

Outcome and incidence of periprosthetic supracondylar femoral fractures in TKA

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ABSTRACT

Background: Periprosthetic supracondylar femoral fractures following total knee arthroplasty (TKA) are infrequent, but is a devastating complication. The purpose of this study was to evaluate the incidence and outcomes of periprosthetic supracondylar femoral fractures following TKA using nonoperative as well as open reduction and internal fixation (ORIF) techniques.

Materials and Methods: Between January 2004 and December 2010, we followed 3,920 operated patients of total knee arthroplasty (TKA) and identified 23 patients with periprosthetic supracondylar fractures. A retrospective analysis of the records of these patients was conducted. Details regarding pre fracture status, treatment offered and the present status were also recorded and analyzed. Time from index arthroplasty to periprosthetic fracture ranged from five days to six years. There were 17 women and 6 men and the average age was 68.26 years (range 52-83 years). Of the 23 patients, 20 patients were treated by operative method, whereas only three patients with relatively undisplaced fractures were treated nonoperatively.

Results: The total incidence of periprosthetic fractures in operated cases of TKA was 0.58%. Three patients had infection after surgery. As per radiological assessment, two of three conservatively treated cases had malunion, whereas among 20 cases treated operatively, 16 had primary union with one malunion. Two patients had union after bone grafting, whereas two had nonunion. The average reduction in the knee score after fracture was 20.53%. Twenty one patients were able to achieve limited but independent activity.

Conclusions: Desirable results for periprosthetic fractures can be obtained if proper and timely intervention is done, taking into account the other comorbid conditions. However, short duration of followup and small number of patients were major limiting factors in this study.

Key words: Distal femoral locking plate, periprosthetic fracture, supracondylar femur fracture, total knee arthroplasty

INTRODUCTION

Periprosthetic supracondylar femur fractures following total knee arthroplasty (TKA) are infrequent, but devastating, complications. Although the prevalence is low at present, ranging from 0.3 to 2.5%, as the number of TKAs performed increases, so will the number of periprosthetic fractures.^{1,2}

Many of these periprosthetic fractures occur as a result of low-energy trauma. Risk factors associated with the development of periprosthetic fractures include osteopenia, osteoporosis and certain disease processes such as rheumatoid arthritis, seizure disorders, Parkinson's disease and myasthenia gravis.^{1,3-7} The use of corticosteroids, old age and female sex have been implicated.^{1,7,8} Processes related to the implant and surgical technique such as anterior femoral notching, malalignment, loosening of the implant and osteolysis play an additional role in the development of periprosthetic fractures.^{3,4,7,9}

Treatment options range from nonoperative methods including casting, traction and bracing to surgical treatment with open reduction and internal fixation (ORIF), intramedullary fixation and even revision arthroplasty. The decision whether to proceed with nonoperative or operative treatment has been subject of great controversy. Rates of nonunion for supracondylar fractures proximal to total knee prostheses are higher than for supracondylar fractures without the knee implant.^{1,3,4,10} Stems, rods, screws and cement may block the medullary canal, preventing

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intramedullary fixation of fractures.^{1,3,4,10} Stems and rods also block screw fixation through the medullary canal to hold plates on the bone. It has been shown that patients sustaining a periprosthetic distal femur fracture have increased morbidity and mortality rates compared to distal femoral fractures without a prosthesis.^{1,3,4,10} If all treatment types are pooled together, the rate of nonunion is 9%, loss of fixation 4%, rate of infection is 3% and the rate of revision surgery is 13%.¹¹ The purpose of this study was to assess the outcome after periprosthetic supracondylar femur fractures following TKA.

MATERIALS AND METHODS

Between January 2004 and December 2010, we followed 3,920 operated patients of TKA and identified 23 patients operated for TKA with a periprosthetic supracondylar fracture [Table 1]. A retrospective analysis of their records was conducted. Details regarding the prefracture status and treatment offered were obtained from the Medical Record Department of the hospital.

