cpd

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Sinus grafting using a synthetic augmentation material

IAN SEDDON PRESENTS A SINUS GRAFTING CASE STUDY WITH HISTOLOGY

Where sufficient bone is available, the reconstruction of edentulous or partially edentulous patients using dental implants has become a viable and predictable treatment option. However, where teeth have been removed for some time in the posterior maxilla, the sinus will pneumatise. This, in association with the natural resorption that occurs in unloaded bone, can result in insufficient bone volume for the support of implants. The main goal of the sinus graft procedure is to generate viable bone in the sinus cavity giving sufficient volume to allow the placement of implants.

As a procedure, sinus grafting is now well accepted and predictable. Indeed grafting by placing an augmentation material under the lining in the sinus cavity has been conducted as a procedure since 1975 (Tatum et al, 1993). The choice of augmentation material however is not so straightforward. The material used must provide the following features:

- Enough bone to ensure long-term osseointegration of the implants
- The ability to produce bone in a site of relatively low vascularisation
- It should transform totally into bone that subsequently will remodel to give the required structure to support the implant
- It should not carry any potential risk of cross infection, should be easy to use, be readily available and reliable.

A further desirable benefit would be a material that did not damage the sinus lining as it was placed. Damage to this lining could result in infection to the graft and in such a case aborting the procedure may be the only option.

Many materials have been used for this procedure including autogenous bone, allograft, xenograft and alloplast materials. More recently research has concentrated on introducing bone growth factors into the surgical site. PRP (Mazor et al, 2004) and bone matrix derived from periosteum cells (Schimming & Schmelzeisen, 2004) mixed with a carrier graft have shown some promise. However, the debate as to which material to use in this procedure still ensues.

In this case study we show the use of a novel material based on a multi-porous tri-calcium phosphate suspended in a hydroxyl sulphate matrix (Fortoss VITAL, Biocomposites Ltd, Staffordshire, UK). This material has the benefit that is applied to the site as a paste that sets and so should not cause damage to the lining. It is fully resorbed and replaced by bone. It is also synthetic and so does not carry the risks associated with other materials from bovine or human sources (Honig, 1999; Wang et al, 2001). The newly formed bone was used to support a single three-unit bridge over two Astra implants (AstraTech Ltd, Stonehouse, Gloucestershire, UK).

CASE STUDY

The male patient (54) had lost upper right molar units due to previous chronic periodontitis. The sinus had subsequently pneumatised and radiographs showed a multi-loculated sinus with minimal basal bone (Figure 1). The patient wished to maximise his chewing function. Due to the lack of basal bone (<5mm), a two-stage therapy was indicated. A sinus graft procedure would be followed with subsequent implant placement once new bony tissue growth had occurred. A sinus graft procedure using irradiated cancellous bone on the left hand side had been successfully conducted a year prior to this surgery. However, the patient was keen to explore synthetic graft materials on the right hand side. Medical history was clear.

SURGICAL PROCEDURE

A conventional lateral window was cut using the Caldwell-Luc approach and the sinus lining was carefully elevated using techniques described by Tatum

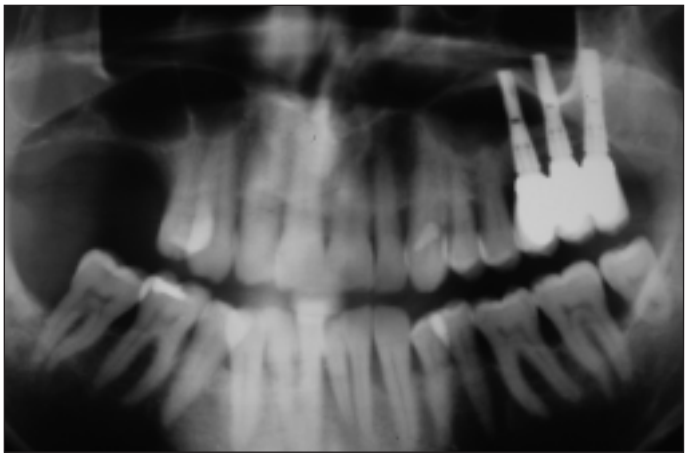

Figure 1: Multi-loculated sinus with minimal basal bone

Ian Seddon BDS is practice principal of the Leckhampton Dental Clinic is Dr. Ian Seddon. He qualified from Victoria University, Manchester after a period of elective study in California

