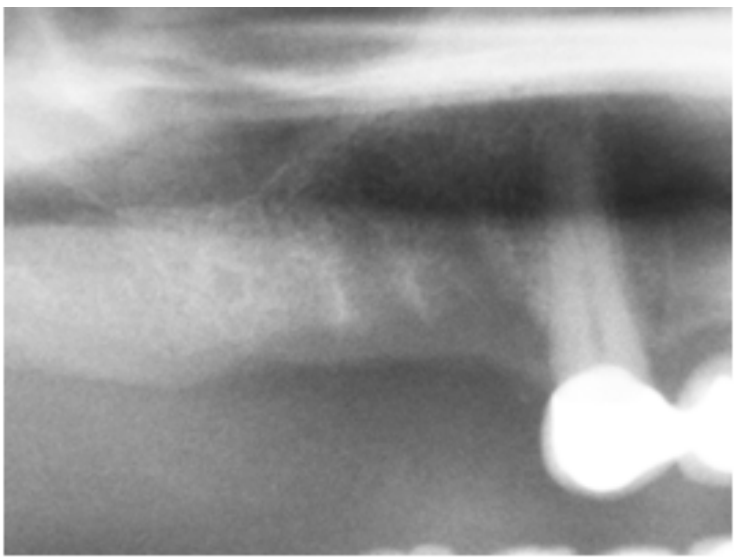


(B): Socket preparation for implants placements

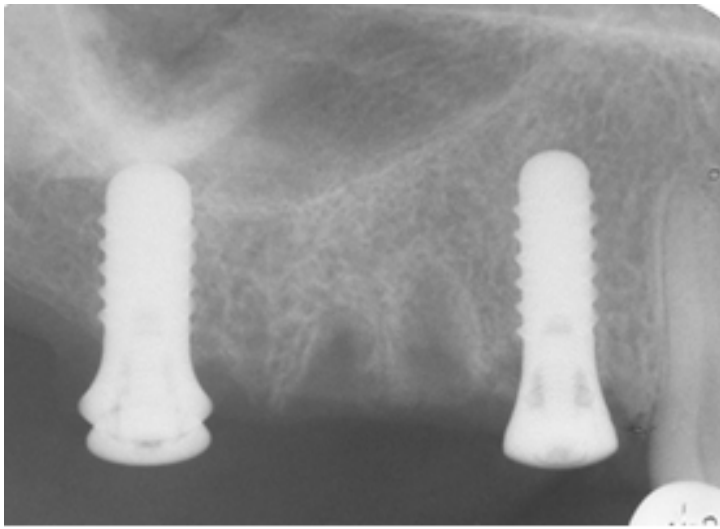
(C): Implants placements into fresh extracted



(D): Bone graft was placed in the defect area



(E): Radiograph for the area after tooth extraction



(F): Implants placements into fresh extracted and prepared socket

Figure 3: Implants placements into fresh extracted sockets with GBR procedures.

Many studies have looked at the results of ridge dimension following tooth extraction after the use of an intra-socket graft with either an absorbable or nonabsorbable membrane, compared to extraction alone without grafting. Sockets that were preserved with graft and membrane on average lost 2.6 mm less ridge width and 1.2 mm less ridge height when compared to sockets that were not grafted. Maxillary sites lost more than mandibular sites, and most ridge resorption occurred on the buccal aspect of the ridge [30]. With that in mind, does every extraction socket need to be grafted? The answer is no. The typical modified protocol use is based on A Simplified Socket Classification and Repair Technique [31].

Classification when existing tooth is still present and the protocol has modifications from the original suggestions and takes into

consideration the geographic location of the tooth, albeit anterior or posterior as well as biotype (thick vs. thin):

Type 1 socket—buccal plate present; soft-tissue present, meanwhile the protocol can be modified to:

Type 1a. (Thick biotype, and buccal plate is present): NO GRAFT (which rarely for posterior teeth due to the pig socket there, and may be for view anterior teeth such as lower central incisors, and upper and lower lateral incisors).

Type 1b. (Thick biotype, anterior tooth, and buccal plate present): Collagen dressing

Type 1c. (Thick biotype, anterior or posterior, and buccal plate present): Bone graft

Type 2 socket—buccal plate missing; soft-tissue present, meanwhile the protocol is bone graft +/- membrane

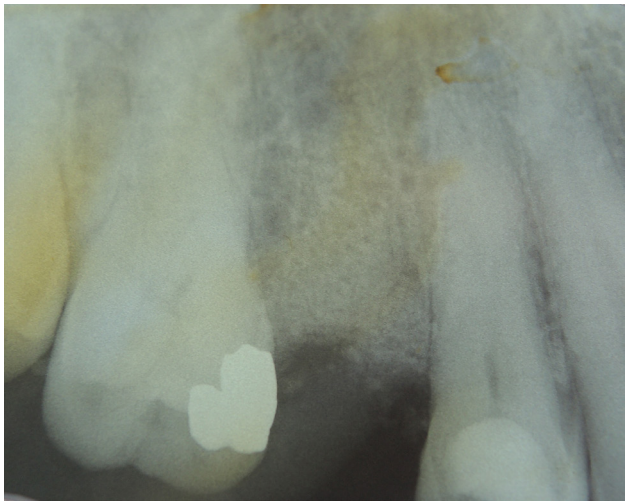
Type 3 socket—buccal plate missing; soft-tissue missing, meanwhile the protocol bone graft + membrane + biologic agent (if keratinized tissue is less than 2 mm, add a soft-tissue graft).

Tinti and benfenati reported in their study that, an intact envelope of bone housing means that the extraction walls are totally present (Figure 3).

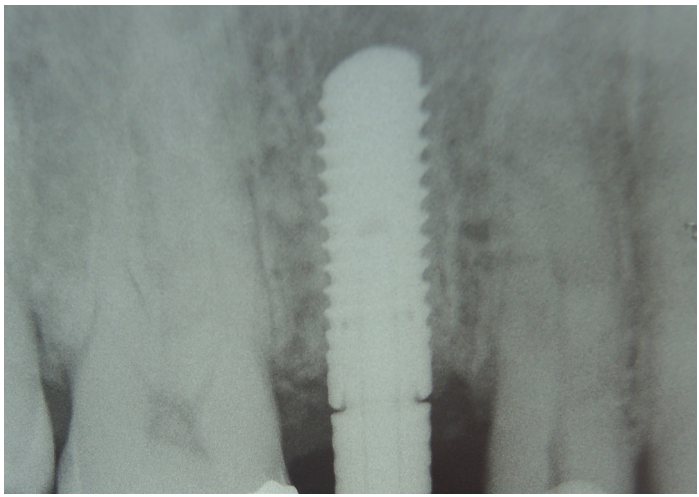
The loss of some or most of this bone is pertinent, as the protective mechanism necessary for clot stability is damaged and implant site development may require a regeneration effort (Figure 4). This description is further applicable when an implant is placed and not completely surrounded by bony walls. Extraction socket defects are thus categorized as Class I or II. In Class I extraction sockets, the envelope of bone is intact and the implant resides within it (Figure 3). In Class II extraction sockets, the envelope of bone is not intact and the implant is not completely surrounded by bony walls, but resides within the outer extent of the envelope of bone (Figure 4) [32].

(A): After tooth extraction

(B): Intra-socket graft immediately after tooth extraction



(C): Three months after Intra-socket graft



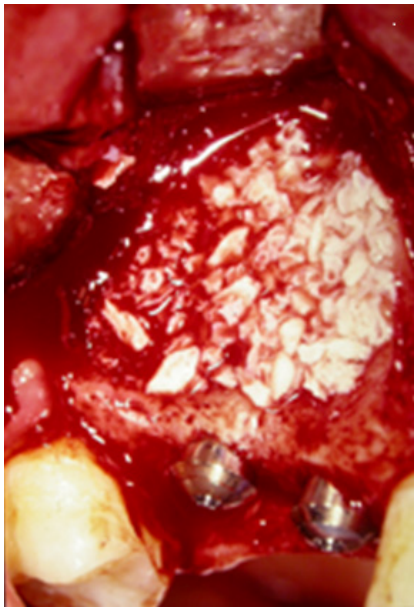
(D): implant placement after bone maturation

Figure 4: Radiograph for staged events separated by enough time to allow bone maturation.

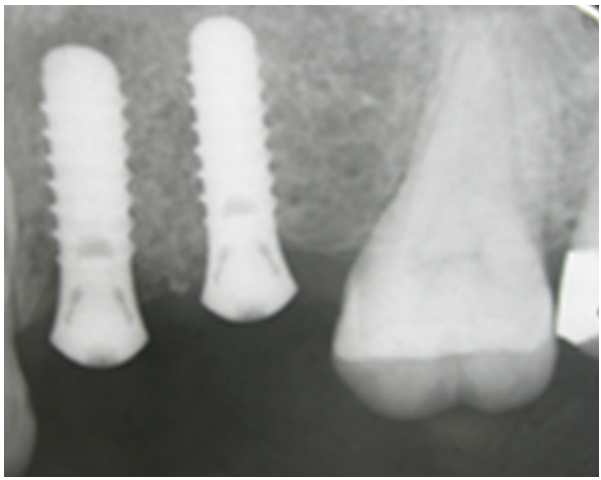
Fenestrations

A fenestration is a vestibular or linguopalatal defect as an expression of a bone thickness deficiency that creates partial exposure of an implant that is completely surrounded by bone. In Class I fenestrations, the implant surface penetrates the wall of bone by an insignificant amount and is located within the envelope of bone (Figure 5). In Class II fenestrations, there is a convexity, and a significant portion of the implant is exposed outside the envelope of bone for reasons of restorability (Figure 6).

