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Use of xenograft bone block for staged ridge augmentation prior to dental implant placement in trauma patients

by James Chesterman, Kathryn Durey and Martin Chan

We review the outcome data of patients who underwent horizontal alveolar ridge augmentation to assess the viability of equine xenograft blocks.

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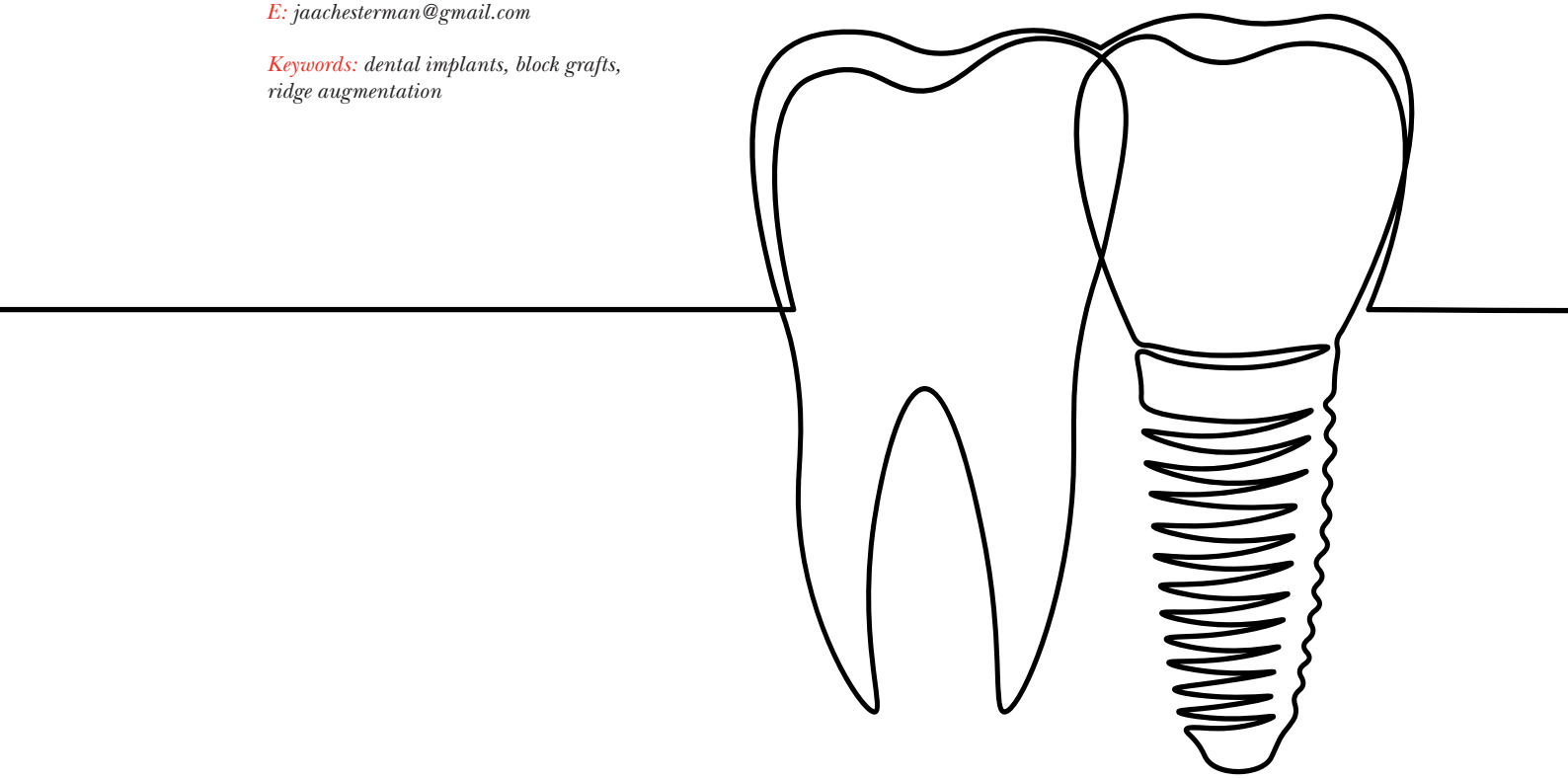


