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ORIGINAL PAPER

Supracondylar periprosthetic femoral fractures following total knee arthroplasty: treatment with a retrograde intramedullary nail

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Abstract Total knee replacement surgery is occasionally complicated by a supracondylar periprosthetic fracture, and this presents a challenging problem in an often frail population. Multiple nonoperative and operative treatments have been described which have the aim of restoring the patient to their pre-injury status. This study retrospectively reviews the results of the largest series to date of 14 such fractures treated by retrograde intramedullary supracondylar nailing and is supportive of its continued use with good functional outcomes, low complication rates, and 100% fracture union.

Résumé Les prothèses totales du genou peuvent être occasionnellement compliquées par une fracture supra condylienne. De nombreuses méthodes thérapeutiques ont été décrites avec le but de restaurer l'état des patients avant la fracture. Une étude rétrospective sur une très large série de 14 fractures traitées par clous intramédullaires rétrogrades ont permis de mettre en évidence un devenir fonctionnel et un taux de complications très bas ainsi qu'un taux de consolidation de 100%.

Introduction

Periprosthetic fractures are challenging complications and the prevalence can be expected to rise with the increasing numbers of patients undergoing total knee replacements (TKR). The literature suggests an expected incidence of between 0.3% and 2.5% [2, 4, 5]. This translates to approximately 160–1,340 fractures per annum in England and Wales given the data from the National Joint Registry [17]. Certain subgroups of patients will be particularly vulnerable, and they generally present additional difficulties associated with comorbidities. These include general medical conditions, advancing age and, of particular interest with regard to fixation, osteoporosis. It is also possible that technical errors arising during surgery such as component malpositioning and notching of the anterior femoral cortex predisposes the femur to a supracondylar fracture [12].

These fractures tend to therefore present in a difficult cohort of patients and numerous treatment modalities are described with inconsistent results and complication rates as high as 30% [4]. Nonoperative treatment may be appropriate for some patients who are poor surgical candidates or present with undisplaced fractures and a stable prosthesis [7, 8] and regimes include traction, casts, or bracing. However, because of poor reported outcomes, the vast majority of displaced fractures warrant surgical intervention [5, 16]. Multiple techniques have been proposed including: blade plates, dynamic condylar screw and plate, condylar buttress plates [9, 25], Rush pins [19], Enders nails [11], and external fixation [22]. More recently, locking plates [1, 13] and the retrograde intramedullary locked supracondylar nail have been described [10, 23, 24].

The aim of this study was to retrospectively review the results of patients who had undergone retrograde locked intramedullary nailing as the treatment of choice for their supracondylar fracture above a TKR.

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Fig. 1 A supracondylar fracture above a well fixed knee arthroplasty

Materials and methods

We identified 15 patients who underwent retrograde intramedullary femoral nailing for the treatment of periprosthetic fractures over the preceding six years. One patient sustained bilateral fractures giving 16 retrograde fixations. All patients had their arthroplasty performed at our hospital and received a posterior cruciate retaining implant.

The medical records were examined retrospectively to determine age, gender, and mechanism of injury. Outcome was measured by time to union, fracture alignment, return to function, use of walking aids, pain, and postoperative complications.

All patients were operated upon by surgeons experienced in intramedullary nailing techniques. A transpatellar tendon approach provided sufficient access to the intercondylar region, and the prostheses were known to provide an adequate entry into the canal via the notch (Fig. 1). A standard cannulated reaming technique was used under fluoroscopic guidance and the supracondylar nail was then