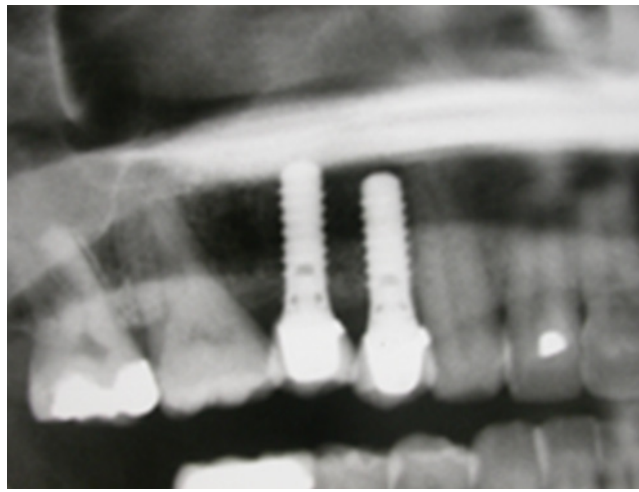
(A): In class II fenestration implant surface penetrates the wall of bone by an insignificant amount and is located within the envelope of the bone



(B): Allogarft bone are positioned to cover the exposed threads

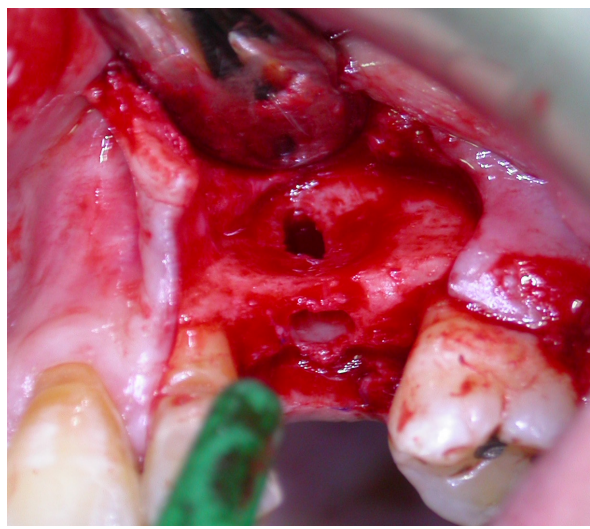


(C): Four months after GBR

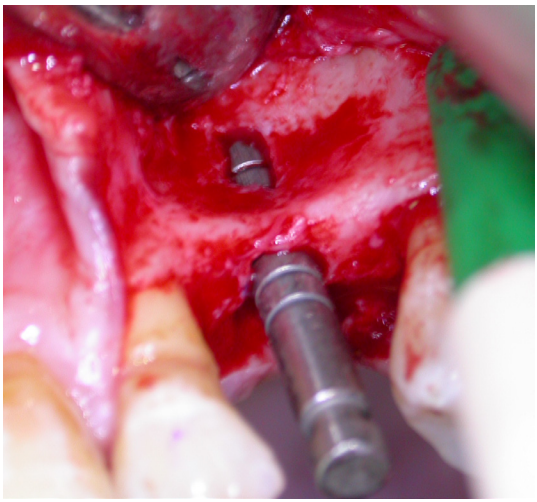


(D): Implant supported PFM crowns

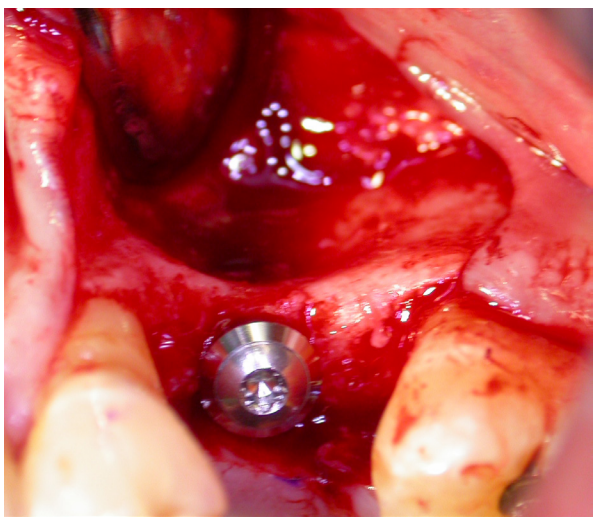
Figure 5: Radiograph



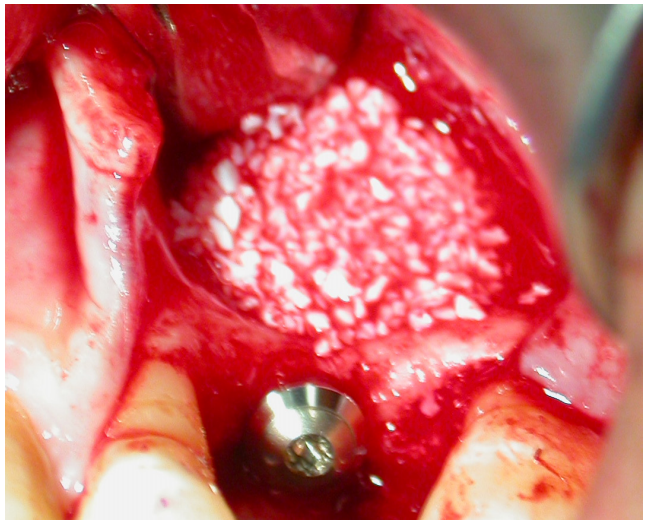
(A): Socket preparation for implants placements



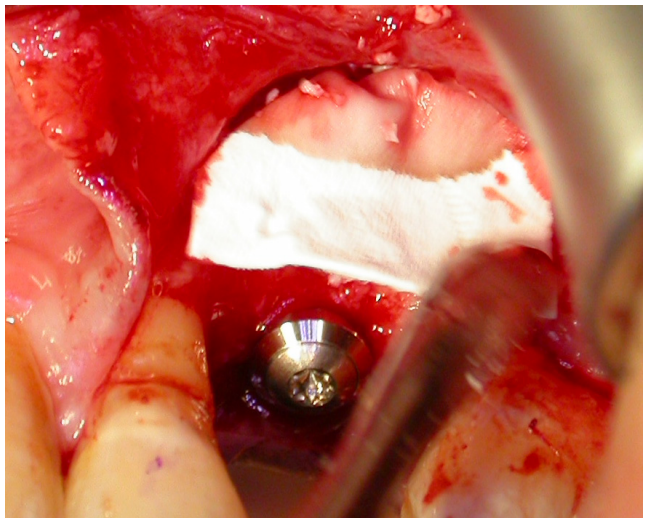
(B): Depth gauge or implant guidance



(C): Implant placed into the prepared socket



(D): Bone graft was placed in the defect area



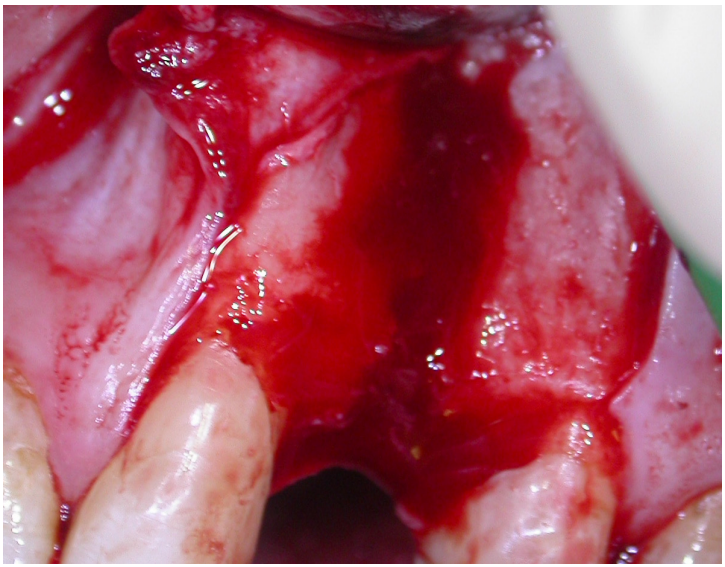
(E): Collagen membrane covered the grafted and implant areas

Figure 6: Class II fenestrations.

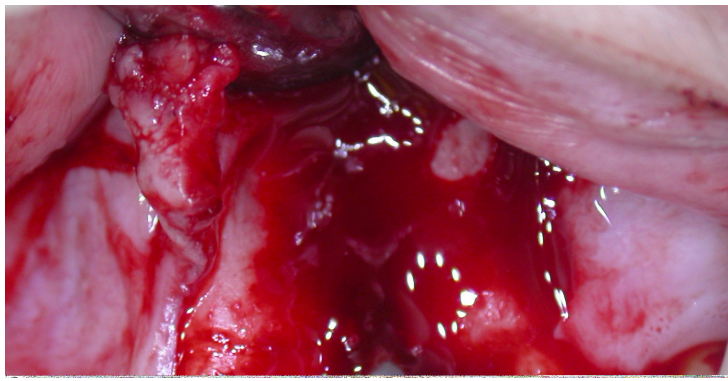
This bony defect can be corrected by two approaches: (1) a staged event, with the implant placed after regeneration takes place (Figure 4); or (2) implant positioning associated with a guided bone regeneration (GBR) technique, using allograft or autogenous bone chips and a barrier membrane, in a one-stage approach if the implant can be placed at an acceptable angle (Figure 3, 6) [32, 33].