Traumatic dental injuries may result in significant hard and soft tissue deficiencies.[1,2] Extensive bone grafting is often required prior to implant placement to allow the correct three-dimensional position of the implant to be achieved in relation to the proposed prosthesis. Where possible, simultaneous implant placement with or without guided bone regeneration is preferred as this reduces the need for multiple surgical procedures, reducing the duration of treatment. However, if the dimensions of the ridge are insufficient to achieve primary implant stability, a staged ridge augmentation procedure is indicated (Figure 1).[3]

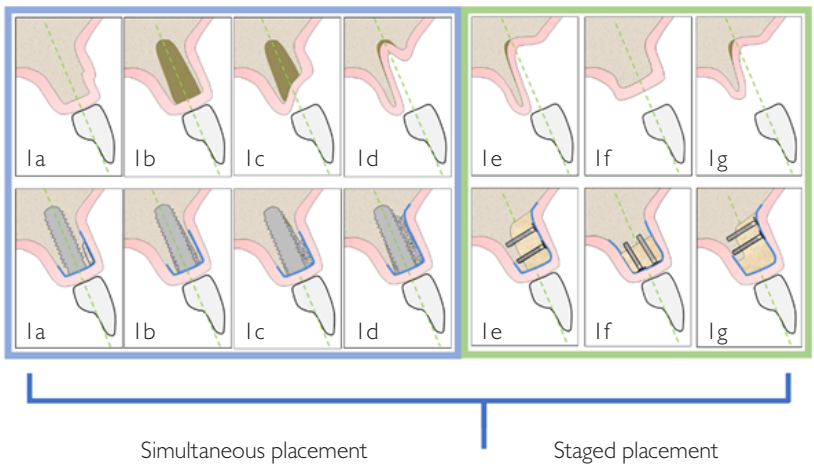
Numerous options have been suggested for staged ridge augmentation such as onlay block grafts, interpositional block grafts, guided bone regeneration (GBR), ridge splitting and distraction osteogenesis.[4] In addition, various bone grafting materials have been described in the literature, including autogenous, allograft, xenograft and synthetic materials. These may be used alongside different occlusive and supporting membranes to facilitate staged GBR.[5]

Autogenous bone is generally considered the gold standard in block grafting owing to its favourable osteoconductive, osteoinductive and osteogenic potential. Autogenous block grafts are also the most documented for horizontal augmentation,[3,6] and they have been shown to predictably and significantly increase alveolar ridge width when used in a staged approach.[7] On the other hand, these grafts are associated with second-site surgery and related morbidities. Joshi demonstrated up to 33% postoperative morbidity from intraoral mandibular chin block grafts, including paraesthesia and pain.[8] Iliac crest grafts require general anaesthesia, and they are associated with donor site morbidity such as scarring, infection, altered sensation, altered gait and pain.[1,9] Furthermore, autogenous grafts are associated with a significant amount of resorption with up to 23% lateral and 42% vertical reduction in dimensions in the graft healing stage prior to implant placement.[10]

Although implant survival rates in staged grafted sites appear to be comparable with non-grafted sites,[11] it is known that there is continued graft resorption resulting in marginal bone loss prior to and following implant placement.[12,13] There is little evidence relating to soft tissue aesthetic outcomes in implants placed in staged grafted sites.[14] However, some authors have demonstrated long-term stability of peri-implant tissues in sites grafted with autogenous block grafts.[15]

The development of materials and techniques that can be used as an alternative to autogenous bone has been a significant area of interest in implant dentistry research. Extensive GBR in a staged approach has been attempted with particulate autogenous and xenograft bone combinations.[16] Particulate bone can provide only limited structural stability unless used in conjunction with self-supporting membranes and titanium meshes. Some authors have reported high success rates with such techniques. Nevertheless, it remains a highly sensitive technique. A common complication of staged GBR is membrane exposure,[11] which may result in complete wound breakdown, particularly if non-resorbable membranes are used.

Figure 1 Alveolar ridge defects and suggested protocol for placement. 1a: Small horizontal ridge defects can be managed with simultaneous guided bone regeneration (GBR) with a resorbable membrane. 1b: Immediate implant placement may require simultaneous GBR to augment the socket and protect the buccal plate. 1c: Larger defects resulting in implant dehiscence can be predictably managed with GBR and non-supporting resorbable membrane if this is supported by the adjacent alveolus. 1d: Large defects resulting in a dehiscence that will not be supported by adjacent alveolus may require a self-supporting membrane (ie titanium-reinforced high-density polytetrafluoroethylene). 1e–g: Ridges lacking adequate height and/or width may require significant staged block grafting to facilitate implant placement.



