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Supracondylar nailing of periprosthetic fractures above total knee arthroplasties

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Abstract Supracondylar nailing was performed in 10 patients who sustained periprosthetic fractures above total knee arthroplasties. The fractures occurred in women with an average age of 67.4 years (range, 42–92 years). All fractures healed in a satisfactory alignment in an average duration of 13.2 weeks (range, 12–18 weeks). None of the fractures needed bone grafting. There were no cases of wound infections, nonunion or delayed union. All patients achieved satisfactory range of movement of the knee joint and preoperative functional status. Main complications included loosening of a distal screw in one patient and fracture above

the short nail following a second injury in another patient. Use of a longer nail where possible and a condylar bolt for distal locking can easily avoid these complications. We conclude that supracondylar nailing, despite some limitations, is a satisfactory method of treatment for a majority of displaced periprosthetic fractures above well-fixed total knee arthroplasties.

Key words Periprosthetic fractures • Total knee arthroplasty • Supracondylar nailing

Introduction

Fractures of the distal femur proximal to total knee arthroplasties are a difficult orthopaedic problem. These fractures usually occur in elderly patients following a minor fall. Various predisposing factors include osteoporosis, rheumatoid arthritis, notching of the anterior cortex, neurological disease and revision arthroplasty [1, 2]. Both conservative and surgical treatments have been recommended to treat these fractures. Conservative treatment is usually employed for an undisplaced fracture and it involves immobilisation in

a brace and nonweight-bearing until the fracture is fully healed [1–3]. Surgical options for a displaced fracture above a well-fixed knee arthroplasty include open reduction and internal fixation using conventional plates [4, 5], minimally invasive fixation using locking plates [6–8], and retrograde supracondylar nailing [9–13]. However, if the prosthesis is loose then a major reconstruction like revision arthroplasty [14, 15], distal femoral allograft [16] or a prosthetic replacement of the distal femur [17] is required. We present our results of using supracondylar nailing in the management of periprosthetic fractures of the distal femur proximal to well fixed knee arthroplasties.

Materials and methods

Ten displaced periprosthetic fractures of the distal femur (Fig. 1a) in ten women were treated with supracondylar nailing (Fig 1b). We used the AIM nail (Depuy Orthopaedics) in six patients, the Smith-Nephew nail in one and the T2 supracondylar nail (Stryker) in three patients. The T2 supracondylar nail uses a condylar bolt to provide mediolateral compression and prevent loosening of the distal interlocking screws. The mean age of the patients was 67.4 years (range, 42–92 years). Low velocity trauma by minor fall was the cause of fracture in all patients. Six fractures were on the right side and four affected the left side. Pre-existing disabilities, associated medical conditions and the type of the knee implants used are shown in Table 1. None of the patients was noted to have notching of the anterior cortex at the time of primary total knee replacement. Four patients suffered from rheumatoid arthritis and

one patient was on steroids for chronic obstructive pulmonary disease. The knee implants were in place for an average duration of 34 months (range, 3 weeks to 72 months).

Surgical technique and rehabilitation

A midline skin incision with medial parapatellar approach was used to access the intercondylar notch. Under radiographic control, fracture reduction was achieved by closed method and the nail was inserted across the fracture site. After the nail was countersunk to avoid impingement, interlocking screws were inserted distally and proximally. Nine patients who were considered to have poor bone quality at the time of surgery needed immobilisation in a removable brace for 6–8 weeks. Active and passive

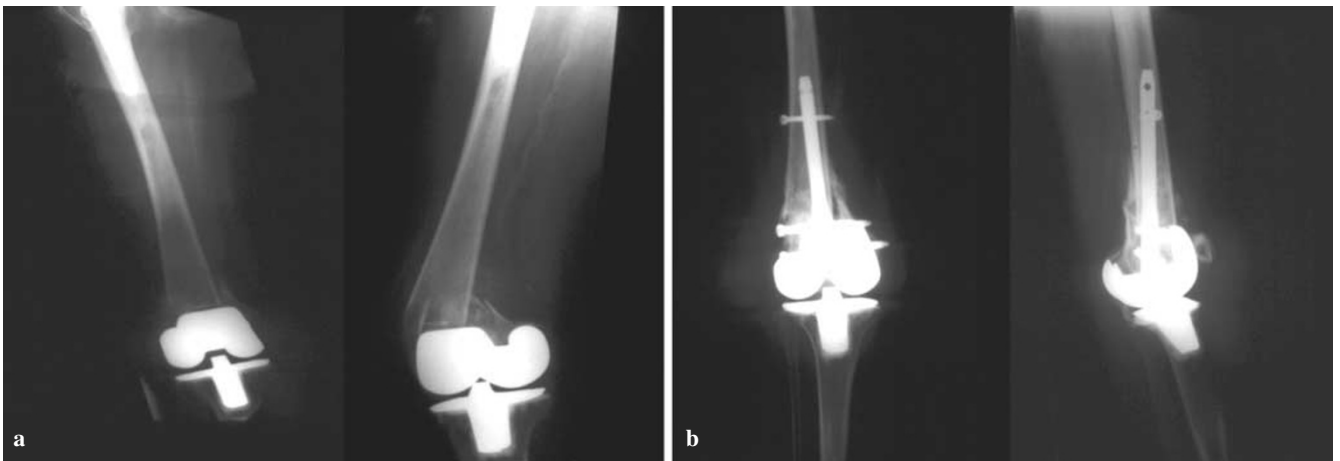


Fig. 1a,b Periprosthetic fracture of the distal femur above knee arthroplasty in 42-year-old woman with rheumatoid arthritis. **a** Pretreatment radiograph. **b** Radiograph of the knee three months after nailing showing satisfactory fracture healing

