

RESEARCH ARTICLE

Long- Stem Total Knee Arthroplasty for Proximal Tibial Stress Fractures in the Elderly Patients

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Abstract

Background: Presentation of proximal tibia stress fracture is not infrequent among elderly patients due to their poor bone stock. Optimal management of patients with severe gonarthrosis of the knee and concurrent tibial stress fracture is not known yet. In this study we report the outcome of primary total knee arthroplasty (TKA) using stemmed components in elderly patients.

Methods: Between 2009 and 2014, a total of 16 elderly patients with proximal tibial stress fractures and concurrent gonarthrosis were treated with TKA using long stemmed components. The diagnosis of stress fractures was confirmed based on the radiographic changes. A standing alignment view was obtained for all patients preoperatively. Union of the fracture site was investigated using plain anteroposterior (AP) and lateral leg x-rays.

Results: All patients experienced significant relieve of symptoms. The Knee Society score and Knee Society functional score averaged 86 ± 4 and 85 ± 6 , respectively. The mean arc of motion of the knee was $118^\circ\pm 2^\circ$ at the latest follow-up. All stress fractures resolved at a mean of 8.3 ± 1.1 weeks. The medial proximal tibial angle was increased from $74.7^\circ\pm 5.7^\circ$ preoperatively to $90.3^\circ\pm 1.1^\circ$ ($P<0.05$) postoperatively. Tegner activity scale was increased from 2.1 ± 1.3 to 3.4 ± 0.9 ($P<0.05$).

Conclusion: According to our findings, patients with stress fracture of proximal tibia and concurrent gonarthrosis can be treated with primary TKA using stemmed components that may bypass the stress fracture and allow healing of the fracture.

Level of evidence: IV

Keywords: Gonarthrosis, Stress fracture, Total knee arthroplasty

Introduction

Stress fracture is a fracture of the bone caused by repeated forces over time (1). Proximal tibial stress fracture is a rare disorder in elderly patients and has been reported to be associated with varus or valgus gonarthrosis, rheumatoid-arthritis,

osteoporosis, and Paget's disease (2-9).

Fatigue and insufficiency fractures have been defined as two forms of stress fractures. Fatigue fracture is classically found in military recruits and runners in whom normal bone is exposed to repeated abnormal

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stresses (1, 10). Insufficient fracture happens when normal stress is applied to abnormal bone such as that in osteoporosis.

The clinical presentation of stress fractures is insidious onset of pain without a history of acute trauma. The hallmark physical finding is focal bone pain with palpation, but findings vary depending on the location of the stress fracture and the time from injury to presentation (11). Early x-rays of the stress fracture are usually not helpful in demonstrating an abnormality. However, with the advancement of the disease, radiographic changes can help visualize periosteal bone formation, horizontal or oblique linear patterns of sclerosis and a frank fracture line (12). When radiographic findings are conclusive, additional studies are not required. If plain films do not support the presumptive diagnosis of stress fracture, three-phase bone scintigraphy is the study of choice (13).

Treatment of proximal tibial stress fracture is challenging and the optimal method remains controversial. Although protected weight bearing along with analgesia is the mainstay of treatment for proximal tibial stress fracture in young people, patients with concurrent gonarthrosis and severe deformity may not respond to non-operative treatment (14). Operative management of young patients with proximal tibial stress fracture may include intramedullary reaming to stimulate healing; but older patients, by the virtue of their age, may suffer from severe knee osteoarthritis that needs to be taken into account in the treatment of stress fractures (15, 16). In addition, periarticular deformity and increased forces around the fracture site may compromise the healing process.

Surgical treatment of proximal tibial stress fractures in elderly patients with arthritic knee includes internal fixation with second-stage total knee arthroplasty (TKA) and one-stage TKA using long-stem tibial components (16). There is minimal data on the outcome of primary TKA using long stem tibia component in these patients. The current study reports the outcomes of primary TKA in a series of elderly patients with concurrent proximal tibial stress fracture and knee osteoarthritis.