With respect to alternative block bone grafts, the options include alloplastic, xenograft and synthetic materials. Nissan *et al* demonstrated good survival rates of implants placed in sites augmented with cancellous bone block allografts ranging from 95.3% to 98.8% in the mandible and maxilla respectively.[17,18] However, these studies had relatively short follow-up periods of four years or less. Allografts have been generally less popular in the UK than alternative materials, probably owing to clinician and patient reluctance to accept human derived donor material.

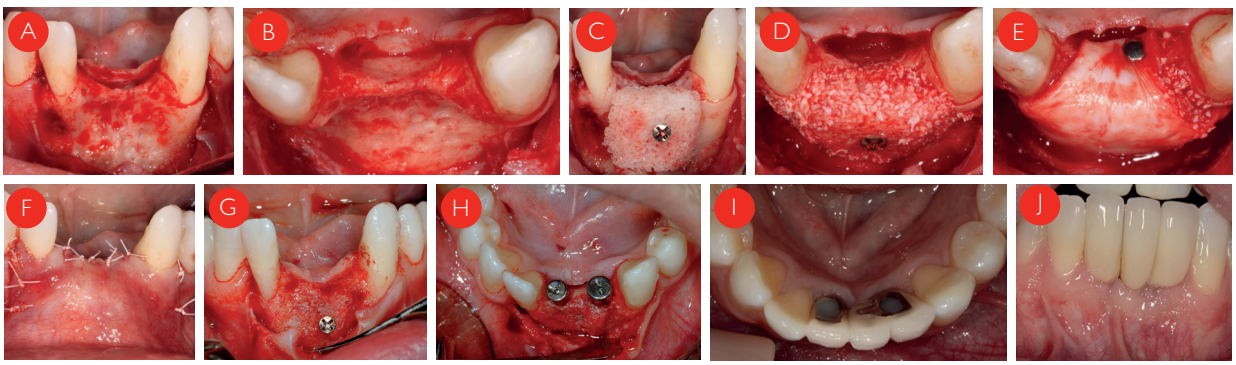
Although fully synthetic block graft materials have been developed, clinical evidence is lacking. In a small clinical study of 15 patients, computer-aided design/computer-aided manufacturing (CAD/CAM) was used to construct blocks of synthetic beta-tricalcium phosphate and hydroxyapatite with the desired dimensions.[19] The implant survival rate was 100% at a mean follow-up of 4.7 years but 20% of the grafts became exposed during healing. While the use of CAD/CAM technology to construct the ideal shape of block graft is promising, the outcomes of such methods and materials are largely unknown, and further research is required.

The use of equine xenograft blocks for ridge augmentation has been demonstrated in a number of animal studies.[20–22] One clinical case series has described outcomes of equine block grafts; however, the authors

Table 1 Summary of case outcomes. GBR = guided bone regeneration.

Case	Graft complications	Implant placement protocol	GBR required at time of placement	Implants placed	Implant survival	Follow-up after implant placement	Maximal marginal bone loss
A	Nil	Transmucosal	No	2	100%	3 years	≤1mm
B	Nil	Transmucosal	No	1	100%	3 years	2mm
C	Nil	Covered	Yes	1	100%	3 years	3mm
D	Nil	Covered	No	1	100%	18 months	2mm
E	Nil	Covered	No	2	50%	3 years	3mm
F	Nil	Covered	Yes	1	100%	3 years	2mm
G	Failed	N/A	N/A	N/A	N/A	N/A	N/A

Figure 2 Case A – a 33-year-old male patient with traumatic tooth loss (LR1, LL1,2). 2a–f: Treatment with a xenograft equine block graft. 2g and 2h: Implant placement (LR1 and LL2) carried out at 9 months following grafting and healing abutments placed. 2i and 2j: Implant restorations at 3 years following implant placement.



did not report on the survival rate of implants placed in these grafted sites.[23] A more recent prospective single-arm study investigated the results of 28 xenograft block bone grafts (Bio-Graft®; Geistlich, Manchester, UK) in 13 patients.[24] Eighty-four per cent of the patients had sufficient bone to place implants after a staged grafting procedure and thirty per cent of the implants placed were lost early. The high failure rate reported was thought to be related to the high incidence of soft tissue dehiscence.

This case series reports the results of seven patients who underwent horizontal alveolar ridge augmentation with equine xenograft blocks. It presents the outcome data for implants placed in these grafted sites with a follow-up period of up to three years.