Table 1 Profile of 10 women with displaced periprosthetic fractures

Case	Age, years	Fracture side	Prosthesis type	Time since TKR	Comorbidities	Union, weeks	Follow-up months	ROM, degrees
1	75	R	PFC	2 years	-	12	22	0–90
2	50	L	IB-II	3 years	MS, RA	18	36	10–90
3	42	R	IB-II	3 years	RA, DM, Bilateral THR-TKR	12	24	0–70
4	92	L	IB-II	4 years	-	16	6	10–90
5	78	L	IB-II	3 years	RA, Bilateral THR	16	20	10–110
6	70	R	IB-II	3 weeks	RA	16	24	10–110
7	52	R	Scorpio	4 years	COPD, Obesity	16	12	0–85
8	90	L	Scorpio	18 months	Left THR	12	12	10–90
9	64	R	Scorpio	6 years	-	12	12	10–80
10	61	R	Scorpio	4 years	Bilateral TKR, Obesity	12	18	0–90

MS, multiple sclerosis; RA, rheumatoid arthritis; DM, diabetes mellitus; THR, total hip replacement; TKR, total knee replacement; COPD, chronic obstructive pulmonary disease; ROM, range of motion

knee mobilisation was started as soon as possible. Partial weight-bearing was allowed for the first eight weeks and then gradually progressed to full weight-bearing between 8 and 12 weeks. All patients were followed in clinic with radiological examination. Radiographs were assessed for fracture healing, alignment at the fracture site and signs of loosening of the knee prostheses. The average follow-up was 17 months (range, 6–36 months).

Results

All ten fractures healed in an average period of 13.2 weeks (range, 12–18 weeks). The alignment at the fracture site was considered satisfactory in all cases as none of the fractures healed in an angulation of more than 10 degrees in any plane. All 10 patients regained their functional range of movement of the knee joint. The average range of movement was 84 degrees (range, 70–100 degrees). There were no postoperative complications like infection, deep vein thrombosis and pulmonary embolism. There were no cases of loss of reduction, delayed union or nonunion.

One patient suffered another fall two months after nailing and sustained a fracture of the shaft of the femur around the proximal end of the nail. This was treated by exchange nailing using a longer supracondylar nail. Both fractures healed in a satisfactory alignment in 18 weeks time. In one patient, distal locking screws became loose and had to be removed but this did not affect the final outcome as the fracture had already healed (Fig. 2). One patient continued to complain of pain and inability to fully straighten the knee joint. Due to persistent symptoms, the

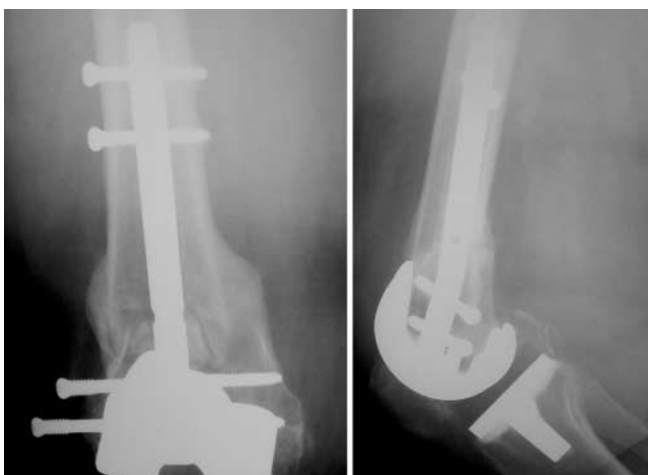


Fig. 2 Radiographs of the knee showing complete fracture union after supracondylar nailing. Note loosening of the distal screws, which were subsequently removed

patient underwent arthroscopy to rule out impingement in the notch. At the 12-month follow-up, the patient continued to be symptomatic although the fracture had fully healed in good alignment. One 92-year-old patient died nine months after surgery due to unrelated reasons but the fracture had healed at the 16-week follow-up. None of the nine surviving patients showed any signs of loosening of the knee prostheses at the latest follow-up and two patients have since undergone total knee replacement on the contralateral side.

