Composite grafting material for maxillary sinus augmentation

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ملخص البحث : يصف هذا التقرير طعما مركبا بديلاً للاستعمال في عمليات رفع قـــاع الجيب الفكي. ويتكون هذا الطعم من مزيج من بـــودرة كبريتات الكالســـيوم نصف المائية وحبيبات من عظم مغاير مازوع للمعدن مع حبيبات من عظم ذاتي. دلت نتائج المتابعة لمدة تسعة أشهر بعد الجراحة على تشـــكل الشـــكات العظمية مع زيادة في كثافة مادة العظم وحدوث اندماج عظمي مع القرسات المزروعة.

This case report describes an alternative method for the use of graft composite in maxillary sinus augmentation procedures. The graft mixture is composed of calcium sulfate hemihydrate powder (Capset®), demineralised xerographic bone particles; DXBP (Laddec®), and autogenous bone particulates (ABP). Nine-month post-operative radiographic follow up showed trabeculation and increase in bone density of the grafted material and osseointegration to the implanted fixtures.

Introduction

The selection of ideal bone substitute to fill osseous defects, osseous-implant defects and in particular to graft maxillary sinus after sinus lifting procedure is still controversial.

The sinus lift procedures was first described by Tatum[1] who used the alveolar crest approach. Boyne and James[2] later introduced lateral osteotomy by the modified Caldwell Luc procedure.

Different materials have been used for sinus grafting. The ideal material is autogenous cancellous bone in terms of osteogenic potential.[2-4] However, the quantity of bone graft obtainable from inta-oral sites may not be adequate. Extra-oral bone graft has the disadvantages of the need for second site for surgery, increased morbidity, hospitalization, general anesthesia, longer surgical time, increased cost, increased patient discomfort and pain which make many patients not prepared to accept such a surgical option.

Several bone substitute materials have been used for sinus grafting. Among these are allografts,[5] hydroxyapatites,[6-7] bone morphogenic proteins,[8] and a variety of combined grafts.[6] Even though reports suggested that bone augmentation after sinus lifting may be obtained using one of these graft materials, it is not yet agreed which of these materials is the graft of choice.

This case report describes an alternative graft composite for use in maxillary sinus augmentation procedures. The graft mixture is composed of calcium sulfate hemihydrate powder (Capset®, Life Core Inc., Chaska, MN, USA), demineralised xerographic bone particle; DXBP (Laddec®, Transphyto S.A. Ferrend, France) and autogenous bone particulates (ABP)

Case Report

A fifty-year-old male patient presented to our clinic with missing left upper first, second premolar and first molar teeth. The patient had expressed his desire for permanent replacements for all the missing teeth. Radiographic evaluation showed insufficient bone height as well as evidence of sinus pneumatization at the site of left first molar (Fig. 1). Treatment plan, indicated the need for replacement of the missing first, second premolar and first molar teeth. The surgical procedure necessitated sinus lift procedure and sinus augmentation in the area of the 1st molar. The patient was operated for simultaneous bone augmentation and implant placement.

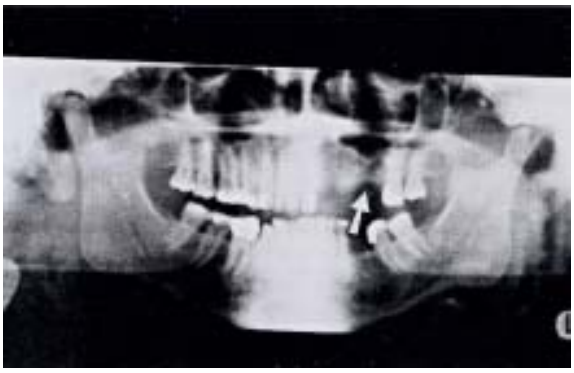

Fig. 1. Orthopantomogram shows missing 1st and 2nd premolar, 1st molar teeth, and preumatization of the left maxillary sinus in the area of first molar ←).

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The surgical procedure was carried out under local anaesthesia which included infra-orbital nerve block, labial infiltration and palatal block of the greater palatine nerve. The horizontal incision of the flap was extended through the crest of the ridge distally from the upper left 1st premolar to the tuberosity of the same side. One vertical incision was made distal to root of the canine and extended to the buccal sulcus. The mucoperiosteal flap was reflected to expose the lateral maxillary wall of the sinus and the alveolar ridge of the surgical site. The exposed ridge was knife-edge shaped, therefore decision was made to flatten it by removing sharp bone edges with bone rongeurs forceps and smoothened with bone file. The chipped bone particles were collected and mixed with the other graft ingredients.

The sinus lift procedure was performed using lateral window approach as described by Boyne and James[2] and modified by Garg and Quinones[9] for the oval osteotomy of the lateral maxillary wall. The bone window of the sinus was relieved and the maxillary sinus lining was elevated carefully. The bone window of the sinus was lifted up to act as a roof for the grafted area (Fig. 2).