Dehiscences

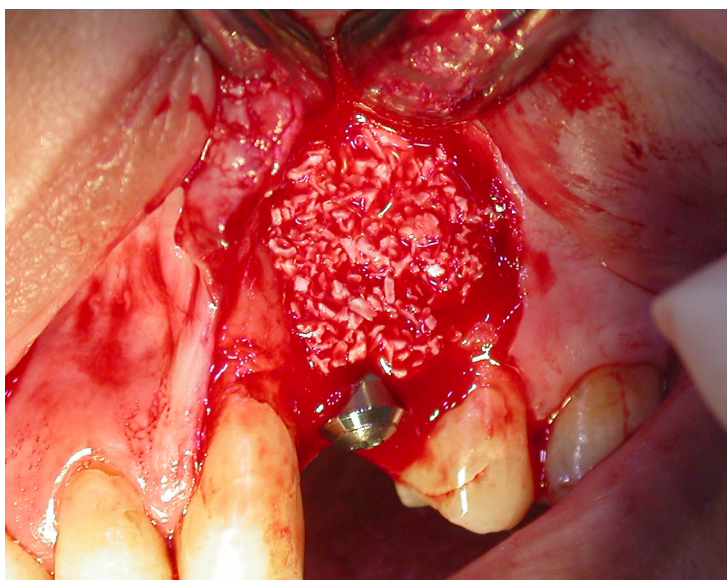
This vestibular or linguopalatal defect is an expression of a bone thickness deficiency <50% that exposes the vestibular surface of the implant from its head in an apical direction. In a Class I dehiscence, the implant surface resides within the envelope of bone (Figure 7, 8).



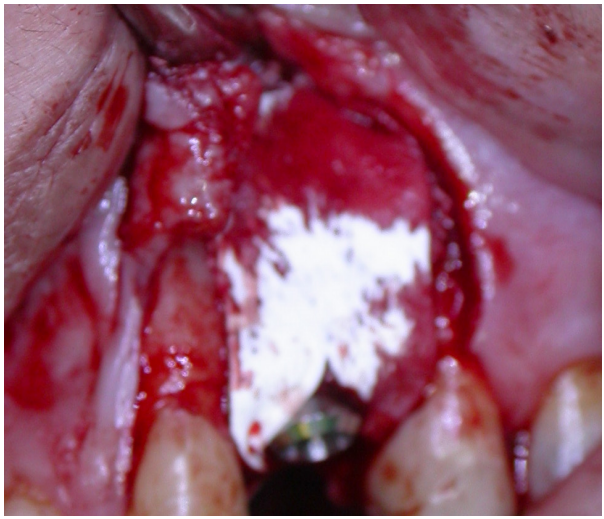
(A): In class I dehiscence there is, a convexity, and a significant portion of the implant is exposed within the envelope of bone.



(B): <50% for apical portion of the implant is exposed its head in an apical direction

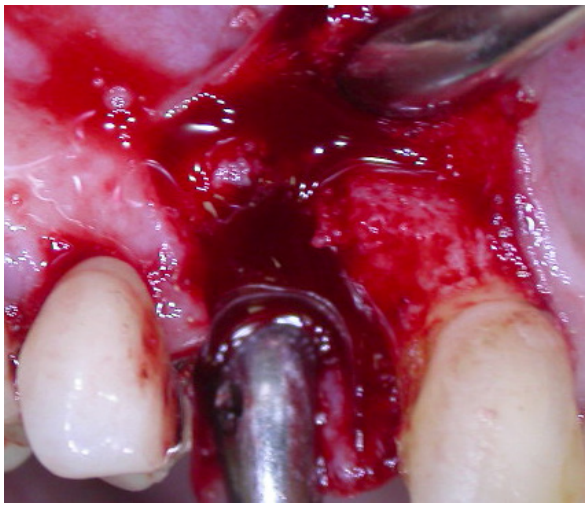


(C): Implant placement with Simultaneous GBR

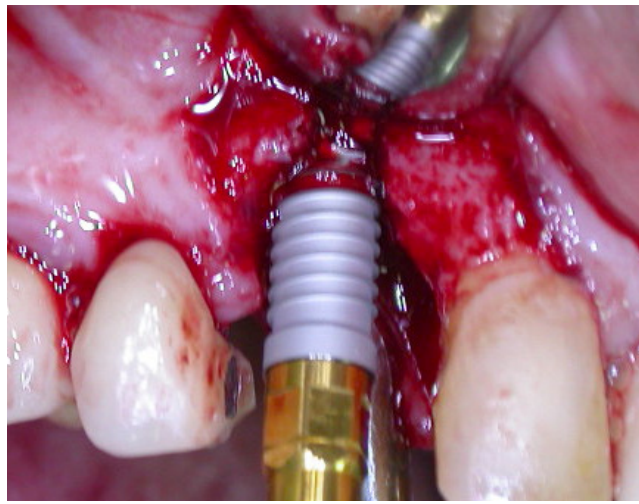


(D): Resorbable collagen membrane covered the grafted and implant area

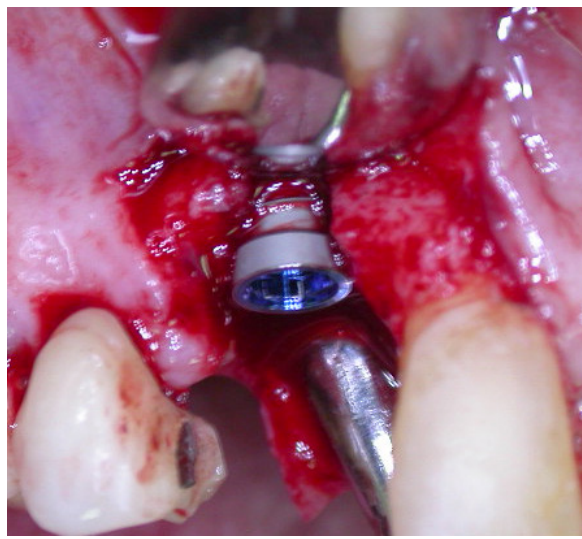
Figure 7: Class I dehiscence



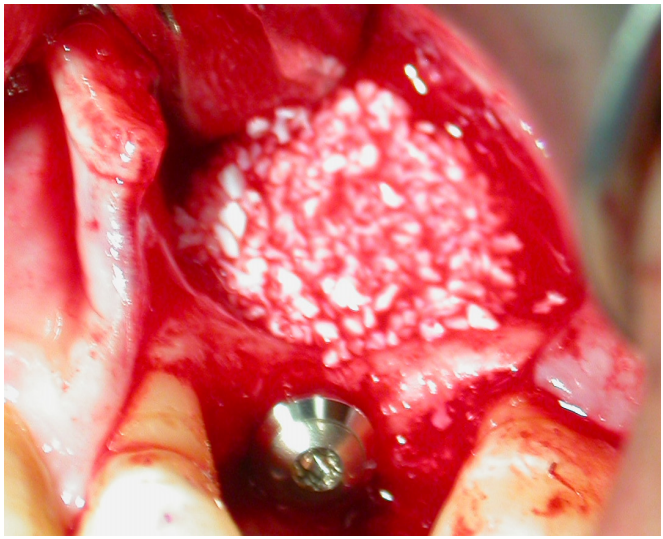
(A): class I dehiscence



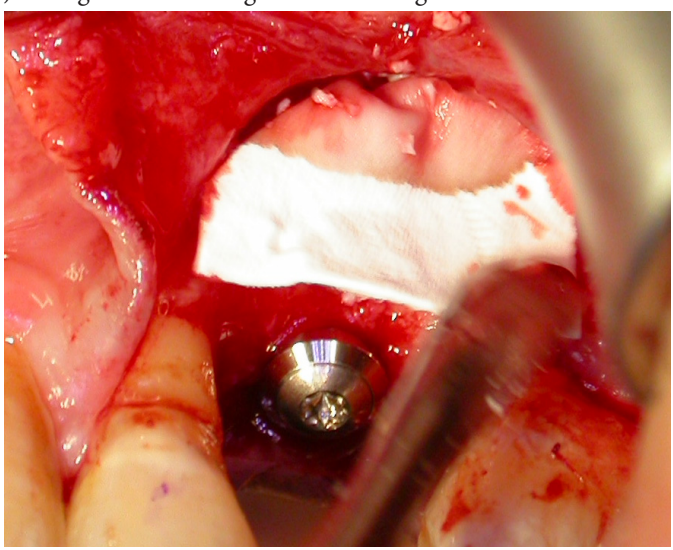
(B): Implant was inserted within the envelope of bone



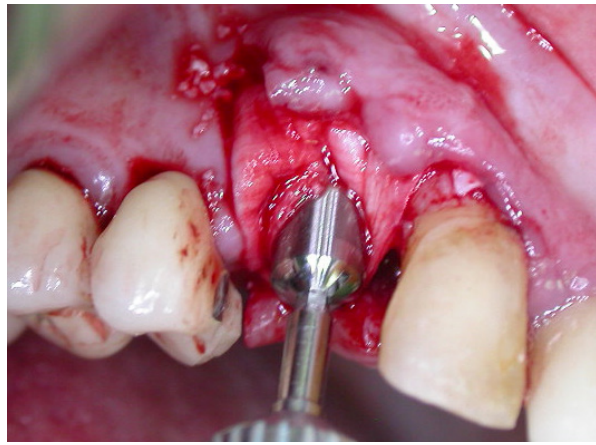
(C): <50% for apical portion of the implant is exposed its head in an apical direction