Discussion

The aim of treatment in fractures of the distal femur proximal to total knee arthroplasties is to achieve a painless and stable knee without any residual malalignment. Conservative treatment has been reported with successful results in these fractures [3]. However, this may be associated with difficulty in maintaining reduction, prolonged period of immobilisation, reduced knee functions, malunion and nonunion. Merckell and Johnson recommended conservative treatment, although nine of 26 patients (35%) in their study required revision arthroplasty because of nonunion, malunion, loosening of components and extensor lag [2]. Culp et al. [1] recommended operative treatment for displaced fractures, as conservative treatment resulted in nonunion in 20% and malunion in 23% of patients. Several authors have recommended open reduction and internal fixation using lateral plates for these fractures [4, 5]. Healy et al. [4] treated 20 fractures with open reduction and internal fixation using a variety of different implants including blade plate, condylar screw and condylar buttress plates. They performed bone grafting in 15 patients and achieved union in 18 patients. Two patients, who did not undergo bone grafting at the time of index surgery, needed reoperation and bone grafting to achieve union. The authors recommended primary bone grafting with internal fixation to increase the chances for union of these difficult fractures [4]. However, internal fixation using plates could be technically demanding in osteopenic bone in elderly patients. Figgie et al. [18] reported union in only five of 10 cases; the remaining five cases needed further surgical procedures. They also noted that eight of 10 cases developed varus alignment despite satisfactory intraoperative alignment due to metaphyseal comminution [18]. To address the problem of poor fixation in osteopenic bone, locking plates have been developed which can be inserted with a minimally invasive approach. Clinical studies have reported good results using locking plates for the treatment of periprosthetic supracondylar femur fractures

[6–8]. Kregor et al. [6] reported a 100% union rate in 13 periprosthetic fractures using locking plate; only one patient needed bone grafting. Raab and Davis reported their results of using a locking plate in 11 fractures of which eight fractures were supplemented with non-structural allograft [7]. They achieved union in 10 patients with a satisfactory alignment. Ricci et al. [8] reported their results of treating 22 periprosthetic fractures without bone graft with a locking plate. Nineteen of 22 fractures (86%) healed after the index procedure. All three patients who failed to heal had insulin-dependent diabetes mellitus; two of these patients developed infected nonunion [8].

A recent cadaveric study of simulated periprosthetic fractures showed greater fracture stability with the use of a retrograde nail than with a less invasive stabilization system [19]. Many studies have now shown high success rates with the supracondylar nail in the management of periprosthetic fractures of the distal femur [9–13]. Four studies involving a total of 19 patients showed a 100% union rate with no complications [9–12]. Gliatis et al. [13] achieved union in all 10 fractures after supracondylar nailing but one fracture united in extreme valgus. Because of the low incidence of this injury, there are few large series reported from one institution. But, our experience and the literature suggest that supracondylar nailing is a simple, safe and minimally invasive procedure. This technique uses the previous incision and does not require soft tissue dissection and bone grafting at the fracture site. It allows early mobilisation and range of motion exercises of the knee joint and maintains the fracture alignment. Complications like a fracture above the nail and loosening of a distal locking screw can occur because of poor bone quality. Use of a longer nail where possible and a condylar bolt for distal locking can avoid these complications. A longer nail also provides better fixation in the proximal femur in the isthmus region and helps to maintain the fracture alignment (Fig. 3). However, this technique also has some limitations. The supracondylar nail cannot be used in an

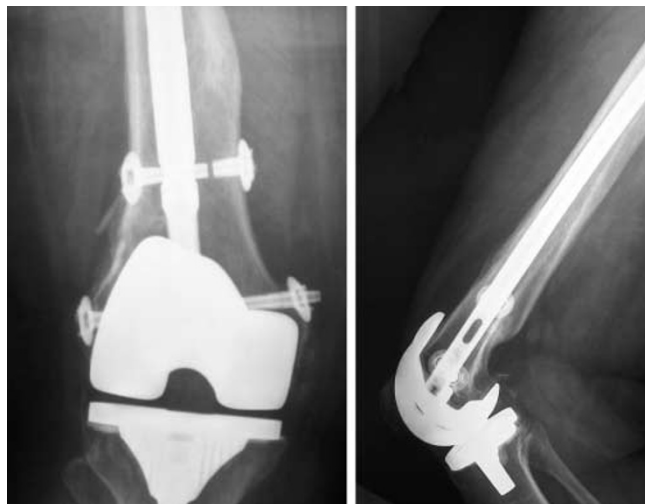


Fig. 3 Radiographs 12 months after fixation of a periprosthetic fracture of the distal femur using a longer nail and condylar bolts for distal locking showing solid fracture union

extremely distal fracture as it may not be possible to achieve good fixation in the distal fragment. In osteopenic bone and comminuted fractures, patients cannot be allowed immediate full weight-bearing and fixation needs to be protected in a brace until the fracture is united. Although most of the modern knee prostheses allow supracondylar nailing, it is important to determine the type of the knee implant as posterior cruciate substituting implants with closed housing do not allow access to the intercondylar notch. Although we used a supracondylar nail in patients with a total hip prosthesis, ideally this implant should be avoided as it can result in a stress riser between the two implants. We chose this implant in these patients because of poor local skin condition or poor medical condition with restricted mobility.

In conclusion, we found supracondylar nailing a satisfactory procedure for management of a displaced distal femoral fracture above a well-fixed total knee arthroplasty.

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