A future with a novel alloplast graft material

Membrane-free guided bone regeneration (GBR)

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The use of barrier membranes in guided bone regeneration (GBR), both non-resorbable and bioabsorbable, to stabilise particulate graft materials and prevent soft-tissue ingrowth has been widely commented on [1]. However, the more frequently used bioabsorbable collagen-based membranes may also interfere with the important periosteal blood supply to the graft site, thus delaying angiogenesis. A synthetic graft material (Fortoss Vital; Biocomposites, Keele, UK) is now available that is both stable and cell-occlusive, possessing nanovascular porosity that enables a built-in barrier function [2].

Numerous particulate graft materials are used in traditional GBR to fill the void beneath the membrane. Autogenous, allograft, xenograft and alloplast materials have all been successfully used and documented. Whilst autogenous bone is often seen as the "gold standard" there are many issues, mainly donor-site morbidity, extended operating time and limited amounts of material. There are also studies showing that the graft may undergo necrosis [3] or resorb, resulting in more extensive bone-bulk loss over the long term [4].

Thus for many years attention has switched to looking for a source of graft material that is both plentiful and cost effective. There are three groups of materials that are commonly used, xenograft (Bio-Oss, Mineross etc.), allograft (Rocky Mountain, Puros etc.) and alloplast.

Alloplasts, or synthetic graft materials, have been used in bone regeneration (orthopaedic, spinal and dental cases) for several decades, but it is only in more recent times that their efficacy has been dramatically improved. Numerous alloplasts are commonly used, including calcium phosphates – β-tricalcium phosphate (β-TCP), hydroxyapatite (HA) – and calcium sulphate (CS).

There is much interest in β-TCP as the materials are fully bio-absorbed, hence "turned over" to result in natural bone formation. Both phase purity and porosity [5] are important in this improved efficacy of β-TCP graft materials; extensive research, beginning with *De Groot* in 1985, has improved our understanding of control of graft turnover in bone regeneration.

The material used in this case study is Fortoss Vital, a biphasic product composed of pure-phase β-TCP combined with ultra-high-purity CS, which is both biocompatible and bacteriostatic. Due to the different rates of bioabsorption in these components, there is an increasing dynamic porosity that supports angiogenesis.

The CS phase has been used as bone filler for many years and enables the graft material when mixed to "set", hence providing initial stability. This increased stability of the graft scaffold supports improved bone formation [6]. The CS phase is resorbed by dissolution at a rate compatible to that of bone formation, providing calcium and sulphate ions, which are keys to bone repair, as well as stimulating angiogenesis [7]. Therefore, after implantation, the material's pore structure starts to open up over subsequent weeks. With the CS already having fulfilled its primary function of initial soft-tissue cell exclusion [8], the increasing, dynamic porosity allows the gradual infiltration of cells and vascularization of the material. The critical periosteal blood has easier access to the graft, and capillaries can grow further into the increased pores without being hindered by the use of traditional membranes [9]. As a result, early new bone formation is achieved at the graft site.

Once the calcium sulphate has been completely resorbed, the β-TCP phase remains in addition to the new bone tissue formed over the previous weeks. The β-TCP phase is then slowly resorbed by osteoclastic processes over the longer term (six to nine months), as part of the remodelling process, to enable the formation of new mature bone.

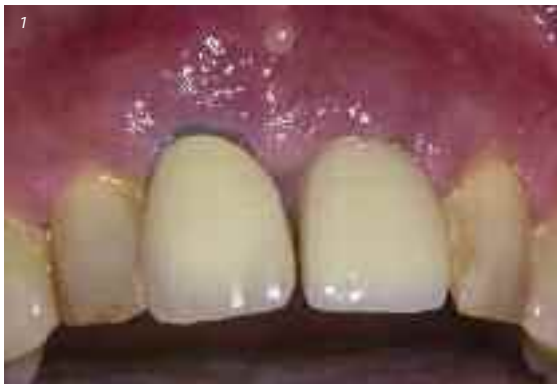


Fig. 1 Root fractured UR central showing diseased tissue.