Materials and Methods

Between 2009 and 2014, we performed TKA in 17 consecutive female patients with proximal tibial stress fractures and concurrent osteoarthritis. All patients were above 55 years old and suffered from severe degenerative changes in the knee joint due to osteoarthritis (14 patients) or rheumatoid arthritis (3 patients). The diagnosis of stress fractures was based on radiographic findings including the sclerotic areas that are often oriented linearly. Periosteal reaction or a cortical break may have also been present. Bone scintigraphy was performed when the x-rays were negative and did not explain the clinical findings.

Standing alignment view was obtained for all patients and knee coronal alignment (the difference between the tibial and femoral mechanical axes), lateral distal

femoral angle (LDFA), and medial proximal tibial angle (MPTA) were measured. All patients were operated on by the same surgeon. Legacy constrained condylar knees (Zimmer Company, USA) were used in 5 patients; tibial stem (Zimmer Company, USA) and Gender femoral components (Zimmer Company, USA) for 7 patients; and LPS femoral components (Zimmer Company, USA) for 5 patients.

The joint was approached through a medial parapatellar arthrotomy. Bone cuts and soft-tissue balancing were performed in the same sequence to correct deformities. The fracture was reduced and fixed by intramedullary tibial guide during tibial cutting in patients with complete fracture. A more constrained prosthesis was used in cases with flexion and extension gap mismatch. The possible bone defects were filled with cement, cement-screw or bone graft. The cement was only placed under the tibial base plate and the proximal part of the stem. A long-stem tibial component was required to bypass the fracture site by approximately two bone diameters length. Knee range of motion (ROM) and full weight bearing was started early after the surgery.

Patients were revisited at 2 weeks and 1, 2, 3, 6, 9, 12 and 24 months postoperatively. Union of the fracture site was investigated in follow ups using plain anteroposterior (AP) and lateral leg x-rays. Union was determined as absence of pain at the fracture site and the presence of three bridging cortices in two orthogonal imaging planes. Patients were asked about the pain and return to the preoperative activity levels. Tegner activity scale was also recorded to compare pre- and post-operative activity levels. The knee ROM measured three times consecutively for each patient using goniometer by senior author and the average value was recorded. To investigate the subjective outcomes, patients were asked about returning to their previous job or sporting activity.

The overall knee society score (KSS) was completed for all patients at the final visit to determine the functional results of the surgery. Scores were graded as excellent (80-100); good (70-79); fair (60-69); and poor (<60). Also, the medial proximal tibial angle (MPTA) was measured on the anteroposterior knee and leg x-rays and compared with the preoperative MPTA [Figure 1].

Statistical Analysis

Statistical analysis was performed using SPSS version 15.0 (SPSS, Chicago, IL). Pre- and postoperative Tegner activity scales were compared using Wilcoxon nonparametric test. Also, the pre- and post-operative MPTAs were compared using a paired t-test. A $P < 0.05$ was considered as statistically significant.

Results

One patient died during the follow up and was excluded from the study. The remaining 16 patients were aged 68.1 ± 7.2 years (ranging between 55-81 years). Stress fractures occurred in 2 patients with severe bilateral varus gonarthrosis, about one year