Methods

This study was carried out retrospectively with a review of patient records to assess performance of xenograft block bone grafts used to augment the alveolar ridge. All consecutively recruited participants required a staged block bone graft prior to implant placement. The alternative gold standard procedure was an intraoral or extraoral autogenous block bone graft. All patients during the study period requiring an intraoral block bone graft were consented for an alternative xenograft equine block bone graft. Use of the patient records was approved for retrospective analysis by Leeds Teaching Hospitals NHS Trust.

The clinical protocol used to treat these cases is described below. All consecutive patients who received a xenograft equine block bone graft to augment the alveolar ridge were included in the study. The treatment was carried out between October 2014 and February 2016 at the Leeds Dental Institute. All adults over the age of 18 years treated with a staged xenograft equine block bone graft were included. All patients required implant rehabilitation following dentoalveolar trauma.

Clinical procedure

Preoperative cone beam computed tomography was performed to determine whether a staged block graft would be required prior to implant placement. Seven onlay block bone grafts were carried out with Osteo-Biol® Sp-Blocks (Tecnoss, Giaveno, Italy), which consist of equine derived rigid cancellous bone (Figures 2c and 4c). The blocks were soaked in warm isotonic saline for ten minutes and shaped to fit the alveolar contour with piezosurgery (Figures 2c and 4c). The crestal incisions were made lingual/palatal to avoid wound edges

directly over the graft. The cortical bone was perforated to facilitate blood supply (Figures 2a and 2b).

The block was secured with a bone screw and additional particulate xenograft was packed around the block (Bio-Oss®; Geistlich) (Figures 2c and 2d). A resorbable collagen membrane of equine origin (Evolution; Tecnoss), which has an estimated resorption time of four months, was placed over the augmented area (Figures 2e, 3d and 4d). Periosteal release was performed to allow tension free closure (Figure 2f). A single dose of prophylactic antibiotics was administered preoperatively.

Cone beam computed tomography was repeated at eight months following block grafting to assess bone dimensions, and plan implant position and size. At nine months, a full mucoperiosteal flap was raised and the bone screw/tacks were removed. Osteotomy sites were prepared using a tooth-supported surgical guide to allow predictable prosthetic driven implant placement (Figures 3f and 4e). Xive® (Dentsply, Charlotte, NC, US) implants were placed and implant stability was deemed good in all cases. Additional GBR was carried out in the event of a buccal dehiscence with locally harvested autogenous bone chips, particulate deproteinised bovine bone mineral (Bio-Oss®) and bilayer porcine collagen membrane (Bio-Gide®; Geistlich).

Implant exposure was carried out at six months in cases requiring additional GBR (Table 1; cases C and F) or where the bone quality was suboptimal (Table 1; cases D and E) and provisional restorations were placed for three months. The definitive screw retained restorations were placed at approximately nine months following implant placement.

Results

One xenograft block graft failed to integrate and was removed with surgical debridement (Table 1; case G). This patient elected to have a removable solution with no further surgery. In summary, six of the seven grafts integrated successfully. A total of eight implants were placed in six patients and one implant was lost as a primary failure (Table 1; case E). The clinical and radiographic outcomes of implants placed in the six patients are illustrated in Table 1 and Figure 5. One patient was lost to follow-up at 18 months.