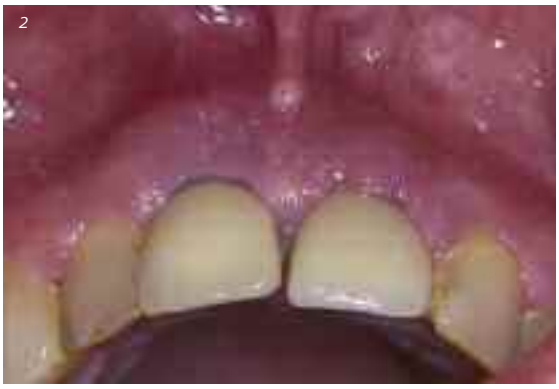


Fig. 2 Occlusal force possible cause of fracture.

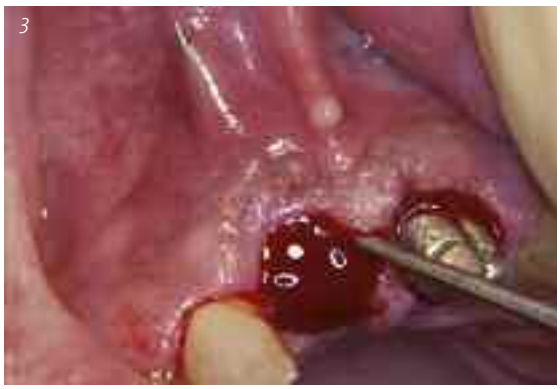


Fig. 3 Post extraction probing to show bone defect.

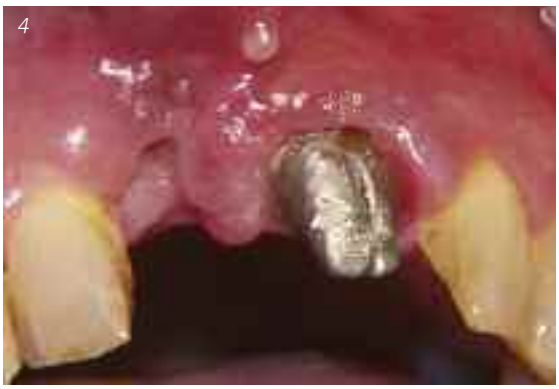


Fig. 4 Post healing (three weeks) showing hard-tissue and soft-tissue loss.

Another important benefit of this novel graft material is a negative Zeta Potential, created by shifting isoelectric potential on the material's surface. This leads to an upward regulation of the proteins associated with osteogenesis (Osteocalcin, CBFA1 and Osteopontin) [8,10] and an increased presence of osteoblasts earlier in the regenerative cycle.

The material has a pedigree extending over ten years in orthopaedic, spinal and dental surgery, with use in over 250,000 bone-grafting procedures to date. With over 800 successful membrane-free and autogenous bone-free dental grafting procedures performed by the author in the last seven years, with consistent predictable results, the performance of the material in GBR has been proven. This is illustrated by the case study presented.

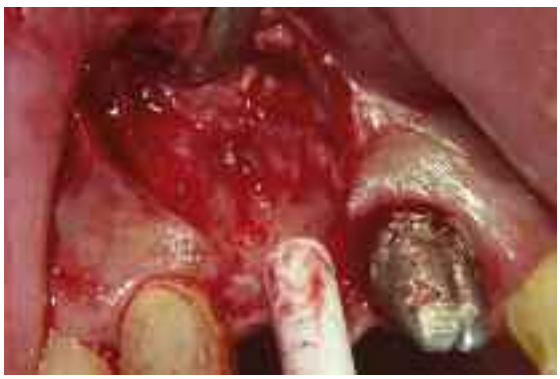


Fig. 5 Site specific flap raised to show bone loss.

Case study

The 69-year-old patient (non-diabetic, cigar smoker) presented with a fractured upper right central incisor (Figs. 1 and 2), which often results in the most extensive bone damage to the surrounding bone and necessitating extraction as soon as possible. Many different treatment options had been advised by other dental surgeons, ranging from a bridge to the removal of all incisors and two implants to be placed in the lateral areas due to the severity of the bone damage, but the patient desired that just the affected central incisor be treated.

