Seven-year outcome data of autogenous block onlay bone grafts used to augment the alveolar ridge prior to implant rehabilitation

James Chesterman*, *Mital Patel, Martin Chan* and *Lachlan Carter examine the efficacy, indications and potential drawbacks of onlay bone grafts

Aims and objectives

This article aims to provide an overview of the outcomes of autogenous block onlay bone grafts in implant dentistry.

Readers will:

• Learn the comparative success rates for extraoral Iliac crest bone grafts (IBG) or intraoral mandibular chin/ramus bone grafts (MBG) in a hospital setting

• See the indications for these treatments

• Understand the potential complications for these treatments.

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The provision of dental implants is only possible if there is a sufficient amount of bone height and width. This is essential for good primary stability and a predictable soft tissue outcome (Esposito et al 2009).

Patients presenting with hypodontia or severe forms of dental trauma are often rehabilitated using dental implants, which allow fixed replacement of their missing teeth (Worsaae et al 2007; Andreasen et al 2011). However, these patients often lack sufficient bone and require alveolar bone grafts to augment prospective implant sites prior to implant placement (Chiapasco et al 2006).

This article aims to provide an overview of the outcomes encountered within a multidisciplinary unit, when providing autogenous block onlay bone grafts, in order to increase bone volume for subsequent implant placement.

Background

Typically autogenous bone can be harvested intraorally from the maxillary tuberosity, the symphysis (chin) and the ramus of the mandible (Triplett and Schow 1996; Chiapasco et al 1999; Raghoebar et al 1996). These grafts have shown reliable success rates (Chiapasco et al 2006; Donos et al 2008). Bone harvested from these sites is usually appropriate for single tooth defects, up to moderately-sized defects with or without additional xenograft augmentation.

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TABLE 1:

Graft type	Cases
Mandibular chin	31
Mandibular ramus	1
Anterior Iliac crest	13

Table 1: Distribution of graft types

TABLE 2:

Graft Type	Anaesthesia	%
Intraoral mandibular	LA	62%
	GA	38%
Extraoral Iliac	LA	0%
	GA	100%

Table 2: Type of anaesthesia used

When more extensive defects arise, a larger volume of bone can be harvested from extraoral sites such as the iliac crest, scapular or calvarium sites (Chiapasco et al 2006).

Bone harvested from intraoral sites is intramembranous bone, which revascularises and heals quicker than bone harvested from extraoral sites (Oppenheimer et al 2008). Therefore, this results in less resorption of the bone. However, this may be more related to the thickness of the cortical bone which inherently revascularises slower than cancellous bone (Oppenheimer et al 2008). The disadvantages are that limited bone can be harvested. For this reason extraoral bone grafts are often necessary when multiple teeth are missing or large defects need grafting.

The literature reports varying success rates for alveolar block onlay bone grafts (ABGs), which makes it difficult to know what to expect from these procedures. A review of the evidence including a wide range of studies, demonstrated a success range of 92-100% for onlay bone grafts (Chiapasco et al 2006).

The Leeds Teaching Hospitals Trust (LTHT) mainly performs grafts harvested from intraoral mandibular and extraoral iliac crest sites, depending on the size of the bony defect. The grafts are harvested and secured to the alveolar bone with titanium bone screws. This is then followed by a second procedure, after a period of healing of around three to four months, to place the implants.

Aims and standards

A retrospective audit was carried out at the LTHT investigating the success and complication rates of ABGs over a seven-year period.

This audit aimed to gather original data on the success and complication rates of ABGs within the LTHT, to see how our results compared to those published in the literature. It was hoped that this would provide invaluable information, which is essential when trying to improve outcomes, but also in planning or consenting patients for such procedures carried out by a multidisciplinary team in a secondary care setting. Based on previous literature the standard set for this audit was that the success rate of ABGs should be 92% or above. The success in this article was determined by the ability to place and restore implants into the grafted bone.