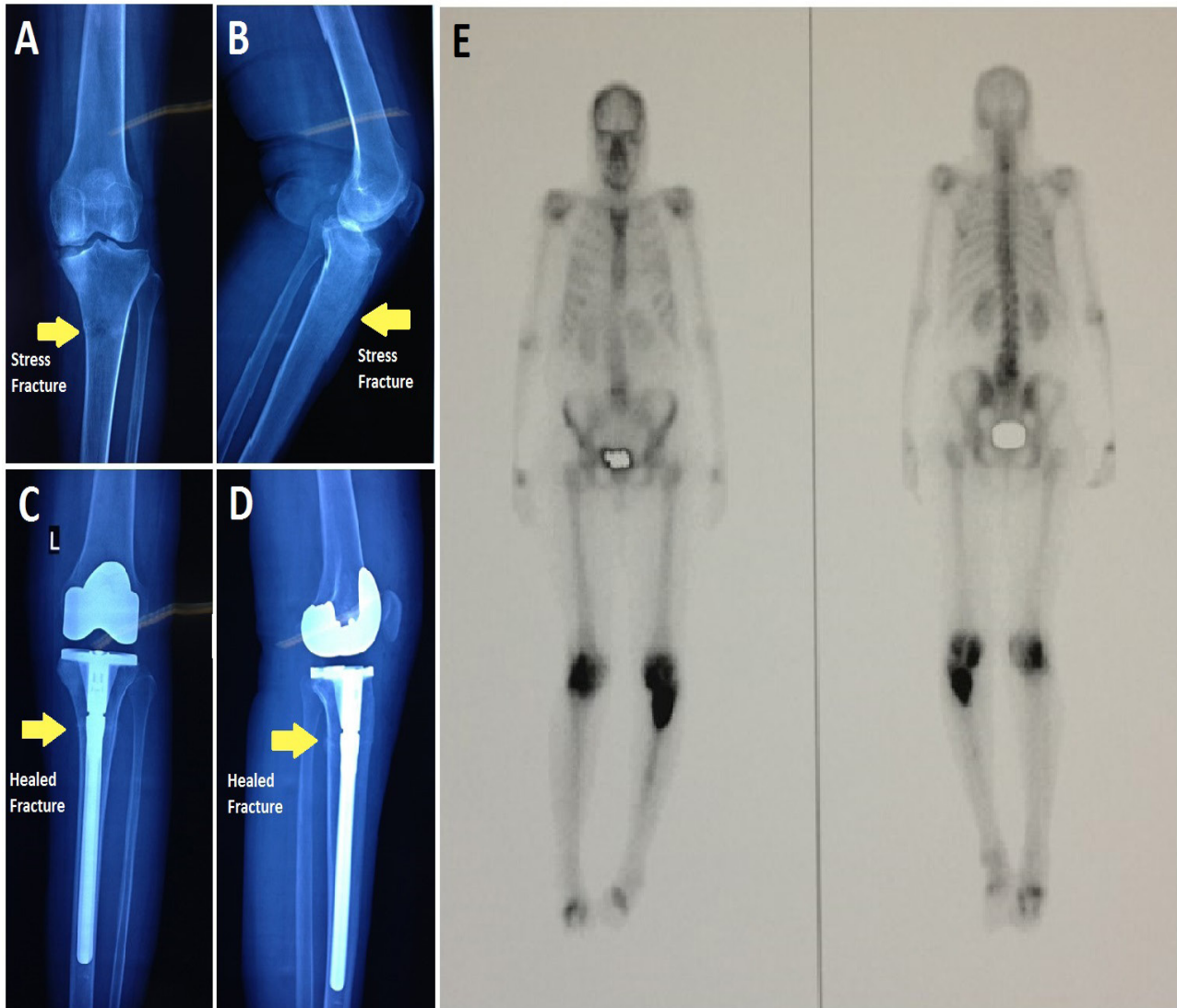


Figure 1. B) Preoperative anteroposterior and lateral views of left knee showing severe osteoarthritis of the tibiofemoral joint and proximal tibial stress fracture; C & D) Anteroposterior and lateral views of the left knee after total knee arthroplasty utilizing stemmed-tibial component; E) Whole body scintigraphy showing increased absorption in left proximal tibia indicating the presence of stress fracture

after conventional TKA of the contralateral knee. Plain x-rays were diagnostic in all patients, except one, in which stress fracture was diagnosed using a bone scintigraphy. The mean preoperative varus angle of the fractured limb was 20.9 ± 1.7 degrees. The fracture site was located at the tibial metaphysodiaphyseal junction in all patients. Four patients had >5 mm posteromedial defects of the proximal tibia that were reconstructed using corticocancellous allograft.