After the removal of the tooth, the extent of the buccal defect became more evident on probing (Fig. 3); due to the extent of the infection, it was decided to allow for soft-tissue closure. After extraction, even where there are no defects, up to 50 per cent of the ridge width may be lost – 50 per cent of that in the first month. This soft-tissue healing period was therefore restricted to three weeks when the extent of this tissue loss was clearly visible (Fig. 4).

A site-specific flap retaining the papillae was then raised using a no. 15 blade, showing the extent of the bone loss (Fig. 5). Limiting the flap size allows the preservation of adjacent soft-tissue aesthetics and is viable because there is no need for extensive flap release, as the graft material is stable and not bulky and does not need to extend laterally for retention.

Fig. 6
Placement of an Intoss Implant (3.5 by 12 mm).

Fig. 7
Primary stability from apical threads.

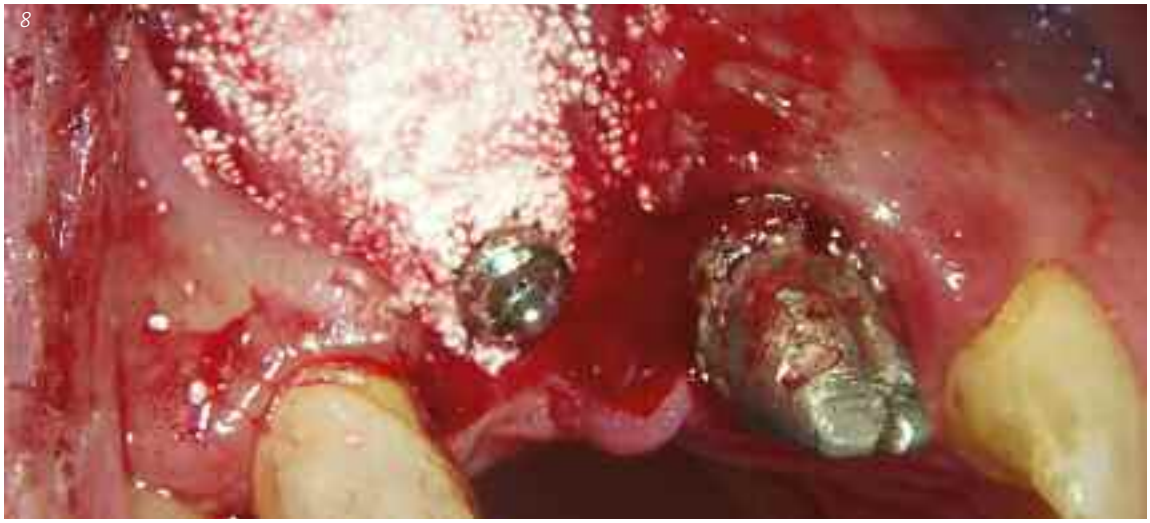
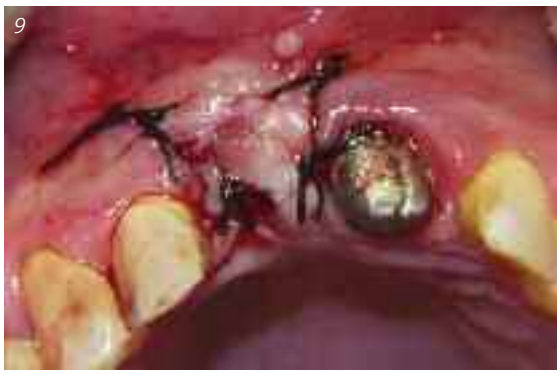


Fig. 8
Graft with Fortoss Vital.



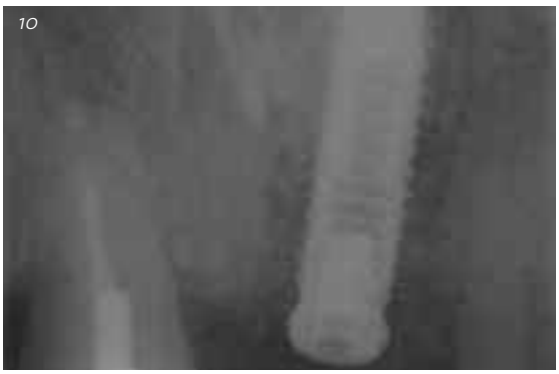


Fig. 9
Suture here with Mersilk (3.0).