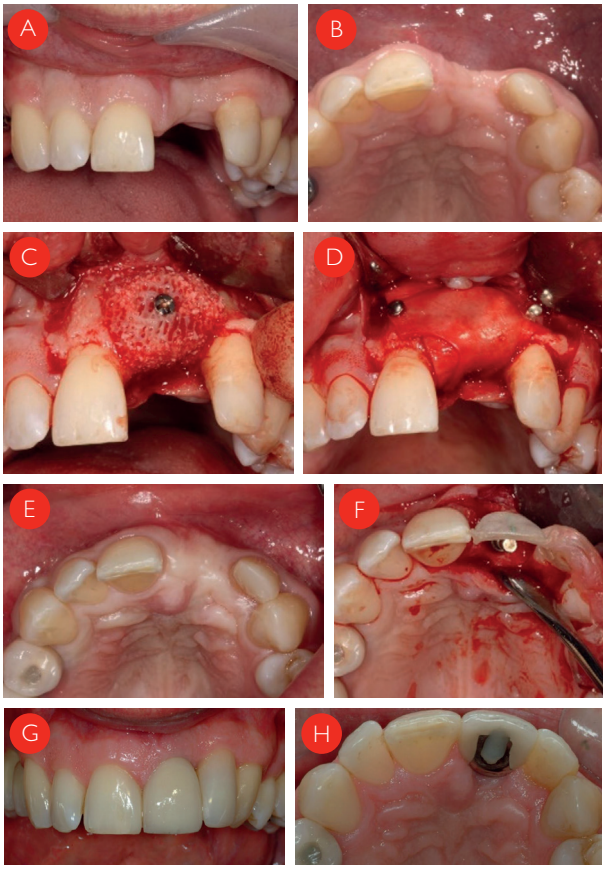


Figure 3 Case B – a 34-year-old male patient with traumatic tooth loss (UR4,5,6, LR3, UL1). 3a–d: The UL1 site was augmented with an equine onlay block graft prior to implant placement. 3e: The increased ridge profile at 9 months following grafting. 3f: The use of a surgical guide to aid correct implant positioning. 3g and 3h: Screw retained implant restoration at 3 years following implant placement.

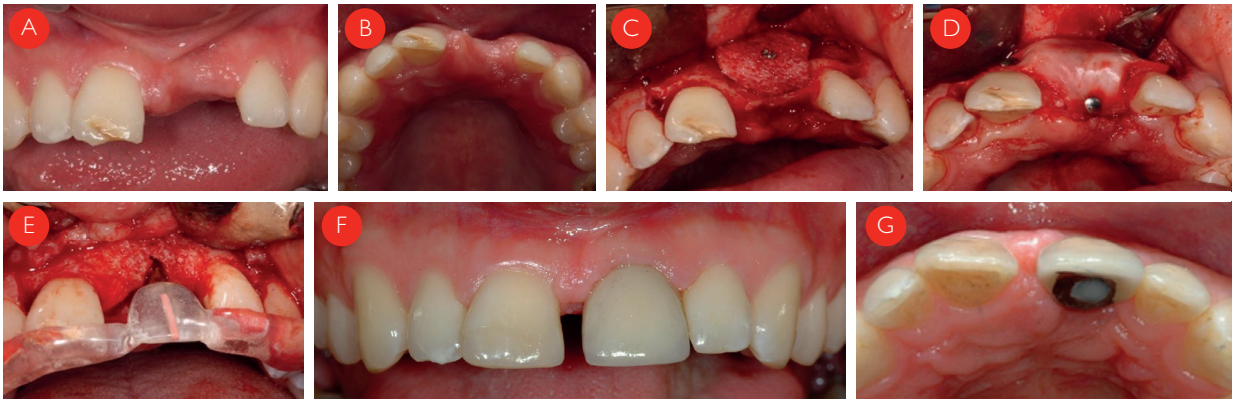
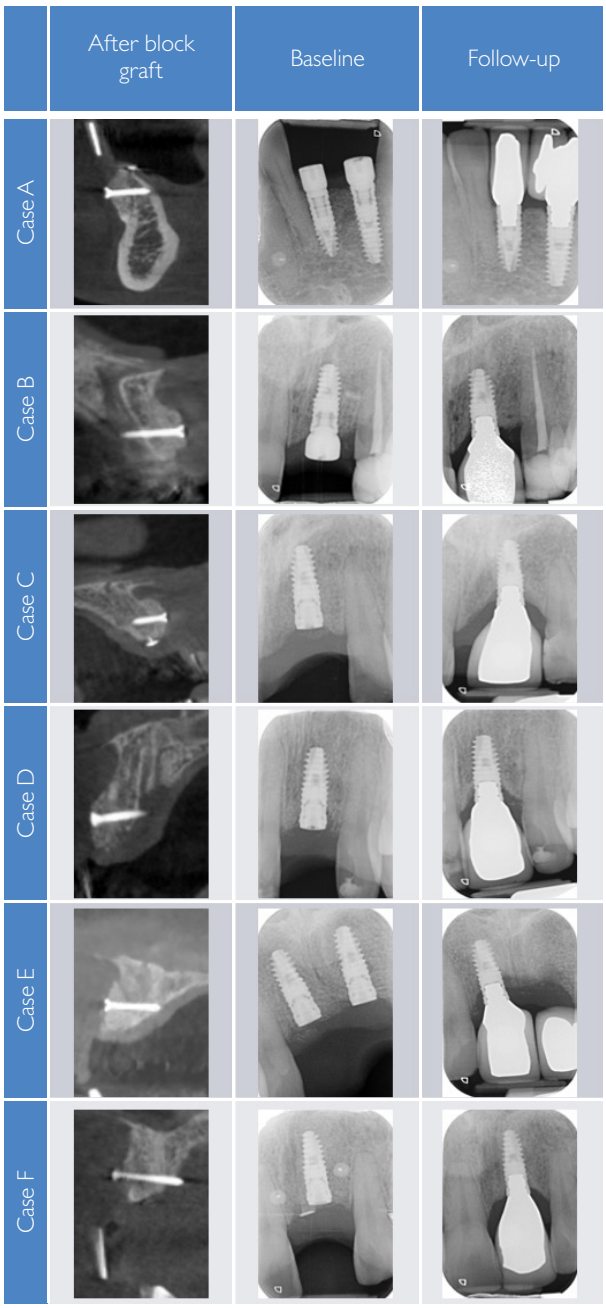