Methodology

Consent to access patient records was obtained following registration of the audit with the LTHT audit governance department. The patients were identified by two methods.

Firstly, the Leeds Dental Institute (LDI), department of restorative dentistry implant surgery log book. This identified patients that had intraoral and extraoral bone grafts. Secondly,

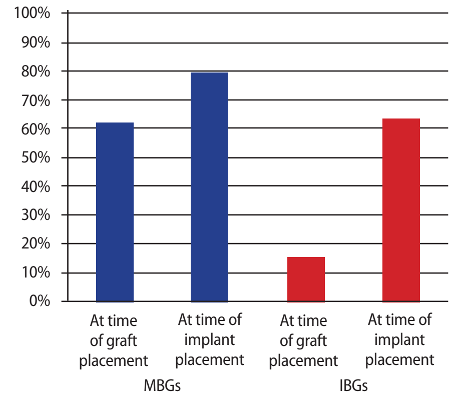

Figure 1: Use of additional xenografts

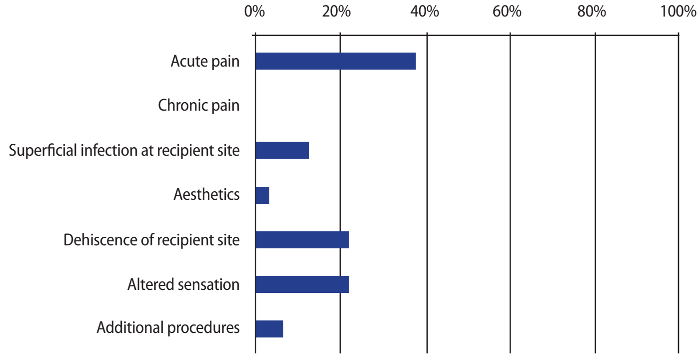

Figure 2: Complication rates for MBGs

to ensure no patients were missed, the Leeds General Infirmary (LGI) coding team was contacted to identify the relevant codes for the ABG procedures carried out by the oral and maxillofacial surgery team. The theatre lists were subsequently searched using the appropriate codes. These two lists were compared in order to eliminate any duplicated patients, given that the treatment of these patients is often multidisciplinary, involving both teams.
The data was collected retrospectively from patient records. The information gathered included:
1. Reason for ABG
2. Surgery site and type of anaesthesia
3. Ability to place and restore implants into function following ABG procedure
4. Any further procedures required at time of graft and implant placement
5. Graft and donor site complications
6. Use of pre/post-prophylactic antibiotics

Results

Distribution of data

A total of 45 patient records were identified to have had an ABG in the last seven years. These were all included in the data collection process.

From the 45 cases, the need for a bone graft was mainly due to trauma (30) and hypodontia (13). Only two cases were related to other reasons and both of these had ectopic teeth as a cause of insufficient bone. The donor site for the bone graft and type of anaesthetic used are illustrated in Tables 1 and 2.

The donor sites were grouped into either extraoral lliac crest bone grafts (IBG) or intraoral mandibular chin/ramus bone grafts (MBG). This was done to avoid having a very small group of mandibular ramus grafts, as there was only one identified case carried out.

Success rate

The overall success rate of the ABGs was 93.5%. The success rate of intra oral MBG was 94% (total 29/31); and for extra oral IBGs was 85% (total 11/13). There were four identified failures, whereby three had necrotic and infected bone at exposure; and one case had undergone extensive resorption, leaving insufficient bone for subsequent implant placement.

Antibiotic prophylaxis

The majority of cases undergoing ABG were managed with pre- and postoperative antibiotic prophylaxis.

Only one mandibular graft received no preoperative antibiotic. All iliac crest grafts received preoperative cover.

One IBG and one MBG case received no postoperative prophylaxis. A variety of oral regimes were prescribed for postoperative antibiotics including amoxicillin 500mg; co-amoxiclav 625mg, or amoxicillin 500mg and metronidazole 400mg.