Fig. 10
Radiograph showing defect and graft material.

After removing the granulation tissue through extensive curettage, an Intoss Bio 3.5 x 12 mm implant (Figs. 6 and 7) was placed into the palatal aspect of the socket. Preference is for thinner cylindrical implants in the aesthetic zone, and the implant is placed with the last thread at the bone level as per the manufacturer advice.

Once the surgical site bleeding had subsided (additional local anaesthetic may aid the haemostasis), the graft material was then mixed to the manufacturer's instructions and placed around the implant to the level of the adjacent bone profile (Fig. 8). It was now critical to control the flow of blood from the adjacent soft-tissue using sterile cotton wool rolls whilst the graft material "set", which took approximately three minutes. The CS phase that facilitates this "set" takes time to set completely, and although the surface may appear hard, it is important to wait the full set time for complete hardening before closure.

The implant is always placed at the time of grafting to help improve graft stability and to benefit from the titanium implant's semi-conductive nature. As the graft material is bacteriostatic, there is no need to mix antibiotics into the graft material as these may affect the implant surface, hindering osseointegration. The stability of this graft material also has an important role in GBR, as the more solid the scaffold, the better the result. The flap was then carefully sutured without tension using Mersilk 3.0 (the author now prefers Vicryl Rapid 4.0), taking care

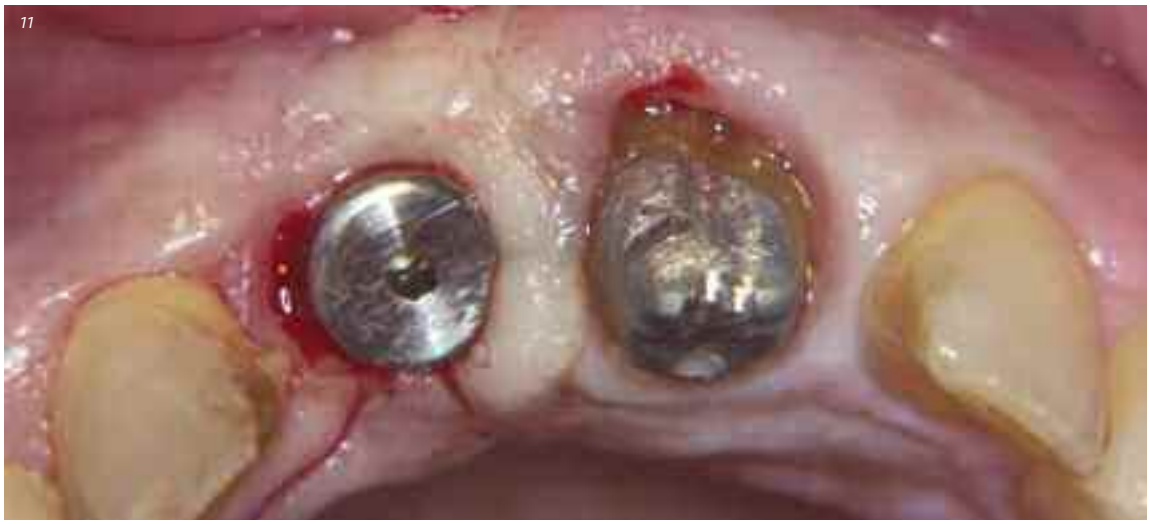


Fig. 11
Healing cap fitted.

Fig. 12
Lava (3M) all-ceramic crowns.

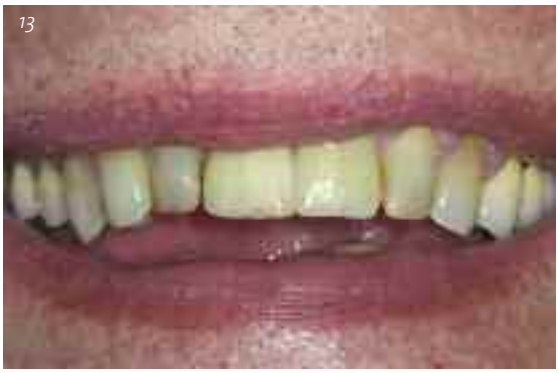


Fig. 13
Fitted patient smiling.