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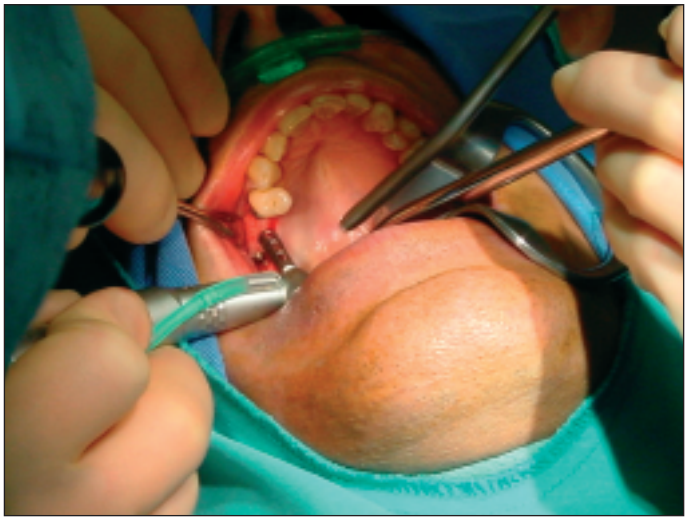

Figure 2: Biopsy sample taken at time of implant placement

(1993). There were no unusual anatomical features apart from a small septum above the pre-molar. A resorbable collagen membrane (BioSorb, Imtec, USA) was placed under the raised lining to reduce any potential problems that might occur with small tears. The synthetic graft was placed into the cavity starting medially and lightly compressing as the sinus was filled distally. No membrane was placed over the window prior to closure. Post-operative healing was uneventful.

Eight months following placement of the graft two 15mm AstraTech 4.5mm ST implants were placed using the conventional approach by well irrigated drilling to produce the osteotomy sites. Bone quality was consistent throughout the length of the osteotomy. The feel of the bone was similar to the contra-lateral sinus at implant placement. Again postoperative healing was uneventful. A 10mm long biopsy sample (Figures 2 & 3) was removed at the time of implant placement using a 4.3mm diameter trephine. In order to prevent damage to the sinus lining, care was taken not to approach within 5mm of the top of the graft.

Results

Bone density assessed radiographically at the time of implant placement shows good regeneration throughout the depth of the augmented site (Figures 4 & 5). A significant increase in bone height can be seen over that shown in the pre-op radiograph (Figure 1). The bone was dense enough to support the implants and was characterised at the time as D2/3.

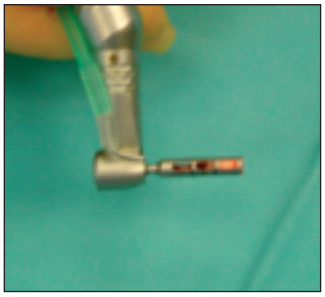

Figure 3: Biopsy sample taken at time of implant placement

The biopsy sample taken at the time of implant placement also showed good evidence of the bone regeneration throughout the length of the sample. Figure 6 shows a van Geison stained biopsy section. Cell nuclei (shown in blue) and the collagen phase of bone (stained pink) are clearly evident. The fragment of unresorbed tri-calcium phosphate is stained black. The presence of bone in close apposition and completely surrounding the fragment is demonstrated. The von Kossa stain shows the bone mineral phase surrounding and in apposition to the unresorbed tri-calcium phosphate particle (Figure 7) and would therefore be said to be, in histopathological terms, normal healthy bone. The interesting observation of these slides however, is that the remaining fragments of tri-calcium phosphate have evidence of osteoblast activity not just around them, but within them.