All the patients were clinically examined for their present status. Detailed history regarding the fracture was obtained. Pre and post fracture knee score were revised. Predisposing factors such as female gender, osteopenia, inflammatory arthritis, increasing age, use of corticosteroids, presence of

notching, manipulation for TKA, major trauma and bone osteolysis were assessed. Prefracture status was difficult to assess exactly as all the patients reported to us post fracture. However, from the history it was clear that they had good range of motion (more than 90°) and had no stiffness.

The inclusion criterion was any patient operated for primary TKA surgery having periprosthetic supracondylar femur fracture and the exclusion criteria were any patients with periprosthetic tibial or patellar fractures, patients with revision TKA and having periprosthetic supracondylar femur fracture, or patients operated by some other surgeon presenting to this institute with periprosthetic supracondylar femur fracture.

The functional outcome of patients was assessed by using the Knee Society Score. The time from index arthroplasty ranged from five days to six years.

We classified the patients having supracondylar fractures according to the Rorabeck's scheme of classification. Rorabeck *et al.* divided periprosthetic supracondylar femur fractures into three types. Type I involves a nondisplaced fracture in association with a stable prosthesis, type II is a stable prosthesis with a displaced fracture and type III involves any fracture in the presence of a loose prosthesis.^{2,12-14}

Table 1: Clinical details of patients

Age (years)	Sex	Mode of injury	Interval between TKA and periprosthetic fracture (months)	Predisposing factors	Classification (Rorabeck classification)
83	M	Low energy	1	Gr 2 Notching, Pd, Osteoporosis	R2
60	F	High energy (RTA)	71	Gr 1 Notching, Osteoporosis	R2
76	F	High energy (RTA)	22	Gr 2 Notching	R2
64	M	High energy (RTA)	12	Gr 1 Notching	R2
73	F	High energy (RTA)	46		R2
64	F	Low energy	0.5		R2
70	M	High energy (RTA)	12	Gr 1 Notching,	R2
78	F	Low energy	0.1	Gr 1 Notching, Osteoporosis	R2
68	F	High energy (RTA)	24	Pd	R2
83	F	Low energy	0.5	Gr 1 Notching,	R2
				Osteoporosis	
70	F	High energy (RTA)	27	Ra	R2
64	F	Low energy	4	Gr 2 Notching	R2
67	F	High energy (RTA)	20	Gr 1 Notching	R2
59	F	Low energy	4	Cemented Bipolar	R2
65	F	Low energy	9	Gr 1 Notching, Ra	R2
72	M	High energy (RTA)	13	Gr 1 Notching, Pd	R2
52	M	High energy (RTA)	17		R2
80	F	Low energy	6	Osteoporosis, Ra	R2
62	F	High energy (RTA)	5	Gr 1 Notching	R2
64	M	Low energy	0.5	Gr 2 Notching	R2
60	F	Low energy	2	Gr 1 Notching	R1
68	F	Low energy	2	Osteoporosis	R1
68	F	High energy (RTA)	32		R1

RTA=Road traffic accidents, Pd=Parkinson's disease, Ra=Rheumatoid arthritis, Gr = Grade

Twenty of the 23 patients were treated by plating [Figure 1]; we used a distal femoral locking plate (DFLP), condylar buttress plate (CBP), or a low contact dynamic compression plate (LCDCP) depending on the fracture.

All patients were followed up first at the time of suture removal and then every six weeks for three visits and then six monthly for functional and radiological assessment.

Depending upon the postoperative fracture reduction quality and the stability of the fixation, physiotherapy was started in the immediate postoperative period. Initially, guarded knee mobilization (with hinged AK brace) was started and gradually independent knee mobilization was introduced. Subsequently, range of motion and strengthening exercises were introduced and once the signs of clinical and radiological union appeared (decreased pain, increased confidence of the patient, increased range of motion and slow disappearance of the fracture line on X-rays), gradual weight bearing was started.