Fig. 2. Lateral bone window of the sinus was cut and pushed upward after sinus lining was relieved from underlying bone and elevated upward.

The height of the alveolar bone at the site of the missing first molar was approximately 4 mm. Implant size 3.75 mm in diameter and 11 in length was used for this site. Early stabilization of this implant was achieved with the remaining ridge height.

Two other implant fixtures were placed in the sites of the missing second and first premolars. They measured 4 mm in diameter x 8 mm in length and 3.75 mm in diameter x 11 mm in length respectively.

The bone graft mixture comprised of DXBP; Laddec®, ABP from the operated alveolar ridge and calcium sulfate power (Capset®). The mixture ratio of Laddec® to ABP was 1:1 and the total bone graft volume ratio to Capset® was 4:1 respectively (Figs. 3a & 3b). The composite graft was mixed thoroughly. Few drops of blood were placed in the bone graft composite to ease its manipulation. The bone graft was then packed and condensed to fill the sinus space.

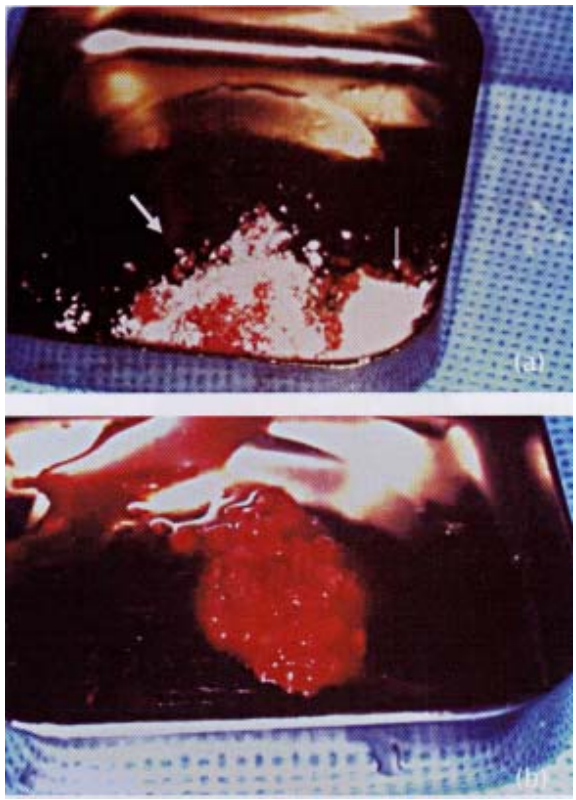

Fig. 3. a) Capset® (←H and Laddec® (←),
b) Collected autogenous bone particles.

Capset® was used again to act as a graft barrier. For this application, calcium sulfate powder was mixed with sterile saline. Dough-like mixture of Capset® was applied to cover the graft for approximately 2 mm in thickness (Figs. 4a & 4b). Following placement of the barrier, the mucoperiosteal flap was returned and interrupted sutures were placed to close the flap. Immediate post-operative radiographs were taken which showed correct position of the inserted implants (Fig. 5).

After 9 months of the implant placement and bone grafting, radiographs of the operated site were taken. When these radiographs were

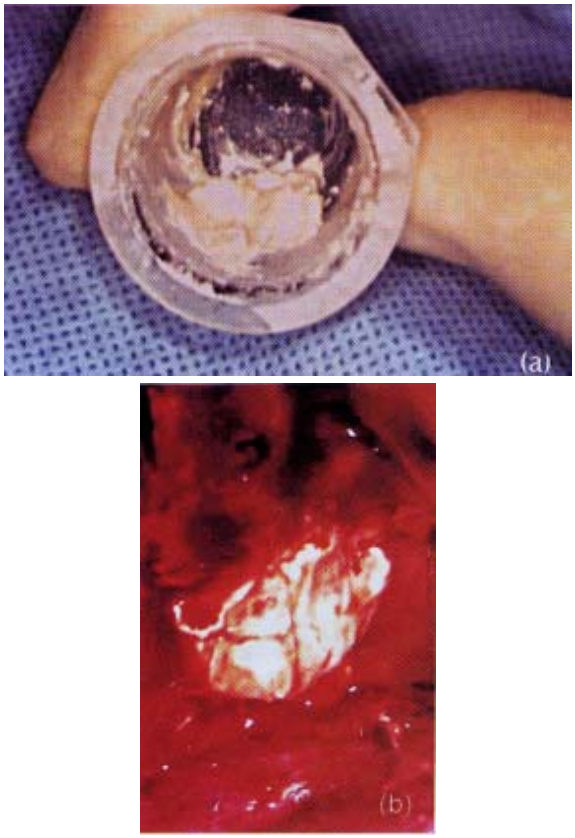

Fig. 4. a) Dough-like mixture of Capset.
b) Calcium sulfate covering the grafted sinus