Fig. 2 Fixation of a fracture with a supracondylar nail

Fig. 3 Radiograph showing the united fracture in satisfactory alignment

Table 1 Patient data

Fracture	Gender	Age	Affected side	Implant	Time to fracture post TKR (y)	Time to union (wk)	ASA score
1	F	66	R	Kinemax[a]	10	20	2
2	F	87	L	AGC[b]	18 days	15	2
3	F	62	R	IB2[c]	15	16	2
4	F	84	L	AGC	6	Died	2
5	M	83	L	AGC	6	24	2
6	F	84	L	IB2	7	12	2
7	F	91	R	Kinemax	8	Died	3
8	F	87	L	Kinemax	5	32	2
9	M	78	R	AGC	5	10	3
10	F	87	R	AGC	5	16	2
11	F	74	L	Kinemax	8	12	2
12	F	74	L	AGC	36 days	53	3
13	F	84	L	AGC	2	12	3
14	F	86	L	Kinemax	11	12	3
15	F	85	R	AGC	6	13	3
16	F	85	L	AGC	5	13	3

M male, *F* female, *L* left, *R* right, *TKR* total knee replacement, *ASA* American Soceity of Anaesthesiologists

[a] Sryker/Howmedica-Osteonics. Limerick, Ireland

[b] Biomet Ltd, Swindon, UK

[c] Zimmer, Swindon, UK

statically locked with seven procedures used a condylar locking bolt (Fig. 2).

Patients were allowed to mobilise the knee as tolerated the day after surgery and subsequently remained touch weight bearing for six weeks. Weight bearing was then progressively instigated, guided by clinical features and X-ray appearances. Fracture union was confirmed when pain had subsided and there was radiological evidence of bridging callus (Fig. 3).

Results

From the 15 patients identified (16 fractures), two died during follow-up of unrelated medical conditions. Although these patients had good fracture alignment on initial X-rays, definitive time to union and postoperative function could not be assessed. The remaining 13 patients (14 fractures) were followed to union. In the study population there were 13 females and two males, with a mean age of 81 years (range, 62–91) (Table 1). The mechanism of injury for all was low energy trauma and all were closed injuries without neurovascular compromise. The average time interval from arthroplasty to fracture was 5.9 years (range, 18 days to 15 years).

Intraoperative complications were few but did include a partial patellar tendon avulsion. This was repaired primarily and did not hinder the postoperative rehabilitation. There were no postoperative infections, thromboembolic events, or neurovascular problems. One patient required removal of a prominent distal locking bolt after the fracture united due to localised soft tissue irritation.

Fracture alignment was assessed by measuring the postoperative films. This appeared "good" as defined by Rorabecks radiological criteria [21] in 11 out of 16 fractures. A valgus deformity of 8–12° was apparent in three cases, one patient had 15° of extension of the distal femoral fragment, and one patient had posterior translation of the distal fragment on the proximal fragment of almost 50%.

All 14 fractures united without any further intervention, 13 united between 10 and 32 weeks (mean 16 weeks), and there was one delayed union (53 weeks). This occurred in the patient with posterior displacement of the distal fragment. No patient required bone grafting or secondary surgery.

Return to pre-injury level of function was achieved by 11 out of 13 patients and the other two required the use of two sticks instead of one. However, one of these patients had deteriorating hip osteoarthritis responsible for most of their mobility limitation. In terms of postoperative pain, 11 were pain free at follow-up and two suffered occasional pain relieved by oral antiinflammatories.

Discussion

The successful management of a periprosthetic supracondylar fracture above a TKR is a challenge for the orthopaedic surgeon. This is in part due to the nature of the presenting patient and also to technical difficulties of stabilising osteoporotic and often comminuted fractures. Whilst most would agree that osteoporosis increases the risk of periprosthetic fractures, the role of notching the anterior femoral cortex remains controversial. Biomechanical studies appear to show a lesser load to failure with notching [12, 14], but a recent large study suggests that it