(D): Autogenous and allograft were bone grafts were collected



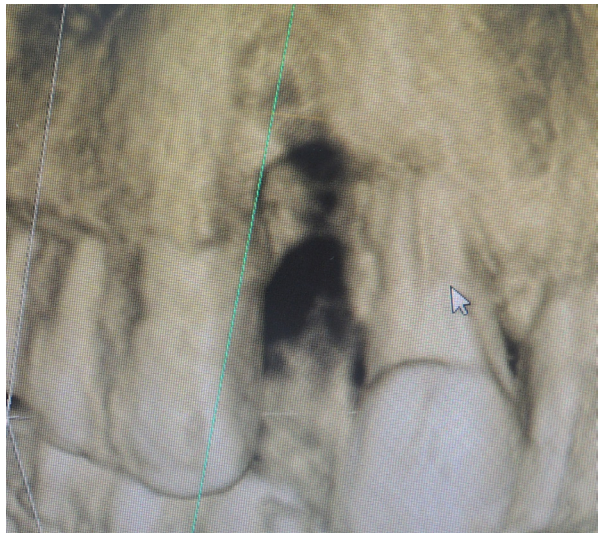
(E): Implant placement with Simultaneous GBR



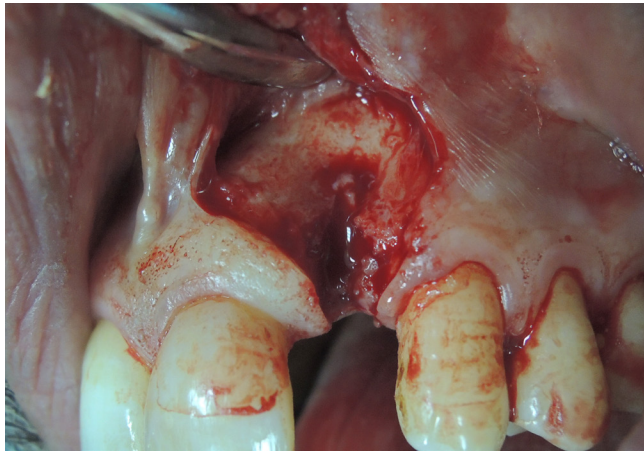
(F): Resorbable collagen membrane covered the grafted and implant areas

Figure 8: Another case for Class I dehiscence.

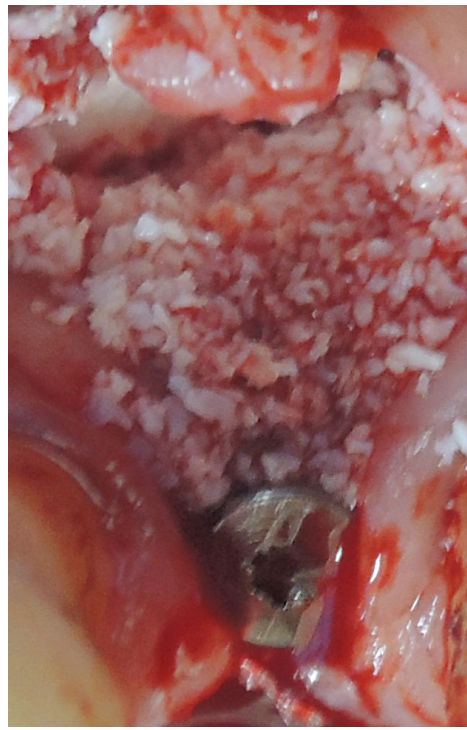
(A): Radiograph for the area 3 months after traumatic extraction



(B): Digital Radiograph and 3-D Imaging



(C): Labial view for the defect area



(D): Implant placement with Simultaneous GBR

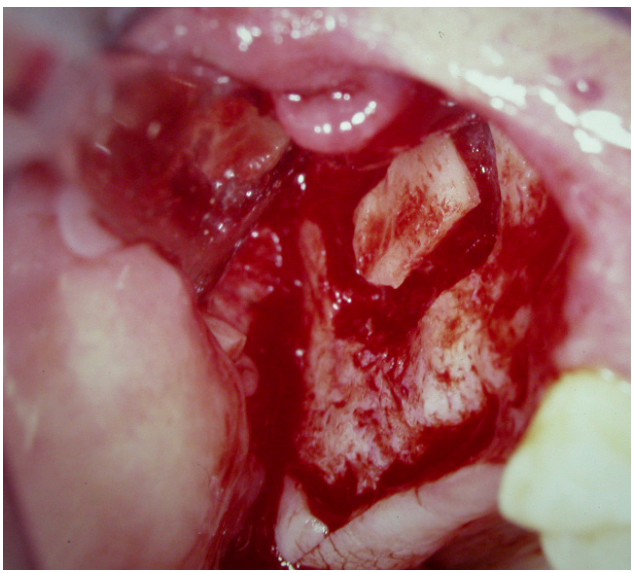
Figure 9: Class II dehiscence.

In a Class II dehiscence, the implant surface resides outside the envelope of bone (Figure 9). The treatment options for this type of defect are very similar to those reported for fenestrations [32, 34].

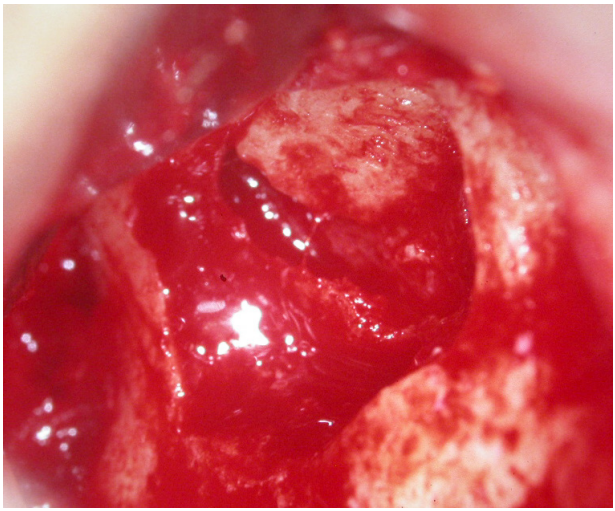
Sinus Augmentation Application

The posterior maxilla creates a unique challenge when minimal bone height remains inferior to the sinus floor. The inadequate bone volume often encountered is a result of combination of ongoing maxillary sinus pneumatization and normal post-extraction bone atrophy.

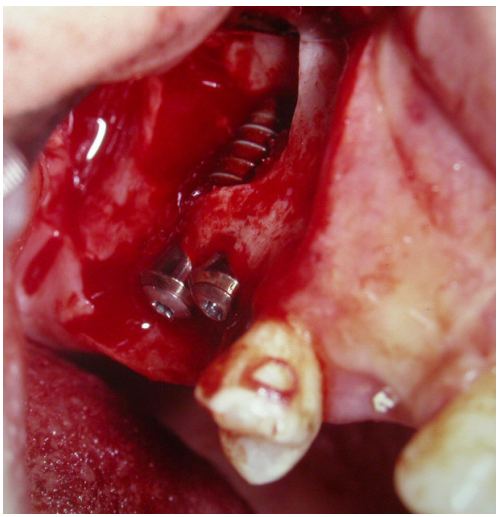
The residual ridge height was measured in the edentulous posterior maxilla, and 43% of the proposed implant sites had > 4 mm of bone crestal to the sinus [35]. To compound the challenges in this area further, the posterior maxilla has a poorer bone quality compared to the mandible, with the highest percentage of type IV bone [36]. Implant therapy in the posterior maxilla often is accomplished using shorter length implants. When an unfavorable crown/root ratio is anticipated, augmentation of the alveolar bone height should be considered. In the absence of an intraoral component of vertical ridge deficiency, augmentation of the maxillary sinus floor through a modified posterior Caldwell-Luc procedure may be performed with a direct lateral window approach sinus augmentation procedure either with simultaneous implants placement as one stage (Figure 10), or with 1st GBR then after few months with implants placements as two stages (Figure 11) [37-39].



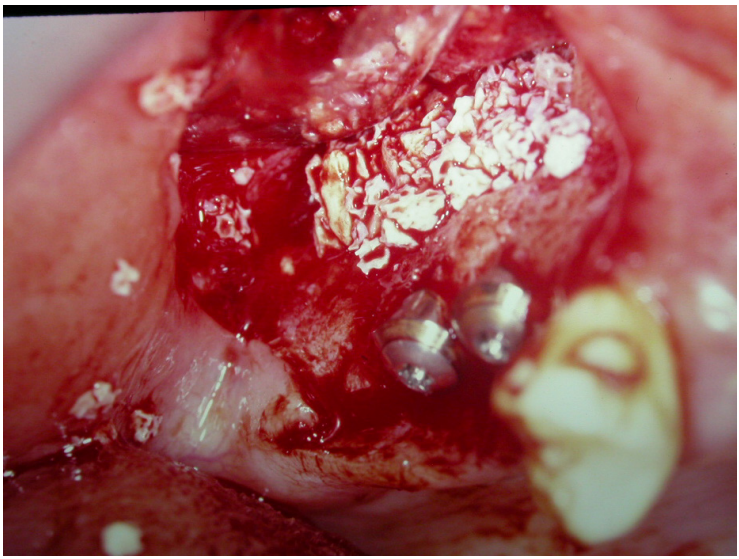
(A): Lateral Window SFE with one stage: Preparation to elevate the sinus floor



(B): Elevation of the trap door and sinus membrane.