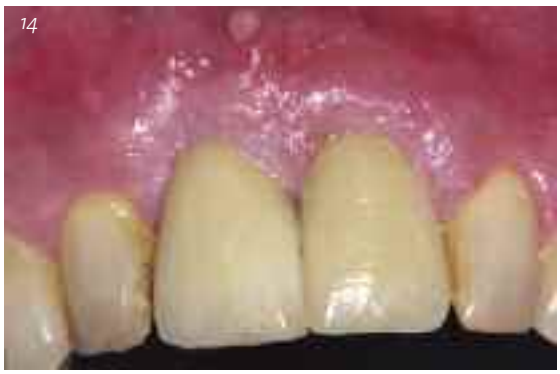


Fig. 14
Two weeks post fit showing restored tissues.

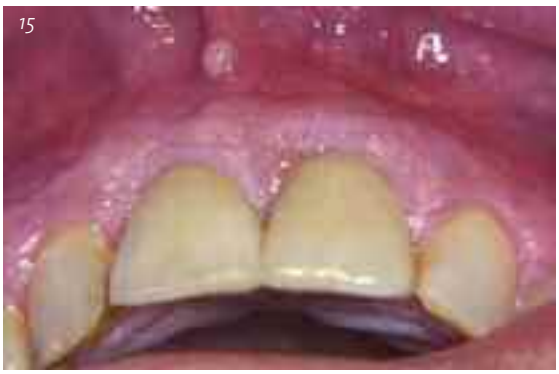


Fig. 15
Restored bone profile and soft tissue.

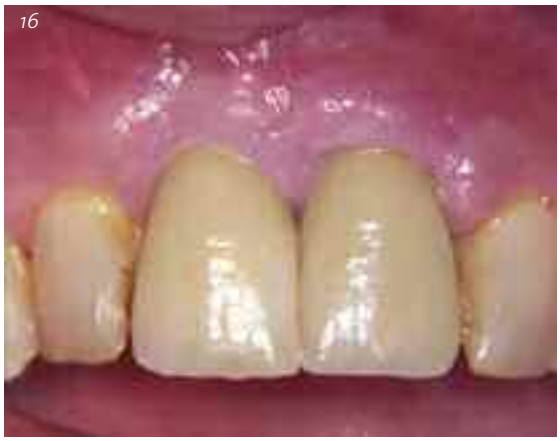
not to put pressure on the graft site (Fig. 9). The graft can be seen on the postoperative radiograph, extending two-thirds of the length of the implant (Fig. 10).

After suturing, a temporary bonded cantilever bridge was fitted using temporary cement (Olympian; Dent Zar, Tarzana, CA, USA). The improved tissue profile was already evident after suturing. The patient was given antibiotics (Amoxycillin, 250 mg q.i.d.) and Ibuprofen and reported no pain or swelling the following day.

A week later, the sutures were removed, showing a healthy healing site; the patient was told to return four months later for the loading phase. Early loading and earlier remodelling, even with severe defects, is an option due to the increased blood supply to the graft site.

During the restorative phase, the healthy gingival tissue and return of the buccal profile were indicative of a successful case, which was confirmed by a radiograph. A tissue punch was used to access the implant and a healing collar fitted for a few days to profile the soft tissue (Fig. 11).

A standard angled titanium abutment was used in conjunction with Lava (3M, St. Paul, MN, USA) full-crown restorations (Fig. 12) cemented to the abutment and the adjacent central incisor. The patient found the result acceptable (Fig. 13) and did not desire any further work on the adjacent laterals. The new regenerated tissues were seen again four weeks later and presented with a restored bone level and profile with acceptable soft-tissue aesthetics (Figs. 14 and 15).