Three of the 23 cases were treated with traction and slab initially, followed by an above-knee cast [Figure 2]. One patient was given an immediate cast due to minimal displacement and swelling. All the patients were evaluated at the end of one week for condition of the plaster as well as for radiological alignment. The cast was continued for an average period of 10-12 weeks. Patients were followed up initially at the end of the first week and then every month for condition of the plaster. Clinical and radiological evaluation was done.

Once the signs of satisfactory radiological union appeared, the cast was removed and physiotherapy started in form of static quadriceps exercises, stretching exercises, knee mobilization and range of motion exercises. Partial weight bearing was allowed for a period of 4-6 weeks and then full weight bearing was started.

RESULTS

The total incidence of the periprosthetic fracture in the operated cases of TKA in our study was 0.58% (23 cases



Figure 1: X-ray of knee joint (anteroposterior and lateral views) showing (a) Peri prosthetic supracondylar femur fracture on Rt. side (R 2 type). (b) Treated operatively with DFLP – immediate postoperative X ray. (c) Final followup showing union



Figure 2: X-ray of knee joint (anteroposterior and lateral views) showing (a) Periprosthetic supracondylar femur fracture on right Side (R 1 type). (b) Union at final followup X-ray (treated conservatively with AK Cast)

out of 3,920 consecutive primary TKAs). The mean postoperative followup was 26 months (range 5-48 months). There were 17 females and 6 males. The average age in the series was 68.3 years (range 52-83 years). Average age was 67.5 years in males (range 52-83 years) and 68.52 years in females (range 59-78 years).

The interval between TKA and periprosthetic fracture averaged 14.38 months (range 0.1-71 months). Of the 23 cases, 11 cases of periprosthetic fractures occurred due to low-velocity trauma; the remaining 12 cases were due to high-velocity motor vehicular accidents (MVAs). Osteoporosis was associated with six cases and these fractures were a consequence of a low-velocity injury. Anterior femoral notching was associated with a total of 14 patients. Ten cases had grade I notching, whereas four cases had grade II notching. One case had an ipsilateral hip implant. Twenty patients had ($n = 20$) had class II fracture (displaced fracture with intact bone-prosthesis interface); three patients (with low-velocity trauma) had class I fracture (undisplaced fracture).

All the 20 cases of displaced fracture were treated operatively with internal fixation. We used distal femoral locking

plate (DFLP) in 16 cases, condylar buttress plate (CBP) in three cases and an low contact dynamic compression plate (LCDCP) in one case. The average duration of hospitalization was 11.08 days; 7.67 days for conservatively managed patients and 11.8 days for operatively managed patients [Table 2].

Three patients had postsurgical infection. No organisms could be isolated from the culture of the discharge. They were treated with surgical debridement and broad-spectrum antibiotics for six weeks. Serial blood counts, erythrocyte sedimentation rate (ESR) and C-reactive protein titers were done and the patients were considered to be free of infection after the titers remained normal for six weeks after stopping the antibiotics. We could achieve union in the form of malunion in one patient, whereas the other two ultimately progressed to radiological nonunion and refused to have any further surgical intervention.

The average duration for clinical union as assessed by the ability of the patient to bear full weight without any walking aid was five months, whereas the average duration of radiological union was seven months. Of the three patients who had malunion, two were from the conservatively

Table 2: Management, duration of hospitalization, complications, knee scores and outcomes