Healing was uneventful and, after a further seven months, the implants were exposed and found to be integrated. Impressions were taken in the usual manner and prepable abutments and a metal bonded bridge fitted (Figures 8 to 12). The implants have now been fully loaded for 24 months. Figure 13 suggests good bone density. The follow up radiograph shows maintenance of bone levels and good maturation of bone.

Discussion

The debate still rages as to the material or mixture of materials that give the best and most predictable results when used in the human sinus. The Sinus Consensus Conference (Jensen et al, 1998) statistically analysed different grafting materials, implant surfaces and timing protocols and concluded that sinus grafting should now be considered a highly predictable and highly therapeutic modality with a success rate of over 90% for implants with at least three years' function. A systematic review and meta-regression analysis of a number of published trials and retrospective analyses (Wallace & Froum, 2003) has reported the following:

- Implant survival for lateral window technique averages 91.8%
- Implant survival in grafted sites was higher than non-grafted

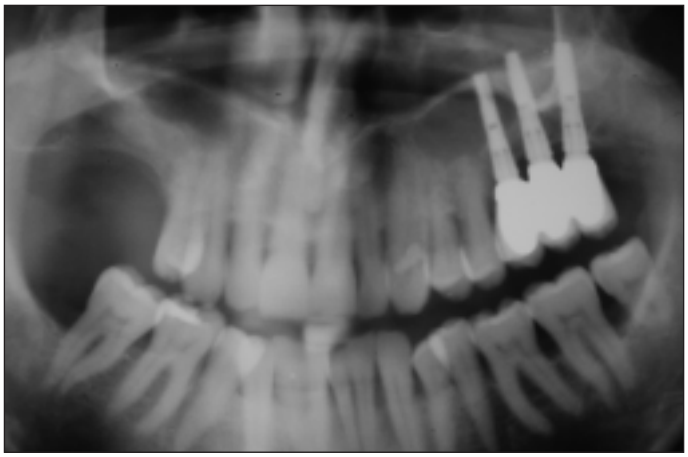

Figure 4: Radiograph showing new bone growth eight months post-op

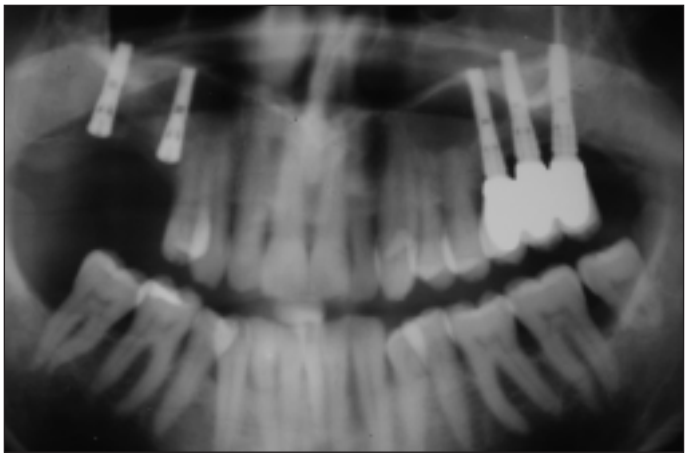

Figure 5: Radiograph at implant placement

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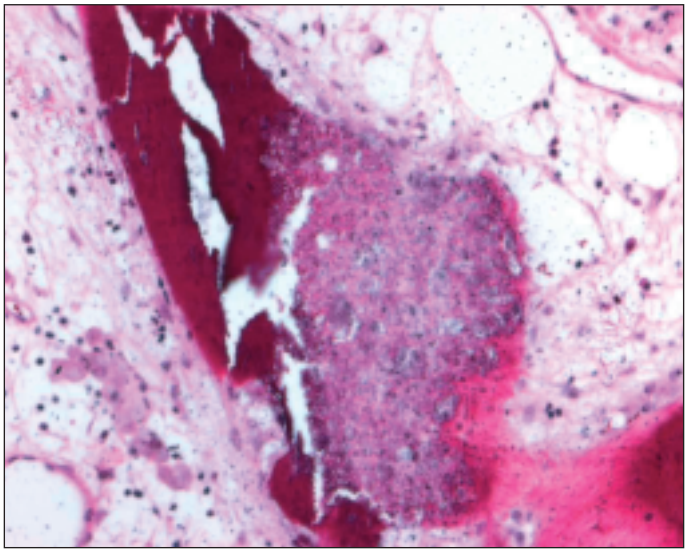

Figure 6: van Geison stained biopsy sample showing collagen phase of bone and induced cells within particle

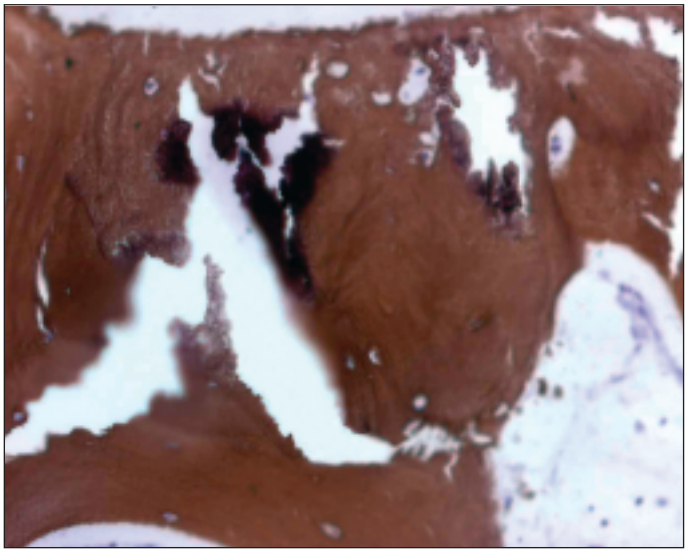

Figure 7: von Kossa stained biopsy sample showing mineral phase of newly formed bone

• Rough-surface implants had a higher survival rate than machined surface implants
• Implants grafted with particulate graft showed a higher survivals rate than those grafted in a sinus augmented with block grafts
