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Impaction bone grafting has potential as an adjunct to the surgical stabilisation of osteoporotic tibial plateau fractures: Early results of a case series

Gerrit J. van de Pol [a,b,1], Lukas D. Iselin [a,b,1], Stuart A. Callary [a,b], Dominic Thewlis [c], Claire F. Jones [a], Gerald J. Atkins [a], Lucian B. Solomon [a,b,*]

[a] Centre for Orthopaedic and Trauma Research, The University of Adelaide, Adelaide, SA 5000, Australia
[b] Department of Orthopaedics and Trauma, Royal Adelaide Hospital, Adelaide, SA 5000, Australia
[c] Sansom Institute for Health Research, University of South Australia, Adelaide, SA 5000, Australia

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ABSTRACT

Introduction: Osteoporotic tibial plateau fractures (TPFs) are difficult to treat with either open reduction internal fixation (ORIF) or acute total knee arthroplasty (TKA). They have high complication rates, poor outcomes and often fail in the short- to mid-term. We investigated the use of impaction bone grafting (IBG) as an adjunct to stabilise the fracture in a cohort of osteoporotic TPFs.

Methods: Nine consecutive osteoporotic TPFs were surgically stabilised with ORIF augmented with IBG or with IBG alone (one pure depression fracture) using on average allograft from 2 femoral heads/case (range 1–4 heads or 25–100 cm^3). The median bone mineral density *T*-score of the patients was −2.9 (−2.5 to −4.5). All patients were mobilised weight-bearing as tolerated immediately after surgery and had regular follow-up to a minimum of 2 years where functional scores were taken and gait was assessed. Fracture reduction was assessed on plain radiographs and computed tomography (CT) scans; maintenance of fracture reduction was monitored using plain radiographs, CT and radiostereometric analysis (RSA). Bone graft remodelling was assessed by comparison of immediate post-operative CT scans with scans at a minimum of 1 year.

Results: All surgeries were uneventful. All patients progressed to full weight bearing within 6 weeks of surgery and regained a normal gait by 3 months. Seven fractures healed with a cranio-caudal migration of less than 3 mm (range 0–2.6 mm using RSA and 0–2 mm using CT). Two fractures had an isolated posterolateral fragment depression of 13.5 mm and 9 mm, respectively, which did not affect the overall joint alignment or clinical outcomes at short-term follow-up. At latest CT follow-up, on average 51% of the graft area (range 36–70%) had remodelled into new host bone.

Conclusion: Impaction bone grafting shows promising results as an adjunct to the surgical stabilisation of osteoporotic TPFs. In this case series the technique provided enough fracture stability for patients to mobilise weight-bearing as tolerated immediately after surgery and achieve full weight-bearing by the sixth postoperative week. There was no failure of fixation and 7 of the 9 cases healed with minimal fracture displacement.

Introduction

Open reduction internal fixation (ORIF) is the treatment of choice for tibial plateau fractures (TPFs) [1–5] but stable fixation is difficult to achieve in the elderly [5–7] and especially in osteoporotic patients [8]. A previous study found that 79% of patients aged over 60 lost reduction and fixation after ORIF of TPFs and for osteoporotic patients, the failure rate was 100% [8]. Lengthy post-operative non-weight-bearing periods did not help prevent these complications [8].

In cases of TPF failure, a total knee arthroplasty (TKA) may be required [9], however these have high complication rates and poor outcomes [10–13], with revision rates of between 8% [13,14] and 40% [10] reported at short- to medium-term follow-up. Alternatively, acute TKA can be performed, but this commonly requires the use of stemmed hinged implants and has similar complication and

* Corresponding author at: Level 4 Bice Building, Royal Adelaide Hospital, North Terrace, Adelaide, SA 5000, Australia. Tel.: +61 8 82222665.
E-mail address: bogdansolomon@mac.com (L.B. Solomon).
[1] These authors equally contributed to the manuscript.

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failure rates [14,15] to TKA performed after failed TPF [13]. Acute TKA has been suggested as a reasonable option in octogenarians [16], given their shorter life expectancy. However, because osteoporosis also affects younger patients, more effective fixation methods are required.