The mean overall KSS and knee society functional score were 86.4 ± 4 and 85 ± 6 , respectively, and were

graded as good or excellent in all patients in the final visit. Also, Tegner activity scale and MPTA were improved significantly after the operation [Table 1]. The MPTA was 87° in one patient; 88° in another; and 91° in two other patients. The mean postoperative MPTA was $90.3 \pm 1.1^\circ$. The mean knee ROM was $118 \pm 2^\circ$ at the final follow-up. The postoperative ROM in one patient was 95° . His knee flexion before the surgery was 90° . All patients had union in at least three cortices of the tibia. The mean time to union was 8.3 ± 1.1 weeks. The union time in one patient with

Table 1. The outcomes of long-stem TKA for proximal tibial stress fractures, based on functional scores and x-ray findings

Score		Mean±SD (range)	Grading (%)	P value	
KSS	Overall	86.4±2.8 (73-91)	Excellent	13	
			Good	3	
	Knee score		Fair	0	
			Poor	0	
	Function score		6±84 (70-90)	Excellent	12
				Good	4
Fair		0			
Poor		0			
Tegner activity scale	Preoperative	2.1±1.3 (2-5)		<0.001	
	Postoperative	3.4±0.9 (2-6)			
MPTA (degree)	Preoperative	74.7±5.7		<0.001	
	Postoperative	90.3± 1.1			

MPTA: Medial Tibial Proximal Angle

rheumatoid arthritis was 6 months. No patient had pain in the leg except one who had local tenderness in proximal medial of the leg, but she had radiologic union in three cortices of the tibia.

Discussion

Proximal tibial stress fracture is a rare but possible disorder in elderly patients with severe varus or valgus knee gonarthrosis. We studied 16 women with proximal tibial stress fractures (at metaphysodiaphyseal junction) suffering from knee arthrosis. All patients had varus deformity and were operated, using the same manner to correct deformity. After one-stage long-stem TKA, complete union was obtained in all patients, without additional approaches to the leg for treating the stress fracture.

Limited number of patients and short-term follow up were the main limitations of this descriptive study.

Because of osteoporosis in old patients achieving stable fixation by plate is difficult. In addition, in this group, prolonged restricted weight bearing is impossible (18).

In contrast, some authors have suggested intramedullary fixation to address stress fracture (15).

In our study, radiographic union was observed during 2 months (8.3±1.1 weeks) after surgery in all patients except one who united after 6 months. These findings were in line with Varner et al. results in which all patients were young athletes and were treated by intramedullary nailing (15).

In a large case series study regarding the treatment of periarticular stress fractures in patients with knee gonarthrosis, Mittal et al. found good outcomes in 31 knees (26 varus and 5 valgus) with tibiofemoral

stress fractures, treated with long-stem total knee arthroplasty. There were 5 patients with intraarticular stress fractures of the tibia that resulted in medial defects of the proximal tibia. The authors reported that all fractures had united without any complications (17).

Our findings demonstrated good to excellent outcomes in patients with extra-articular stress fractures involving varus gonarthrosis using long-stem total knee arthroplasty, as in Mittal et al. findings. In contrast, the cases in Mittal et al study were heterogenous with intra- and extra articular fractures.

Sawant et al. described the results of one- stage TKA using a long-stem tibial component for treatment of proximal tibial stress fractures in an arthritic knee with valgus deformity in 4 patients. Healing and acceptable outcomes occurred in all of their patients (19). Although we studied the outcomes in patients with varus gonarthrosis, the results were similar.

It seems that long-stem TKA for correction of varus and/valgus deformities can alter tension stresses to compression stresses at the fracture site (20).

A long stem total knee arthroplasty bridging the fracture site has the advantages of restoring the joint alignment and treating the arthrosis in one procedure, thus allowing the fracture to unite and reduce knee pain simultaneously. It also allows immediate patient mobilization without the need for casting or splinting. However possible complications of knee arthroplasty with a long tibial stem such as intraoperative periprosthetic fracture during tibial component insertion and longer operation time should be taken into consideration. Thus some authors have used valgus corrective tibial osteotomy and fixation with plate for treatment of these patients (21). We did not

observed any tibial periprosthetic fracture, however, postoperative mild varus deformity was seen in two patients (3 degrees in one patient and 2 degrees in the other one) because of indirect reduction of the fracture in these patients.

Based on our findings, long-stem TKA is a good option for treatment of proximal tibial stress fractures in elderly patients with degenerative changes of the knee. It allows simultaneous treatment of knee arthritis and stress fracture, while maintains good tibial alignment. TKA was associated with satisfactory clinical, radiological and functional outcomes without any complications. However, further prospective long-term studies with more patients are required.

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