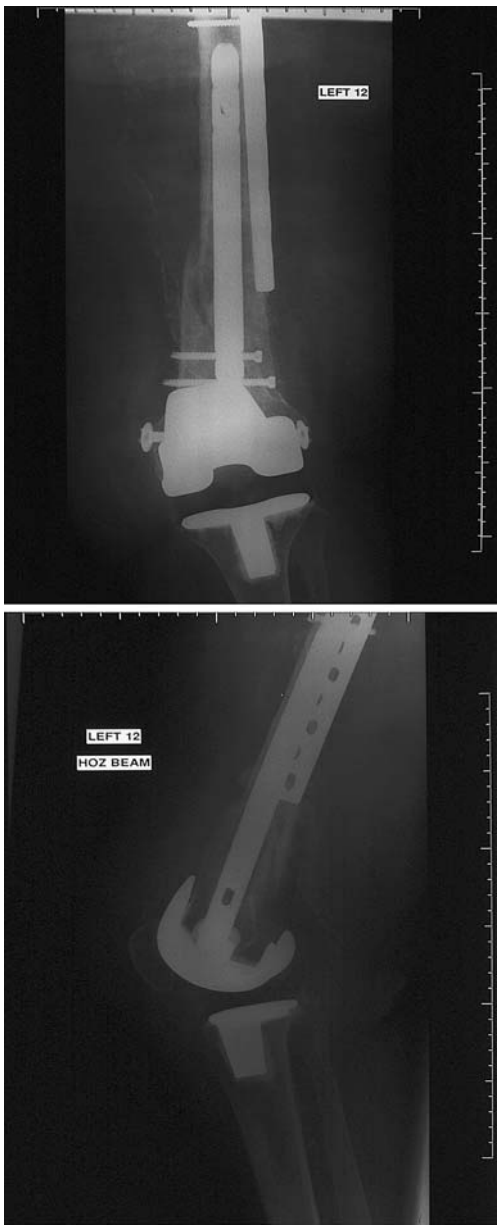

Fig. 4 Radiograph illustrating a retrograde nail in the presence of preexisting metalwork

may not be as important clinically as previously suspected [20].

To obtain a satisfactory patient outcome it has been stated that one needs to achieve fracture union, pain free range of knee movement from 0–90° with less than 2 cm of shortening, <5° varus/valgus, <10° deformity in the sagittal plane, and a return to pre-injury level of ambulation [21]. This would be difficult to achieve with nonoperative methods, and the majority of fractures will therefore benefit from operative intervention. However, maintenance of fracture reduction with standard plating methods has proven difficult and has often required extensile approaches with extensive soft tissue dissection. Fixation often fails and the risk of nonunion, further surgery, and infection tends to be high [9, 16]. Recent advances in locking plating technology hold particular benefits for osteoporotic bone and can be attempted through a minimally invasive approach, which has led to several publications with acceptable results [1, 13, 18]. However, these approaches are technically demanding and expensive, and removal of locking plates, if required, can prove difficult.

Intramedullary fixation does have certain advantages over extramedullary techniques and has demonstrated good short and mid-term results [10, 24]. Typically, there is little or no disturbance to soft tissue attachments at the fracture site, and the construct has been demonstrated to have a biomechanical advantage [3]. The surgical time is minimised, blood loss is low, and the procedure is familiar and relatively straightforward. Preoperative planning is extremely important to identify the type of prosthesis in situ to ensure that there is adequate access to the notch for entry into the canal. A recent study has looked at the most common prostheses used in the UK and developed a reference chart to facilitate this [6]. Of import, they also noted that notch position is probably more important than the notch size. The use of diamond tipped drill systems has been used to create an entry point in implants which impede notch access [15].

The choice of nail should ideally allow a good selection of distal locking options and variable nail lengths. Difficulties with nailing can arise when there is preexisting metalwork in the proximal femur. The femoral component of a hip arthroplasty may mean that an overlapping plating technique is more appropriate to avoid a vulnerable short section of femur between implants. If the proximal femur has been plated, then nailing is still feasible with removal of some of the distal screws from the plate and overlapping of the implants (Fig. 4).

In our institute, in this largest series to date, we have found that retrograde nailing for a supracondylar fracture above a TKR provides excellent functional results and a 100% union rate. We therefore feel able to recommend it in the treatment of these difficult fractures.

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