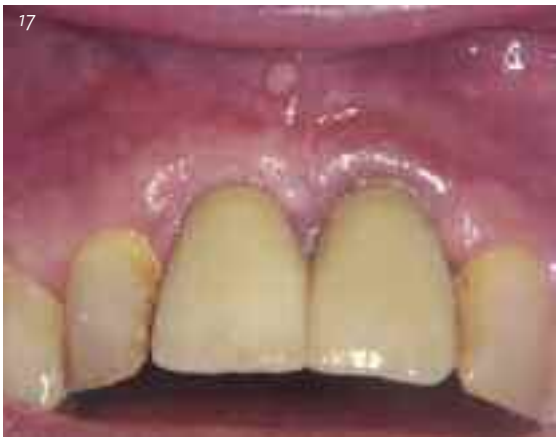


Fig. 16
Loaded for one year, healthy tissues.

Fig. 17
Loaded for nearly three years, issue with UL central.

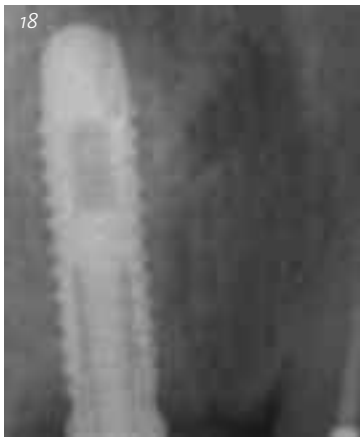


Fig. 18 Radiograph showing good bone levels on the implant.

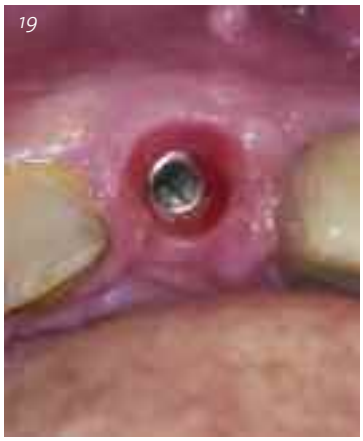


Fig. 19 Crown removed to show healthy tissues at nearly three years.

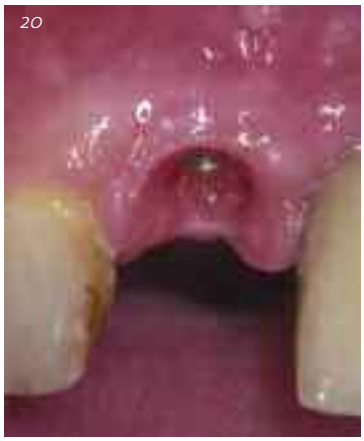


Fig. 20 Healthy papillae and emergence profile.

The patient returned for a routine follow-up one year later. The tissues still appeared healthy (Fig. 16), and on the radiograph the bone level appeared to be sound.

After two and a half years of loading, the patient presented with an issue with the UL1, and the soft tissue appeared unhealthy (Fig. 17). The bone tissue around the implant was still acceptable as seen on the radiograph (Fig. 18). The crown and abutment were removed to repair a slight ceramic fracture on the palatal aspect, and this showed healthy emergence profile with papillae despite the issues with the adjacent teeth (Figs. 19 and 20). The upper left central incisor will be removed soon, and a further implant placed, at which time further study of the GBR site will be conducted.

Conclusion

The unique ability of Fortoss Vital to be both stable and occlusive to soft-tissue cells has made membrane-free GBR a reality, allowing full utilization of the periosteal blood supply in bone regeneration. This allows the surgeon to work in a manner complementary to natural bone-healing pathways, using this fully biocompatible, bacteriostatic and bioabsorbable material to return diseased and damaged bone to its former natural state, without any residual foreign particles.

This readily available, affordable material reduces the need for difficult consent issues or donor-site trauma, leading to an increase in treatment plan acceptance by patients.

Fortoss Vital has only been used in a dental surgery for the last nine years, but the long-term results and retention of the bone profile in grafted sites has been impressive. Whilst more study is needed, there appear to be significant benefits for patient and surgeon alike with the use of this novel material. ■

Visit the web to find the list of references (www.teamwork-media.de). Follow the link "Journale online" in the left sidebar.

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