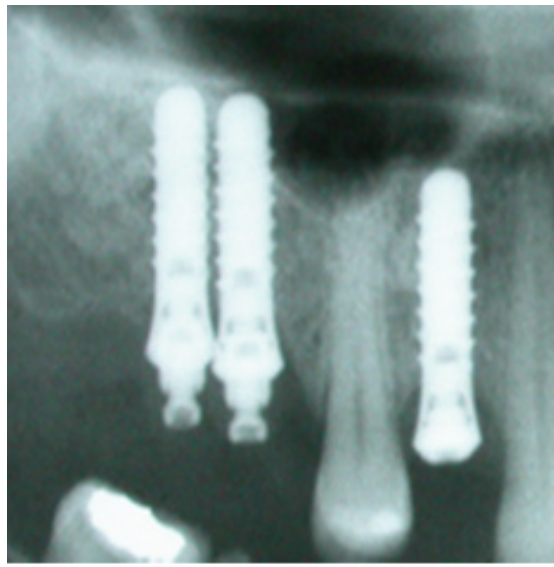


(C): Both implants were placed with good primary stability

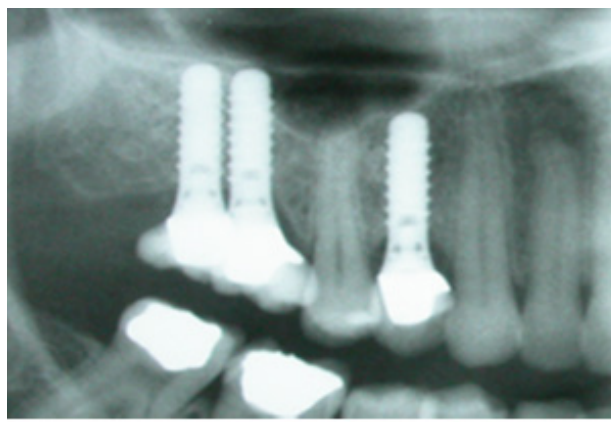


(D): The fenestration defect was repaired by Bio-Oss granules which were placecd over the implant surface for contour augmentation

(E): Radiograph before the procedure

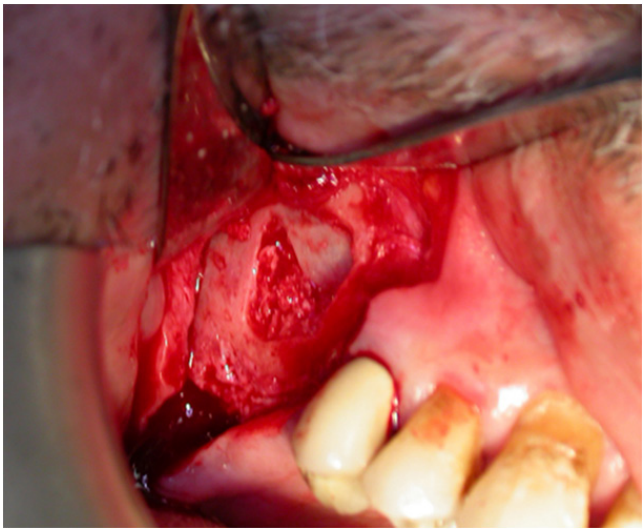


(F): Radiographs 5 months after surgery for the right maxillary site, demonstrating stable peri-implant condition

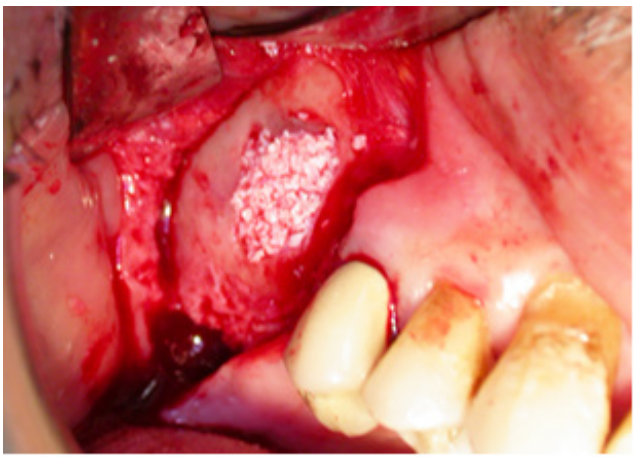


(G): Final prosthodontic restorations

Figure 10: A direct lateral window approach sinus augmentation procedure with simultaneous implant placement as one atge.

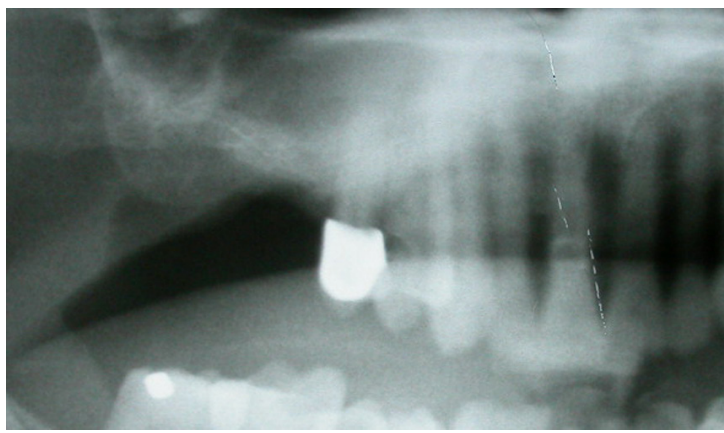


(A): The composite graft in the created defect following elevation the schneiderian membrane

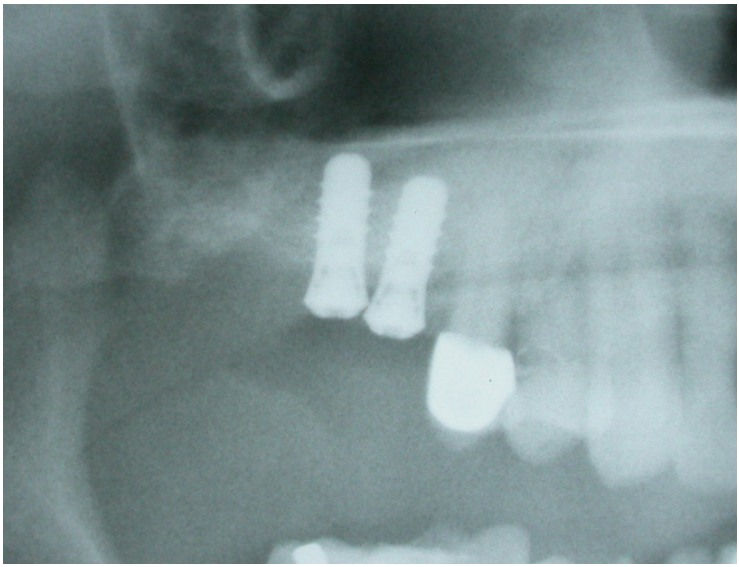


(B): Bio-Oss granules were placed over the composite graft for contour augmentation

(C): The bone grafts were covered with collagen membrane



(D): Postoperative radiograph for the 1st stage of lateral Window SFE



(E): Postoperative radiograph for the 2nd stage of lateral Window SFE

Figure 11: Guided bone regeneration as one stage, then after few months with implants placements as 2nd stage.

Horizontal Ridge Deficiencies

It has been shown that although bone collapse after tooth loss is usually three dimensional (3D), the horizontal deficiency or width loss develops to a larger extent [40,41]. Alveolar width deficiency can represent loss of buccal (labial) cortical or medullary bone, or both. Deficiency of the buccal cortex (cortical plate) after tooth extraction can present significant difficulty in implant reconstruction [42,43]. The buccal cortical plate with a thickness ,2 mm next to an implant appears to have a higher risk of subsequent resorption [44]. A variety of implant-driven bone augmentation techniques for the deficient alveolar bone have been proposed [45,46]. Most of these techniques are

designed to improve horizontal bone loss before or simultaneously with dental implant placement.

Different studies reported that the use of autologous grafts exhibit the highest success rates amongst these and autogenous bone grafts are considered the gold standard because their osteogenic, osteoinductive and osteoconductive properties maximize the success of graft incorporation [47,48].

In this section will be reported the techniques to improve horizontal bone loss simultaneously with dental implant placement with different reported surgical cases with either autologous or artificial bone grafts.

Tinti and benfenati reported in their study that, The vestibular or linguopalatal defect is characterized by a bone thickness deficiency, with subsequent exposure of > 50% of the implant diameter [32]. In a Class I HRD, the exposed implant surface (> 50%) resides within the envelope of bone (Figure 12 (A)).