• Implant survival was higher when a membrane was placed over the lateral window
• The use of 100% autogenous or the inclusion of autogenous bone as a component of a composite graft did not affect implant survival.

It appears then, that most well researched augmentation materials produce adequate bone for implant support in the maxillary sinus. Indeed, the use of tri-calcium phosphate in this procedure is not new. Histomorphometric studies have shown that, when using such an alloplast alone, (i.e. not in conjunction with a human derived or animal derived product) predictable bone growth can be obtained (Wheeler, 1997; Szabo et al, 2001). The latter reference also makes some very pertinent observations when comparing autogenous bone to tri-calcium phosphate when used in the human sinus:
• In the same patient, when the formation of bone was slow, it was slow for both materials
• Individual patient factors strongly influenced the fates of the various graft materials.

For successful bone growth to occur, the tri-calcium phosphate must however exhibit certain characteristics. The tri-calcium phosphate used in the Fortoss VITAL is said to be multi-porous. This type of microstructure has been shown to produce osteogenesis in a bony site (Ohgushi et al, 1997; Yuan et al, 1998). Alloplast materials with such a microstructure have been shown to possess the ability to adsorb host bone proteins. In contrast, materials without such a microstructure were slow to develop bone (if any bone was developed at all). The evidence of osteoblast activity within the particles in the biopsy sample taken in this case study at the time of implant placement suggests adsorption of bone proteins has occurred in the use of Fortoss VITAL. This could be evidence of some form of osseoinduction reported in Ohgushi et al (1997) and Yuan et al (1998).