Preoperative antibiotics were found to be amoxicillin 500mg intravenously (IV) at induction for general anaesthetic cases, and 3g oral amoxicillin one hour prior to local anaesthetic cases where prescribed. Those with penicillin allergies were prescribed clarythromycin 500mg IV at induction preoperatively and/or oral erythromycin 500mg post-operatively. Postoperative antibiotics were prescribed for a five- to seven-day course.

Additional grafting

The use of additional bone augmentation in conjunction with ABGs was assessed, including those performed at the time of the original graft and at the time of implant placement (Figure 1).

A greater proportion of MBGs received additional augmentation at both stages compared with IBGs. The choice of material for all additional augmentation at the time of grafting was deproteinised natural bovine bone mineral particulate xenograft (Bio-Oss, Geistlich) and autogenous cancellous bone material harvested from the donor site, mixed together.

The deproteinised bovine bone xenograft was used more frequently at the implant placement stage than at the primary grafting stage. In most cases it was combined with a porcine derived collagen membrane (Bio-Gide, Geistlich, Switzerland). Of the 23 MBGs that underwent additional grafting with xenograft particulate material, four were placed with no membrane.

Complications

The complication rates for MBGs and IBGs are shown in Figures 2 and 3 respectively. The average duration of pain experienced by patients was 10.6 for IBGs and 3.8 days for MBGs (Figure 4).

Acute pain was the most common complication. Chronic pain was rare with only one patient, who received an IBG, reporting over 30 days of discomfort. No patients reported permanent pain symptoms.

MBG complications

Complications specific to intraoral MBG included superficial infections at the recipient site (12.5%), dehiscences of intraoral wounds (21.9%) and altered sensation in the donor site region (21.9%). One patient showed discolouration of the lower incisors following a mandibular chin graft procedure, indicating potential devitalisation. The dehiscences often resulted in exposure of grafts and membranes if present, but with no detrimental effects. Most paraesthesia resolved within two weeks. Following a chin graft, one patient had permanent numbness of the lower lip and one patient experienced a lump within the lower lip soft tissue, thought to be a mucocele. No patients reported an altered profile of the chin.

IBG complications

Complications specific to extraoral IBGs included superficial infections (15.4%), dehiscences of recipient sites (23.1%) and scarring problems (15.4%). One patient

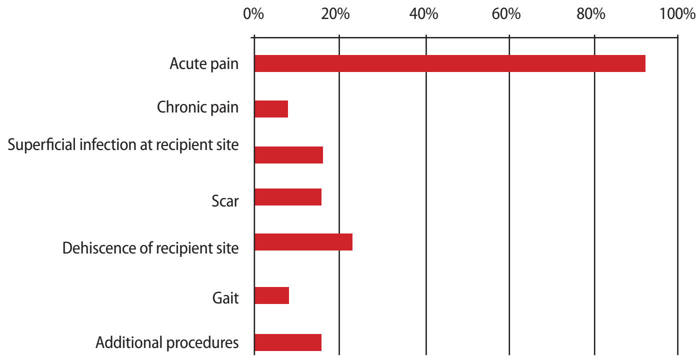

Figure 3: Complication rates for IBGs

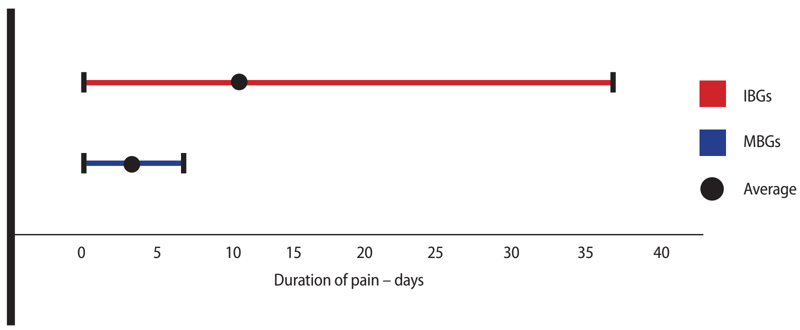

Figure 4: Average and range of duration of pain as a complication of onlay block bone grafts

reported dissatisfaction with permanent scarring and one patient experienced gait disturbances for 12 weeks. There were no reported neurological deficits from the donor site, permanent gait disturbances, haematomas or crest fractures.