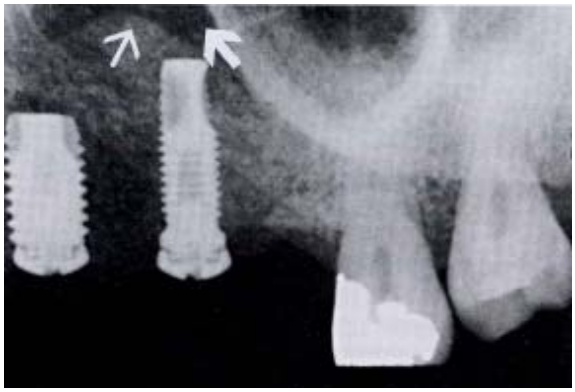

Fig. 5. Immediate post-operative radiograph of the implants and the grafted sinus. Note radiographic texture of the grafted sinus with appearance of radio-opacity of the lateral bone window of the maxillary sinus (←), and radiolucent spots of the grafted materials (←).

compared to the immediate post-operative radiographs, the former showed an increase in bone density in the grafted area and the implants appeared to be osseointegrated and lined with bone (Fig. 6).

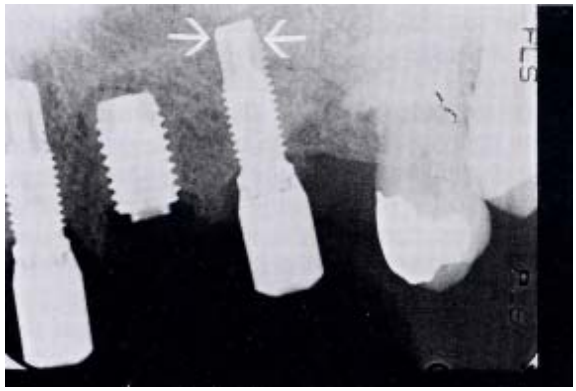

Fig. 6. Radiograph of the implants and the grafted sinus 9 months post-operative. Note normal trabecular bone covering whole length of the implant in the grafted sinus (<-). Also, note osseointegration of all the inserted implants.

Discussion

The graft mixture used in the reported case consisted of calcium sulfate powder (Capset®) to increase rate of bone mineralization during bone healing and to act as a barrier to prevent ingrowth of non osteogenic cells into the graft, with DXBP acting as osteoinductive scaffold bone filler and ABP as osteoinductive potential to enhance bone cells differentiation to increase rate of bone ingrowth.

Plaster of Paris is the hemihydrate form of calcium sulfate. It has a history of medical use for over a century.[10] Pelteir[11,12] an orthopedic surgeon could be credited with the modern surgical use of calcium sulfate for filling osseous defects. In dentistry, various forms of calcium sulfate mixtures have been used with promising results.[13,14]

Plaster of Paris is used also as a guided tissue regeneration barrier[15-17] and as a vehicle for bone morphogenic protein.[18]

An advantage of mixing calcium powder with the grafting materials is that it acts as a direct source for calcium supply during osteogenesis process and also binds directly to the host bone.[19]

Sottosanti[16] and Anson[17] investigated mixing calcium sulfate to freeze-dried bone allografts and found reduced particle loss and accelerated rate of bone regeneration in periodontal defects and in exposed dental implants. Earlier Pelteir and Orn[12] added calcium sulfate to autogenous and homogenous bone grafts in dogs and observed accelerated bone healing when compared to healing in the control of allogenic bone grafts without calcium sulfate.

However, Pecora et al[20] grafted elevated maxillary sinus with calcium sulfate alone and

noted that although calcium sulfate material appeared a favorable bone filler, it failed to augment the whole of the elevated sinus space. The grafted sinuses showed bone formation in the base and center of the sinus but did not regenerate bone in the third upper part of the inserted implants.

In an unpublished study, the author found that mixing calcium sulfate with different grafting materials increased the rate of osteogenesis compared to control osseous defects filled with the same graft, but without added calcium sulfate. In this unpublished study, the author also found that calcium sulfate could not be used as a bone filler alone without the presence of a scaffold grafting material.

The speed of dissolution of the material, empties the osseous cavity in a shorter time than the time required for bone growth to fill in. This results in inadequate new bone ingrowth in the spaces of the resorbed material. The collapse of complete bone healing in osseous defects filled with calcium sulfate alone was due to the absence of a scaffold material that allows the bone remodeling process to take place in a gradual physiologic timing. The active bone remodeling process was centered in the middle of the defect only whereas border of the defects was empty from active bone regeneration.

Shaffer and App[21] have documented clinical observation which was in agreement with our conclusion. They implanted calcium sulfate material into human periodontal defects and found that defects filled with calcium sulfate alone did not induce more bone formation than the control.

Pelteir[12] and Frame[19] have reported that although calcium sulfate enhances bone formation, it appears that the resorption rate is faster than the rate of bone growth.

In conclusion, calcium sulfate cannot be used alone as a bone filling material. The composite graft of autogenous bone particles, demineralized xenography bone particles and calcium sulfate appeared to be an alternative viable grafting material for sinus grafting procedures.

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