Interval to definitive management (days)	Treatment	Duration of hospitalization (days)	Complications	Knee score		Functional outcome	Radiological union
				Post TKA	Final followup		
2	Operative (DFLP)	22	Infection	80	0 (nonunion)	F4 (10)	Absent
3	Operative (DFLP)	21	Infection	92	72	F4 (20)	Malunion
2	Operative (DFLP)	10	Delayed union after BG	94	88	F1 (75)	Present
1	Operative (DFLP)	7		90	84	F2 (60)	Present
5	Operative (DFLP)	8		92	84	F2 (55)	Present
21	Operative (DFLP)	12		84	80	F2 (70)	Present
2	Operative (CBP)	7		86	84	F2 (65)	Present
4	Operative (DFLP)	11		90	88	F1 (85)	Present
2	Operative (DFLP)	12		82	80	F2 (65)	Present
3	Operative (DFLP)	17		86	82	F2 (50)	Present
3	Operative (DFLP+Rev TKA)	18	Delayed union after BG	86	82	F2 (65)	Present
2	Operative (DFLP)	7		88	88	F1 (85)	Present
1	Operative (DFLP)	12	*S/F (Refracture)	88	82	F2 (70)	Present
5	Operative (DFLP)	11		88	84	F2 (55)	Present
3	Operative (DFLP)	10		90	88	F1 (75)	Present
6	Operative (CBP)	15	Infection	80	0 (nonunion)	F4 (15)	Absent
28	Operative (CBP)	7		84	60	F3 (45)	Present
6	Operative (DFLP)	12		84	79	F3 (35)	Present
3	Operative (LCDCP+TBW)	8		90	88	F1 (85)	Present
1	Operative (DFLP)	5		88	86	F1 (80)	Present
0	Conservative (AK cast×12 wks)	4		92	80	F2 (65)	Malunion
14	Conservative (AK cast×10 wks)	14		92	82	F2 (70)	Present
3	Conservative (AK cast×10 wks)	5		88	78	F2 (60)	Malunion

DFLP=Distal femoral locking plate, CBP=Condylar buttress plating, LCDCP=Low contact dynamic compression plating, TBW=Tension band wiring, BG=Bone grafting, rev TKA=Revision total knee arthroplasty

managed group. The average Knee Society Score on final followup was 80 in the conservatively managed patients and 87.0 in the operated patients. Seventeen of the 23 patients were ambulatory at the latest followup, whereas two were non ambulatory (functional category 4). Thirteen of the 17 patients required assistive devices for ambulation. Most patients were able to achieve limited but independent activity. Residual alignment at last followup for operated cases was 3.77° of valgus and that for conservatively treated cases was 8.67° of valgus [Table 2].

DISCUSSION

The literature remains fairly divided on the best treatment method of periprosthetic supracondylar femur fractures since Hirsch *et al.*¹⁵ first described this entity in 1980 as a series of four cases. Nonoperative conservative management, using casting, traction and immobilization, can be complicated by delayed union, muscular atrophy, loss of function, venous thromboembolism and physical deconditioning. Multiple factors must be considered before deciding on the plan of treatment. These include the fracture pattern, degree of displacement and the type of prosthesis used. The functional status of the prosthesis, including loosening, wear and instability, as well as the quality of the surrounding bone, must also be taken into account. Good outcomes were defined previously as healed fractures without joint pain and a 90° arc of motion. Furthermore, it has also been suggested that shortening of the affected limb up to 2 cm and 5° of valgus/varus deformity is acceptable in these cases.^{1,2,16,17} Operative management of fracture is undertaken with the goal of achieving fracture stability and union, while allowing early mobilization of the patient. Methods of surgical fixation include standard ORIF techniques using CBPs, condylar screws, or blade plates, retrograde intramedullary rods and supracondylar nails.