Other procedures required

The recipient site sometimes required more extensive treatment, with two of the IBGs requiring sinus lifts at time of graft placement.

Two of the MBGs required connective tissue grafts to increase the soft tissue widths, to ensure stable soft tissues around the implants and improve aesthetics.

Discussion

An adequate quantity and quality of bone, with a well-formed cortex and densely trabeculated medullary spaces served with a good blood supply are essential for successful osseointegration of implants (Albrektsson et al 1981). It is therefore important that these cases are managed with a thorough prosthodontically-driven planning stage and a carefully executed surgical procedure.

The overall success rate of 93.5% meets the standard set for this audit. This was based on success rates reported in the current literature as being between 92-100% (Chiapasco et al 2006).

When the MBG and IBG are considered separately, the IBG success rate falls short of the standard set. A possible reason for this higher failure rate may be due to case selection and the fact that higher-risk, more complicated cases often undergo an IBG. IBGs may fail more frequently due to the amount of bone augmented, which is likely to increase the tension over the graft (Pommer et al 2012).

Another complication of IBGs over MBGs is the nature of the bone, which is endochondral in origin and may revascularise less rapidly (Oppenheimer et al 2008). In addition, the thickness of the cortical portion of the graft in the MBGs is thicker, which will resorb more slowly over IBGs (Oppenheimer et al 2008).

The infection rates noted are difficult to explain. The use of antibiotics may contribute to infection rates discussed later. A departmental protocol for antibiotic prophylaxis would aid future auditing. Any trends within the success rates could then advocate the use of such antibiotic prescribing. There are many confounding factors that may be linked to the cause of infection such as the use of xenograft materials, excessive tension in the wound or lack of primary closure, whether antibiotic prophylaxis was given, and any medical co-morbidities of the patient.

One of the biggest challenges surgeons face when carrying out large block onlay grafts is trying to close the wound primarily with a limited amount of soft tissue, while ensuring minimum tension in the flap. Despite adequate periosteal release this can still be a problem and may sometimes result in tension in the flap or lack of primary closure.

In these cases good postoperative patient care is essential to minimise the chances of the site and graft becoming infected.

In cases where it is obvious that there is going to be a lack of soft tissue (eg, shallow sulcus depth) alternative procures may need to be considered as opposed to a block onlay graft. These can include distraction osteogenesis, ridge split techniques, interpositional grafts and the use of short implants (Sbordone 2009).

Work by Rocchietta et al (2008) looked at the predictability of some of the above procedures and they showed great promise. However, Tonetti et al (2008) explained that 'the evidence base is circumscribed to a limited number of studies with few investigators'.

Therefore, the management of large – and particularly vertical – defects remains under scrutiny for the best course of action. It is important as clinicians to consider the limitations and alternatives that may provide less invasive and/or more predictable outcomes. For instance, where short implants could be placed over grafting an area this may provide a suitable alternative that is less invasive to the patient. Equally, if a large vertical defect exists, distraction osteogenesis may provide a more predictable outcome, at the cost of increased treatment time.

The use of prophylactic antibiotics was not consistent over the oral and maxillofacial surgery (OMFS) and restorative departments, including the type and duration of antibiotic cover. Within the restorative department the protocol for onlay block bone grafts is amoxicillin 3g, one hour preoperatively, followed by five days oral amoxicillin 500mg and metronidazole 400mg. There is currently no OMFS protocol, which is often lead by individual consultants.