The hydroxyl sulphate matrix has a number of benefits. Firstly it acts as a binder for the tri-calcium phosphate. However, it is also bacteriostatic, a quality that is a great benefit in a sinus. Secondly it forms a relatively smooth paste and so reduces the risk of damage to the sinus lining. Whilst the hydroxyl sulphate matrix has certain desirable handling characteristics, early work on its combination with tri-calcium phosphate suggested that there were major benefits in terms of speed and quality of bone growth.

Conclusions

Using Fortoss VITAL in the sinus has resulted in a stable platform for the support of the Astra implants. Whilst the therapy was successful, it should be noted that this is only one case and further research is required. Further animal and clinical studies are being conducted and are due to be reported later this year. These are awaited with interest.

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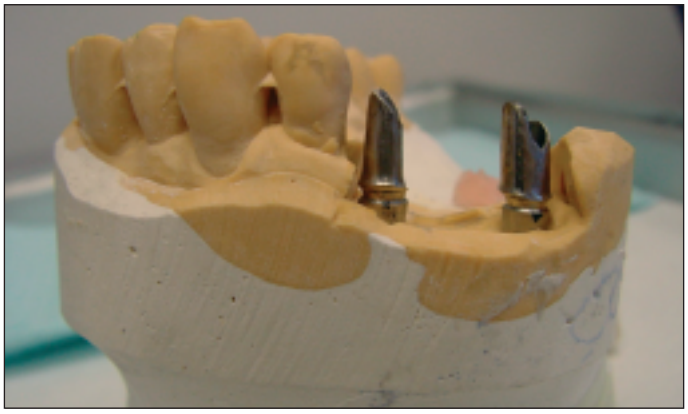

Figure 8: Showing prepable Implant abutments

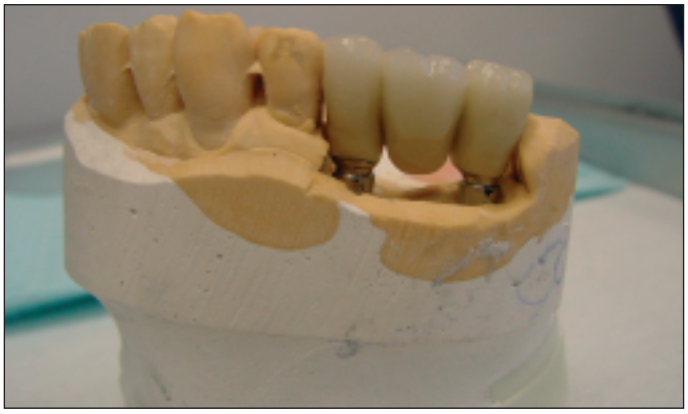

Figure 9: Final restoration

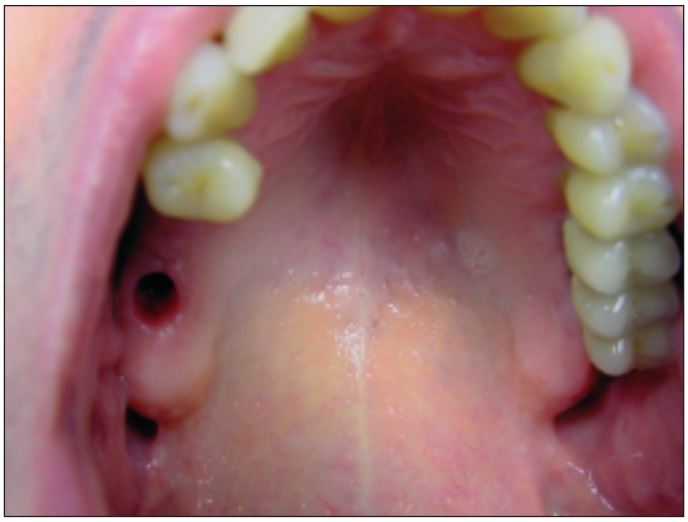

Figure 10: Healthy soft tissue profile formed by healing abutments prior to preppable abutment placement