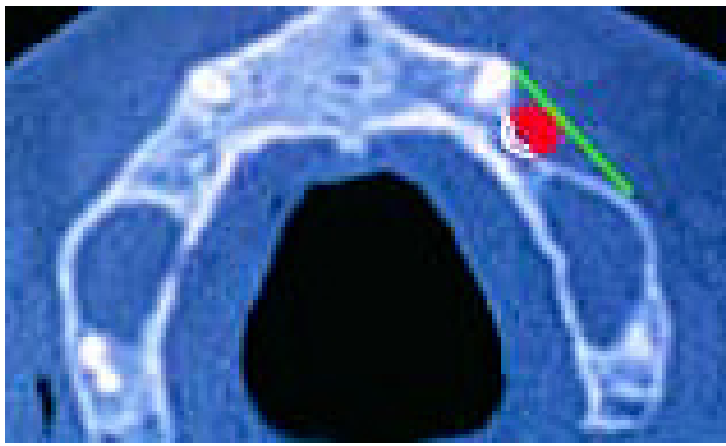


Figure 12(A): Class I HRD: The exposed implant surface (> 50%) resides within the envelop of the bone

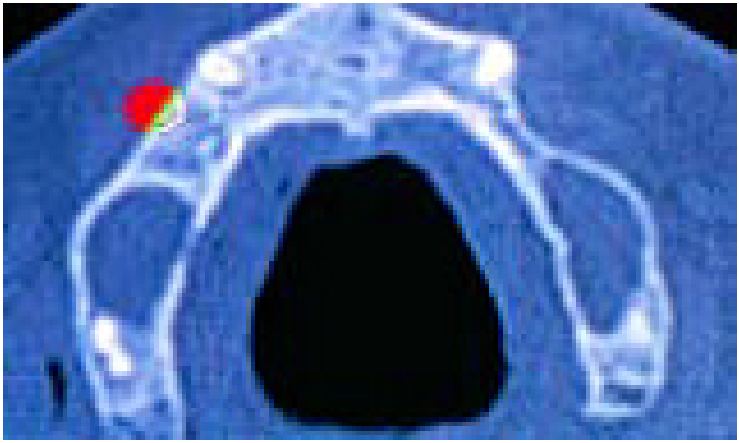
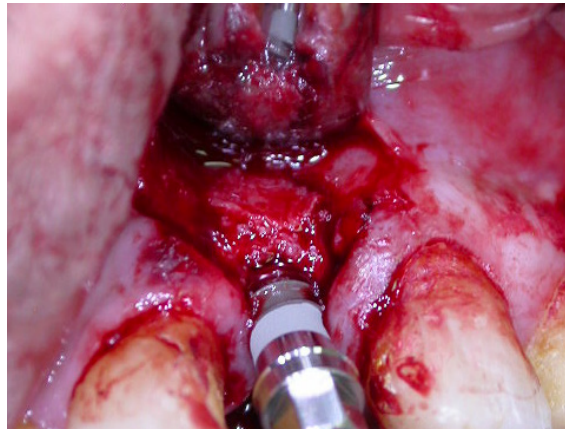


Figure 12 (B): Class II HRD: The exposed implant surface (> 50%) resides outside the envelope of bone.

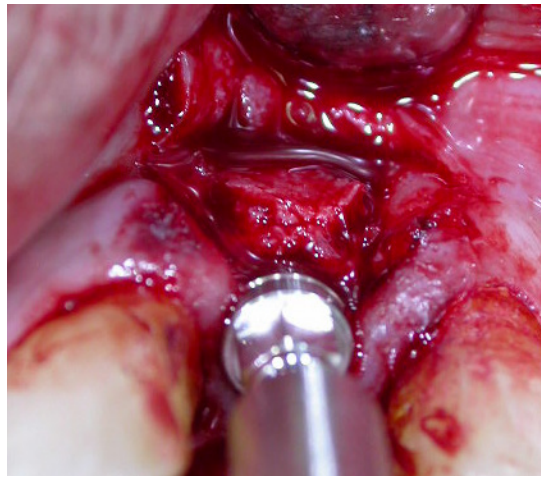
Deficiencies

In a Class II HRD, the exposed implant surface (> 50%) resides outside the envelope of bone (Figure 12 (B)). HRDs managed by dental implant placement with simultaneous GBR can be corrected by four approaches:

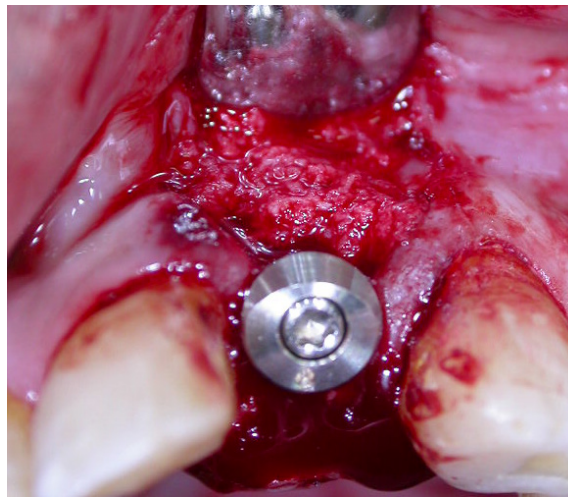
I- Splitting the edentulous ridge so that the buccal wall moves in a buccal direction, widening the coronal surface of the ridge. This is most effective when the three dimensional radiograph shows the ridge form to be similar to an isosceles triangle. The widened ridge can receive an implant immediately if the implant can be placed at an acceptable angle, or it can be treated as a staged event, with the implant placed after regeneration takes place. The advantage of this technique is that it requires very little graft material. The disadvantage is that it is very technique sensitive [49-51]. This aproach could be for single (Figure 13) or multiple implants placements (Figure 14) [52].



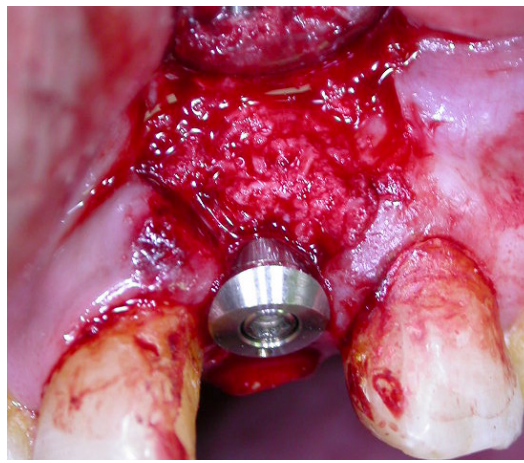
(A) : Single immediate Implant insertion after splitting the edentulous ridge



(B): The complete immediate implant placement with more widening the coronal surface of the ridge



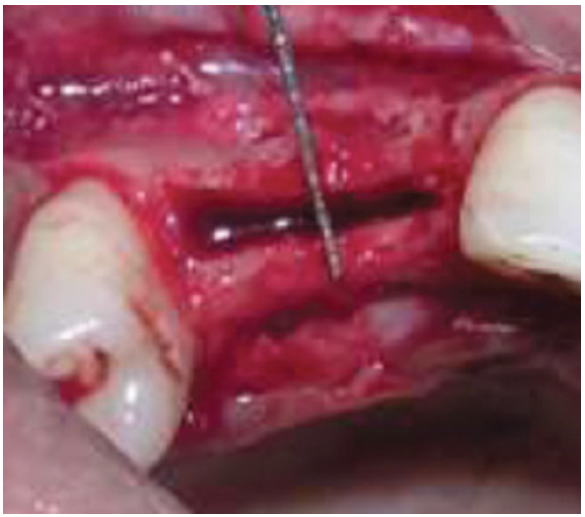
(C): Occ. view for the mplant placement with splitting the edentulous ridge which requires very little graft material



(D): Labial view

Figure 13: Splitting the edentulous ridge for single implant placement.

(A): Bucco-lingual deficient alveolar ridge

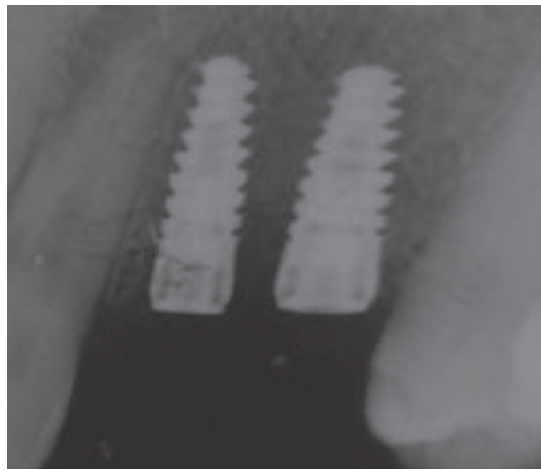


(B): Alveolar ridge after bone spreading

(C): Implant in place

(D): allograft bone in space of bone spread

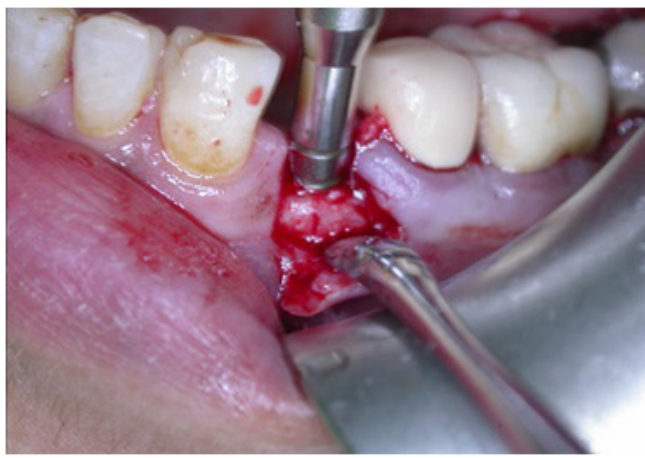
(E) : Postoperative 6 months after removal of gingival former



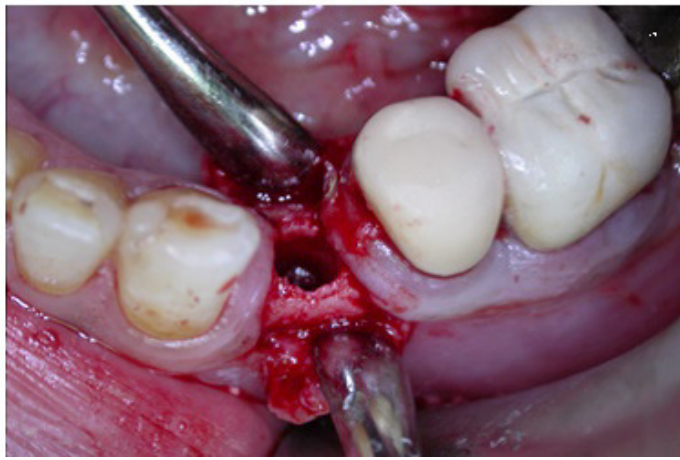
(F): Postoperative 6 months intraoral periapical radiograph

Figure 14: Splitting the edentulous ridge for multiple implants placements.