There was no obvious link identified with respect to antibiotic prophylaxis and failure of cases. In the event of failure/infection, the cases received both pre- and postoperative antibiotic prophylaxis. A recent systematic review found that some evidence suggests 2g amoxicillin, one hour preoperatively, significantly reduces short term implant failure (Esposito et al 2010). There is little evidence looking specifically at bone grafting, although, guidelines from the Scottish Intercollegiate Guidelines Network (SIGN) recommend single dose preoperative antibiotic regimes for intraoral bone grafts (SIGN 2008).

MBGs received additional augmentation at time of graft and implant placement more frequently than the IBGs. This may be due to the limited bone that can be obtained from the different intraoral sites. This may also be related to clinician preference and experience. Most of the additional augmentation procedures were restoratively-led rather than OMFS-led. One of the reasons for this is that at LTHT most of the dental implants are placed by the restorative specialist by adopting a prosthetically-driven implant placement protocol.

Acute pain was the most common complication with ABGs, which was of longer duration for IBGs, where more invasive and extensive treatment is required. Another complication was graft site wound dehiscence, which is mainly due to tension within the flap following graft placement (Pommer et al 2012).

The rate of infection was similar between MBGs and IBGs. One infection was suspected to be related to cystic remnants within the site.

Other complications for the IBGs were gait disturbance, scarring and altered sensation.

MBGs, and in particular chin grafts, affected the sensation of the lip and labial mucosa.

When a chin graft is harvested the mental nerve is often stretched (Joshi 2004). The mechanism of nerve injury is thought to be neuropraxia of the incisive nerve or the terminal branches of the mental nerve (Joshi 2004). In many cases this is often temporary, where four patients (12.9%) experienced this. However, two patients (6.7%) reported permanent changes, one of the teeth and one of the lip/chin.

An MBG was also associated with signs of devitalisation of lower incisors from the donor site in one case. Normally the teeth have a 5mm safety margin to avoid this. However, in some cases the space may not allow for this, which may compromise the vitality of the incisors.

These irreversible risk factors are rare but as the results of this audit show, they can have a significant impact on the patient's quality of life or the need for further treatment, such as root canal treatment. It is essential that clinicians discuss the risk factors and the possible complications with the patient as part of the informed consent process. A careful surgical approach with sufficient relieving incisions should be performed to prevent excessive tension during harvesting.

MBGs at LTHT are consistent with similar complication rates from the literature, with few patients experiencing permanent morbidities and/or failure (Joshi 2004).

The literature reports low morbidity with IBGs with similar rates of complications as this audit (Barone et al 2011).

However, the use of MBGs offers several advantages, including reduced operating times, reduced morbidity, reduced hospitalisation and no cutaneous scarring (Cordaro et al 2002). There is often no need for a general anaesthetic.

However, the amount of bone required often determines the donor site that can be used. Small, single-tooth-sized defects can be augmented with intraoral block grafts provided there is sufficient bone at the donor site.

In cases of multiple missing teeth, more often than not the clinician needs to consider an extraoral bone graft. The iliac crest graft has many advantages including its osteogenic potential, relative ease of harvesting large bone volumes and the ability to carry out simultaneous surgery at donor and recipient site. This can significantly reduce the time the patient has to be under general anaesthetic for what is often an elective procedure.

Conclusion

This outcome data shows that block onlay bone graft procedures are a successful, reliable and safe treatment modality for patients with insufficient bone for implants. The use of ABGs within the LTHT is comparable with terms of success and complication rates presented within the current literature. Appropriate planning and carefully executed surgical procedures are essential to the overall success.

However, these procedures are not without their failures and complications. Given that these are expensive treatments, those involved must maximise their success and consider alternatives that may offer less risk to the patients.

Patients must be aware of such options, together with the information of their relative merits and downfalls in order to be able to give informed consent to the grafting procedure.

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