Previously, because internal fixation was expected to fail, in our institution osteoporotic TPFs were treated non-operatively with the view that a TKA could be performed at a later stage. Unsatisfactory results and a progressive increase in the prevalence of these fractures led us to look for alternative treatment options. Impaction bone grafting (IBG) has previously been used to reconstruct bone stock at revision hip replacement surgery [17,18] and shown to be a feasible option to augment ORIF of TPF [19,20] in non-osteoporotic patients. Therefore IBG was seen as a reconstruction technique that could potentially augment ORIF of osteoporotic TPFs by improving screw purchase, preventing loss of fixation, and providing the stability required to allow early weight-bearing. We commenced using IBG to augment the fixation of TPF in 2008. Our indications for using IBG in these fractures have evolved and now include any patient in whom articular fracture fixation is deemed compromised by low bone mineral density (BMD), subchondral voids larger than 2 cm^3 and articular comminution that cannot be effectively supported with a raft of subchondral screws. Since 2008, all patients under our care suspected of having a low BMD have undergone a dual energy X-ray absorptiometry (DEXA) scan and had their fracture fixation augmented with IBG.

The aim of this study was to assess the feasibility of IBG to augment internal fixation of osteoporotic TPF by investigating whether IBG prevents failure of fixation in osteoporotic TPFs in a consecutive patient series. To do this we measured the fracture migration during healing in these patients. In addition, we investigated the functional recovery of these patients and the remodelling of the allograft used for IBG.

Methods

Ethics

This study was approved by the Human Research Ethics Committee of the Royal Adelaide Hospital.

Patients

Osteoporosis was defined as a BMD *T*-score ≤−2.5 [21]. If not known at presentation, patients suspected of an osteoporotic TPF had a perioperative DEXA scan. Suspected osteoporotic TPFs included all TPFs in postmenopausal women, multi-comminuted TPFs and low velocity TPFs in patients aged over 50.

Since 2008, of the 115 TPFs treated by the senior author, 14 were proven to be osteoporotic and underwent augmentation with IBG. All patients who had sustained an osteoporotic TPF agreed to participate in the study. Of this continuous cohort, nine fractures in nine patients have undergone follow-up for a minimum of 2 years and were included in this paper. Patient demographics, co-morbidities, fracture characteristics and treatment characteristics are presented in Table 1.

Reconstruction

One patient sustained a pure depression fracture with an intact proximal tibial cortex and was treated with IBG, through a window in the anterolateral tibia, without fixation. All other cases had ORIF and IBG (Fig. 1). In these cases IBG was performed after the proximal tibia was first contained by stabilising depressed articular fragments with subchondral screws and split fracture components with buttress plates. Additional screws were inserted as required after completion of IBG. All screws applied before IBG were regularly retightened during the IBG. Lateral condyle fractures were stabilised with a large lateral L buttress locking plate and a raft of subchondral screws (SynthesInc., West Chester, PA, USA) through an anterolateral [19] or a posterolateral approach [22]. The approach was determined preoperatively based on the comminution of the cortex of the lateral tibial condyle. Cases with anterior comminution were treated through an anterolateral approach, allowing bone graft impaction against a contained posterior cortex. Cases with posterior comminution were treated through a posterolateral approach, allowing bone impaction against a contained anterolateral cortex. The one case of medial condyle fracture was stabilised with small locking LC-DCP plates (SynthesInc.) through anteromedial and posteromedial approaches. Reduction of depressed articular fragments was assessed under direct vision. Any meniscal tears were addressed

Table 1
Patient demographics.

Patient	Age	*T*-score	AO fracture classification	Schatzker classification	Preoperative fracture depression on CT (mm)	Time to surgery (days)	Surgical approaches and fixation	Femoral heads used	D/C after surgery (days)	Relevant co-morbidities
1	55	−3.6	B3	2	24.0	2	AL. Raft of subchondral screws and lateral buttress plate	4	8	Nil
2	66	−4.5	B3	2	20.1	4	AL, PL. Raft of subchondral screws and lateral buttress plate	1	3	Cardiomyopathy, COPD
3	78	−2.9	B3	2	0.7	2	AL. Raft of subchondral screws and lateral buttress plate	2	3	Cardiac failure, osteoporosis (on bisphosphonates)
4	65	−2.5	B2	3	0.6	7	AL. IBG alone	3	3	Nil
5	56	−2.5	B3	2	5.0	4	AL. Raft of subchondral screws and lateral buttress plate	1	4	Nil
6	58	−3	C2	6	26.0	6	AL, PM, PL. Raft of subchondral screws and lateral + medial + posterior plates	2	9	Nil
7	64	−4.4	B1	1	0.0	4	AL. Lateral buttress plate	3	6	Recent ankle fracture
8	68	−2.6	B3	2	6.0	1	PL. Subchondral screws only	1	8	Nil
9	58	−2.9	B3	2	15.5	4	AL. Raft of subchondral screws and lateral buttress plate	2	11	Recent neck of femur fracture
Median	64	−2.9				4		2	6	

AL = anterolateral, PM = posteromedial, PL = posterolateral with transfibular osteotomy approach.