Figure 4 Case C – a 21-year-old male patient with tooth loss (UR1) sustained when aged 10 years with a high frenal attachment. 4a–d: The UL1 site was augmented with an equine onlay block graft prior to implant placement. 4e: At 9 months, implant placement was undertaken with local guided bone regeneration to augment the small buccal dehiscence. The implant was left covered. 4f and 4g: Screw retained implant restoration at 3 years following implant placement.

Figure 5 Cone beam computed tomography at 8 months after the block graft (to assess bone dimensions and plan implant position and size), immediately after implant placement (to establish baseline) and at last follow-up visit



At the time of implant placement, the xenograft bone blocks had minimal resorption, were well integrated with surrounding bone and well vascularised. In two cases, additional GBR was provided at the time of implant placement (Bio-Oss® and Bio-Gide®). Postoperative healing was uneventful in all implants placed. All implants are associated with early marginal bone remodelling of 1–3mm (Table 1, Figure 5). Where cases were followed up for three years, the marginal bone remained stable between two and three years (Table 1, Figure 5; cases A–C, E and F).

Discussion

The technique presented in this case series has similar implant survival outcomes to other staged bone grafting procedures.[11,14,17,18] The marginal bone loss is greater than expected when compared with sites grafted with autogenous blocks from intraoral and extraoral iliac crest sites, with an average of 0.09–0.17mm and 1.8mm marginal bone loss respectively over ten years.[25,26]

A significant limiting factor is the brittle property of the xenograft blocks and the wound tension can be hard to control to prevent wound breakdown. In our opinion, these procedures are highly technique sensitive and can result in graft failure. The grafts appear to be limited to a 1–2 tooth sized defect and require a longer healing time (9 months prior to implant placement) than autogenous bone. Further GBR may be required at the time of implant placement with additional biomaterials, which is similar to autogenous block grafting techniques. This complicates the procedure and buried healing may therefore be necessary following implant placement.

The results of this study must be interpreted with caution given that it is low quality evidence from a retrospective case series. There is no control group to compare the outcomes with the accepted gold standard autogenous block bone grafts. There may be confounding factors that are not accounted for, such as defect size. There is also potential for recruitment bias with respect to patient selection for the study. In addition, there is a strong likelihood of recall bias and reporting bias as the results are based on historical patient records.

To our knowledge, this case series is the second publication reporting the outcomes of implants placed in xenograft block grafts. While it is low quality evidence, it demonstrates that despite the limitations of xenograft block grafts, these can be used successfully to augment the alveolar ridge. There is reduction in clinical surgical time required for second-site surgery to harvest an autogenous graft. This procedure is therefore more cost effective than autogenous block grafts. The cases in our series appear to have fewer associated failures than those reported by Ortiz-Vigón *et al.*[24] However, the cases presented in that prospective study appeared to involve larger grafted areas with most patients being treated with multiple blocks.

The use of xenograft block bone grafting materials has limited long-term outcomes data and further evidence is required before these block grafts can be recommended routinely. Nevertheless, in the case of a 1–2-tooth sized, 1-walled defect where autogenous block grafting is not possible or not preferable, these xenograft block bone grafts offer a viable alternative. It is important that

patients are informed of the benefits and limitations of the available options prior to treatment.

Conclusions

The use of xenograft equine blocks to augment horizontally deficient alveolar ridges prior to implant placement is a viable option for a 1–2-tooth sized, 1-walled defect. It offers an alternative to extraoral and intraoral autogenous block grafts that avoids surgery at a second site and is more cost effective. However, the treatment duration is longer and there appears to be greater early peri-implant marginal bone loss than for autogenous block grafts. The methods illustrated are highly technique sensitive and careful case selection is required. Further clinical evidence is required to justify equine xenograft block grafts to routinely augment the alveolar ridge prior to implant placement.

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