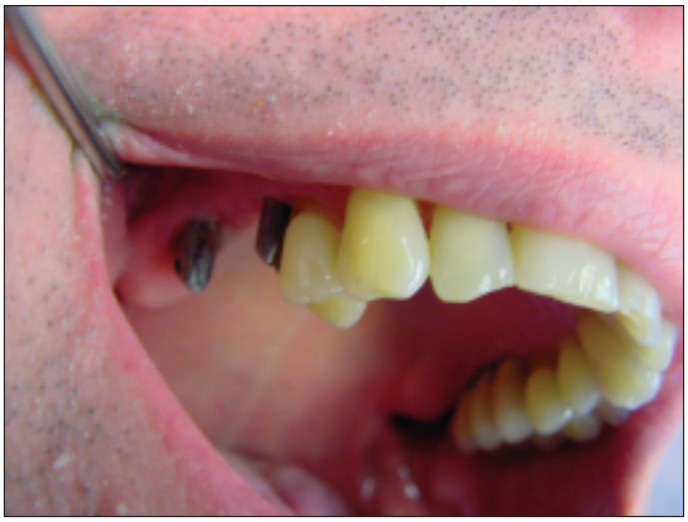

Figure 11: Preppable abutments in position

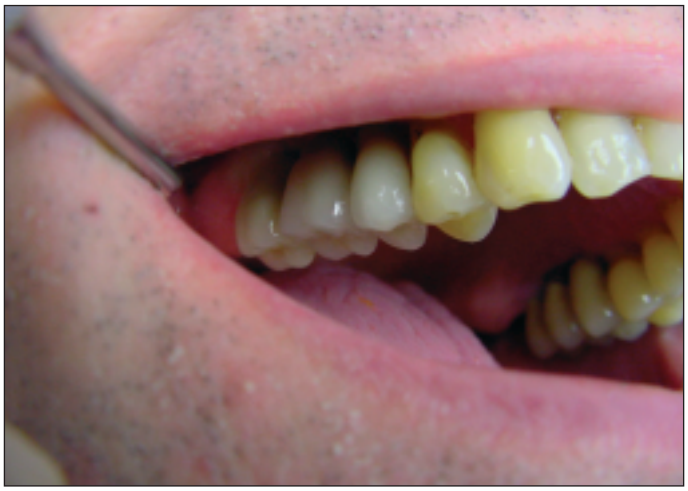

Figure 12: Final restoration in position

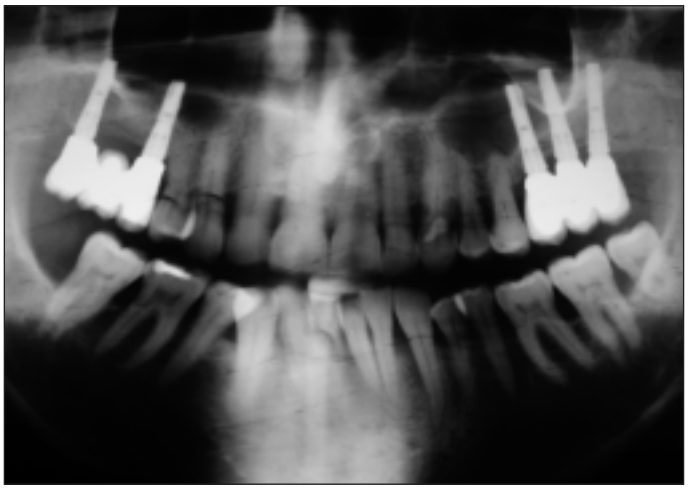

Figure 13: Showing good bone density in upper right site grafted with VITAL at two years post implant loading

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