Osteoporosis is a significant risk factor for postoperative periprosthetic fractures. In our study, it was associated with six cases and the majority of fractures associated with osteoporosis occurred following a low-velocity trauma. Paraschou *et al.* in their study showed that osteoporosis was associated with six patients out of a total of 15; all fractures were due to low-velocity trauma and the results were similar to those of our study.¹⁸

Notching is an important factor for these fractures. It has been shown that 3 mm anterior femoral notching resulted in torsional load to failure by 55 N-m.^{13,14} The risk of fracture was initially thought to be due to a decrease in bending and torsional strength associated with notching. These results, however, were based on mathematical and biomechanical studies, but in clinical practice, little evidence is available to support this theory.¹⁹ Ritter *et al.*,⁵ in their retrospective

analysis, demonstrated no difference in knees with or without notching. Their observations were attributed to osseous remodeling and stress redistribution. In our study, notching was seen in 14 patients; 10 cases had grade I notching, whereas four cases had a grade II notching. Of the 14 cases, seven cases had a fracture within six months of TKA, whereas others had a fracture after six months.

Sochart *et al.* (1996)¹⁷ studied nonsurgical management of supracondylar fractures above total knee arthroplasty. They showed that nonoperative treatment of fractures above well-fixed components can, however, be as successful as surgical intervention and remains a viable first line approach. Three patients who fell in Rorabeck's category R1 were treated conservatively. Although two of them were malunited, all the three fractures united at final followup and none of them needed re intervention or had any other complication.

Of the 20 operated patients, 16 underwent DFLP, whereas three patients had CBP and one patient was managed with LCDCP. Moran *et al.*²⁰ reported on 15 displaced fractures treated with DFLP. Thirteen of them showed acceptable radiological union within three months; one patient had malunion, whereas one had nonunion which later united following bone grafting.

The average duration of hospitalization in our study was 11.08 days, 7.67 days in conservatively managed patients and 11.8 days in operated cases. Six of the 20 operated cases required some form of re intervention after primary management of periprosthetic fracture which increased the duration of hospitalization ranging from 5 to 15 days with an average increase of six days as compared to the average duration without any re intervention. The average reduction in the knee score after periprosthetic fracture is 20.53%, which shows that the periprosthetic fracture ultimately hampers the functional outcome of a TKA. As per functional assessment based on the knee score at the final followup, 25% achieved category F1 (>75), 55% achieved category F2 (50-75), 8% F3 (25-50) and 12% fell in F4 (<25).

Bezwada *et al.*¹² reported three patients with fracture nonunion with varus misalignment at the end of nine months after operative management of periprosthetic fracture. They were treated with autologous bone graft and showed union after three months. Thus, bone grafting may be a handy tool for treating delayed union/nonunion whenever necessary.

Matthew *et al.*²¹ compared the less invasive stabilization system (LISS) and retrograde intramedullary nailing in periprosthetic fractures after TKA. These results suggested that the retrograde-inserted nail may provide greater stability for the management of periprosthetic supracondylar femur

fractures. Intramedullary nailing is now becoming a method of choice for the treatment of fractures at a relatively proximal level due to good results and relatively fewer complications.²²

Bobak *et al.*²³ studied pericemented nailing using an intramedullary nail augmented with polymethyl methacrylate (PMMA) cement in five patients. They showed that nailed cementoplasty is proposed as a salvage procedure in octogenarians unfit for lengthy interventions. Beris *et al.*²⁴ reported three cases of periprosthetic fractures after TKA treated with Ilizarov external fixator followed up for three years. Uncomplicated healing of fracture with excellent alignment of lower extremity was achieved in 12 weeks after surgery.

The ultimate goal of management in periprosthetic fractures is to restore anatomical alignment and achieve stable fixation and early mobilization. If the prosthesis or implant is loose, or bone quality is poor, then the implant should be revised. If the prosthesis or implant is stable and bone quality is adequate for fixation, then the implant should be retained while the fracture is fixed following standard principles.²⁵⁻³¹ However, a short duration of followup and small number of patients are major limiting factors of this study.

To conclude, we found that the total incidence of periprosthetic fractures in operated TKA was 0.58% (23 of 3,920); 87% patients (20 of 23) fell in the R2 category of Rorabeck's classification. Desirable results for periprosthetic fracture can be obtained if proper and timely intervention is done, taking into consideration other comorbid conditions.

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