(A): Defect limited exclusively to the bucco-lingual direction with concavity due to bone loss



(B): Osteotomy preparation with osteotome technique



(C): The final diameter of implant bed was established and the crestal bone thickness reached 6.35 mm bucco-lingually

(D): Implant in position was placed at the implant installation

(E): Intraloral view after 6 weeks of healing with good soft-tissue healing

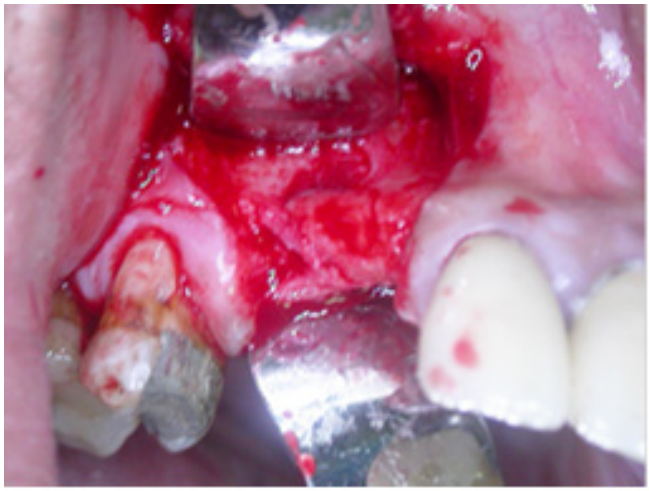
(F) Final prosthesis in place

Figure 15: Ostoetome technique associated with immediate implant placemen

II- Ostoetome technique associated with immediate implant placement using is gentle; offers advantages for patients include less surgical trauma, a shorter treatment time, and reducing the need for costly procedures [53]. This technique offers a viable alternative to bone grafting in select cases for lateral bone expansion where teeth have been missing for a considerable period of time (Figure 15).

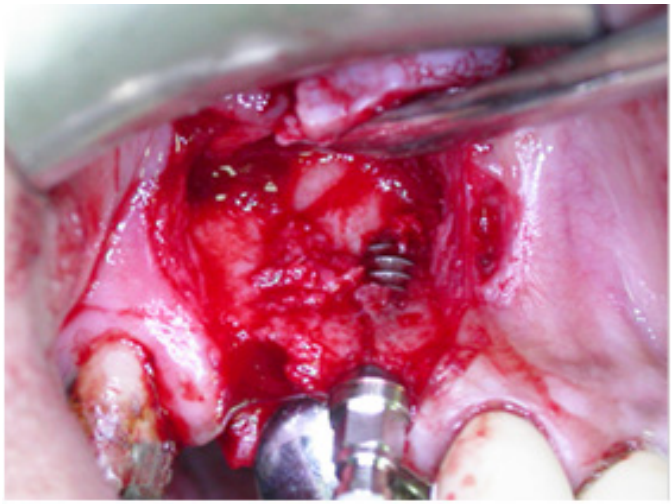
III- The bone surface can be decorticated and particulate bone and a barrier membrane used to enhance the thickness of bone which is often performed as part of a guided bone regeneration procedure (GBR). The biologic rationale for decortication of bone is to allow progenitor cells easy access to a GBR-treated site and to facilitate prompt angiogenesis. It also may enhance the physical connection between a bone graft and a recipient site [54]. Decortications of the bone frequently prior to placing a bone graft (Figure 16) [55].

(A): The defect area

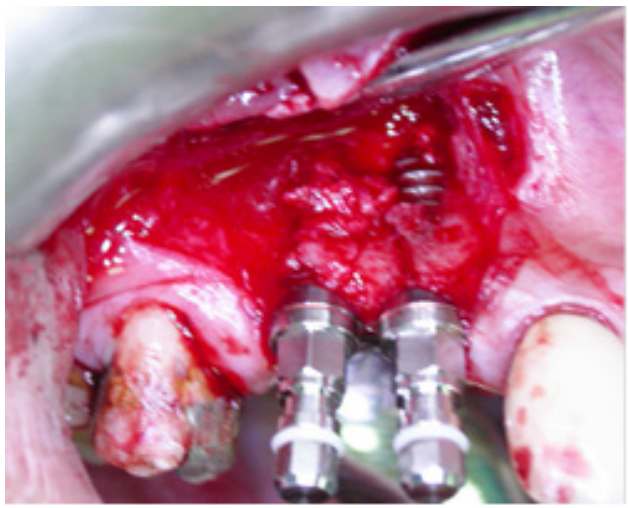


(B): Bone Decortications in Enhancing Implants placements with GBR

(C): 1st implant placement insertion



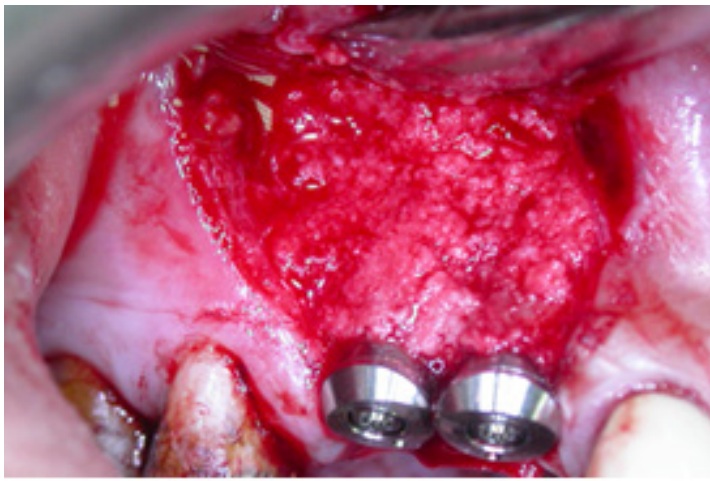
(D): Completed 1st implant placements



E): Complete implants placements with bone decortication

(F): Autogenous bone was taken by pilot implant drills from implants sockets

(G): Atuogenous bone grafts were collected



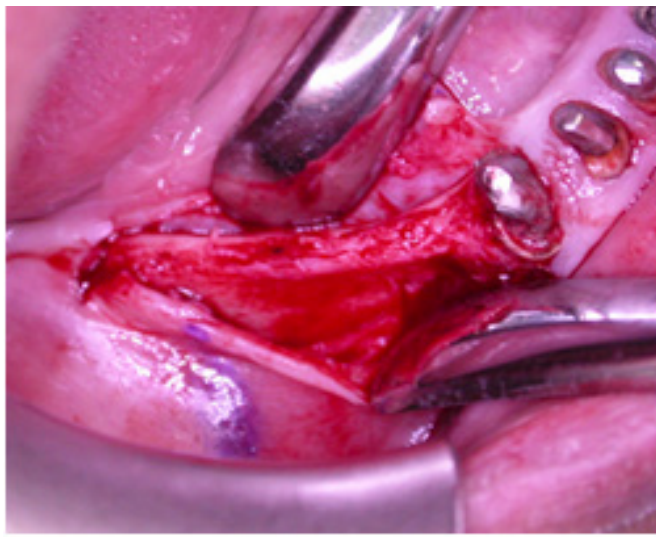
(H): Implants placements with simultaneous GBR

Figure 16: Decortication for the bone surface, with the application of particulate bones and barrier membranes to enhance the thickness of bones.

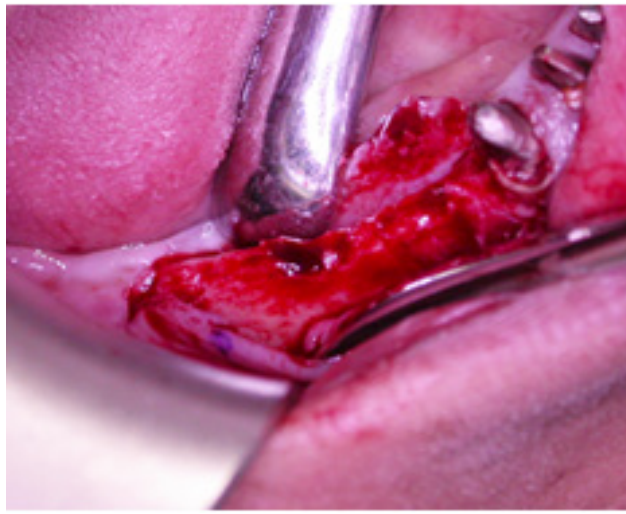
IV- Implant positioning can be associated with a GBR technique, using autogenous bone chips and a barrier membrane, in a one-stage approach if the implant can be placed at an acceptable angle (Figures 17-19) [56].

V- An intra or extra oral bone block graft can be harvested to expand the volume of bone. The obvious disadvantage is that this requires significant harvesting from a secondary site, but it is frequently the treatment of the choice because of the predictability. This technique is especially useful when the native bone is parallel and does not have a wide base, when widening a knife-like edentulous ridge. This site development technique is appropriate for areas of long-standing edentulism and where the alveolar process has not expanded to accommodate the erupting teeth (Figure 20) [57,58].

17 (A): Defect in the lower arch in premolar areas



17 (B): The exposed bone area with defect

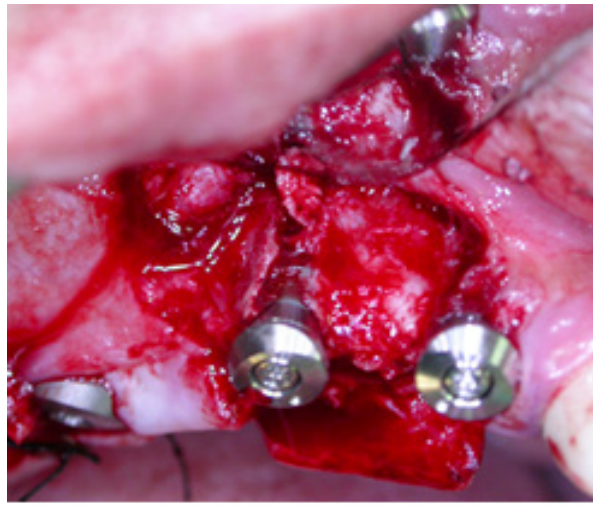


17 (C): Areas were prepared for implants placement

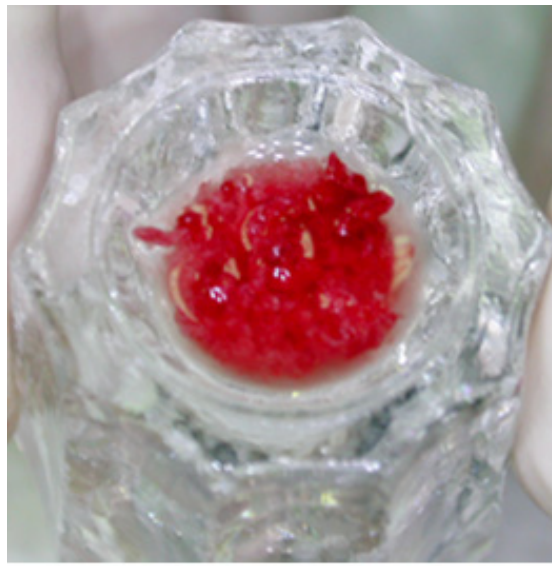
17 (D): Autogenous bone chips were collected

17 (E): Bone chips was applied over the implant surfaces

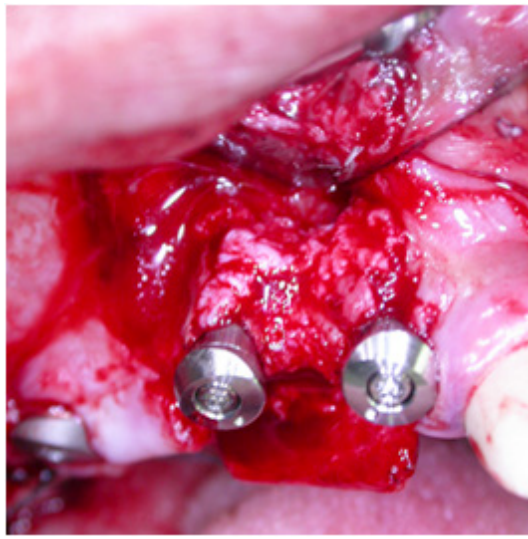
18 (A): Implants placements procedure



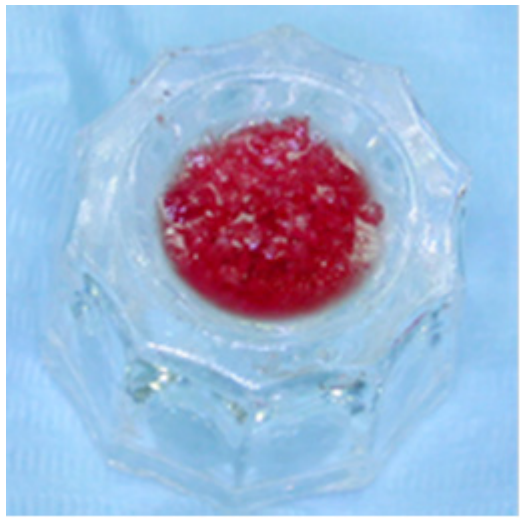
18 (B): Exposed bone area with defect after implants placements



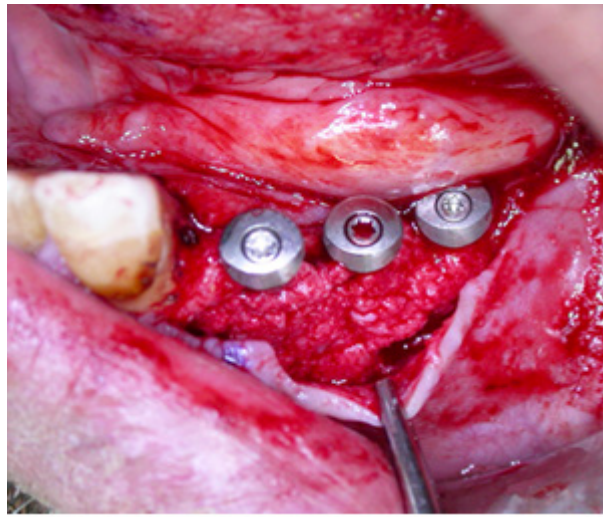
18 (C): Autogenous bone chips were collected



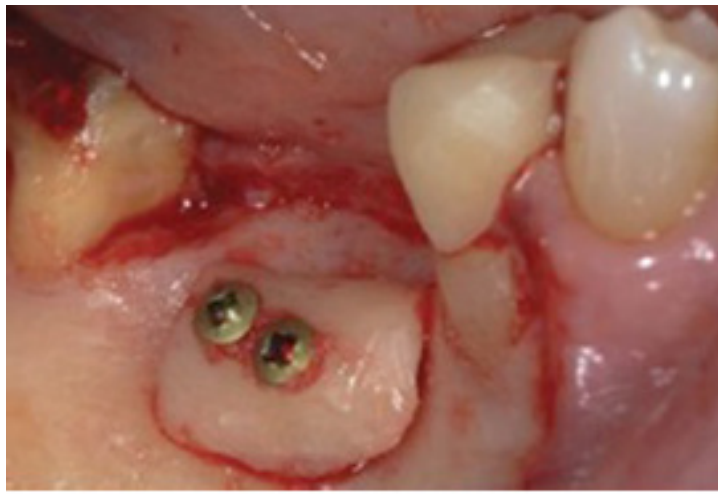
18 (D): Implants placements with simultaneous GBR technique using autogenous bone chips in a one-stage approach



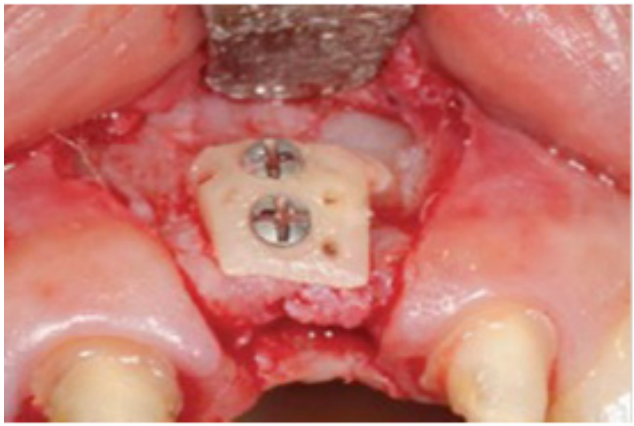
19 (A): Autogenous bone chips were collected



19 (B): Implants placements with simultaneous GBR technique using autogenous bone chips in a one-stage approach



(A): Bone block graft was harvested from chin donor site



(B): Bone block graft was harvested from iliac crest

(C): Another case for bone block graft was harvested from iliac crest and fixed with screws in the area with simultaneous implants placements

Figure 20: Extra-oral bone block graft was harvested to expand the volume of bone.

Conclusion

Various anticipated techniques, biomaterials, and tools have been described in the literature that clinicians may use to reconstruct bone deficiencies. However, most importantly, the success of alveolar ridge augmentation procedures mainly depends on clinician experience and skill. The surgical risks may be increased for challenging reconstructions. Therefore, the clinician and patient should carefully evaluate the benefits and risks of the operation and decide on the most ideal treatment option. Prosthetic-driven augmentation is recommended for a better outcome. After all, the use of. dental Implant Placement with simultaneous guided bone regeneration in oral rehabilitation has become a standard of care in daily practice and is being performed to minimize the risk complications and to ensure predictable and stable long term results.

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