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Research Paper: Long Low-profile Proximal Tibial Locking Plate for the Fixation of Periprosthetic Femoral Fractures Above the Prosthesis: A Pilot Study

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ABSTRACT

Background: Anatomic distal femoral Locking Compression Plate (LCP) is generally used to fix distal femoral fractures. However, these plates are not suitable for periprosthetic femoral fracture after Total Knee Arthroplasty (TKA), mainly due to prosthesis impingement.

Objectives: In this case series, we report the outcome of proximal tibial LCP fixation in treating periprosthetic femoral fracture after TKA.

Methods: Twelve patients with a periprosthetic femoral fracture who underwent surgical treatment were included in this study. According to Su et al. classification, all fractures were type II, originating from the femoral component with proximal extension. Fractures were managed with open reduction and plate fixation. The plate choice was either a long low-profile proximal tibial LCP (n=9) or a short anatomic distal femoral LCP (n=3).

Results: The patients were one man and 11 women with a Mean±SD age of 74.5±9.3 years and a Mean±SD follow-up of 2.8±1.3 years. Union of fracture was observed in all fractures fixed with a long locking plate during a Mean±SD period of 3.1±2.1 months. Fixation failed in three patients who were managed with a short plate. These patients underwent revision surgery with a long low-profile proximal tibial LCP. In one of them, the fixation failed again and was finally fixed with a tumor prosthesis. The other two fractures were united with no complications.

Conclusion: Long low-profile proximal tibial LCP resolved the impingement problem by prosthesis, caused by short anatomic distal femoral LCP in treating periprosthetic femoral fractures above the prosthesis. However, future large-scale comparative studies are required before recommending LCP for routine implications in these fractures.

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1. Introduction

Periprosthetic fracture is a challenging complication after Total Knee Arthroplasty (TKA). Also, the incidence of this fracture has continually increased since the last few years owing to the increased number of TKA procedures [1-3]. The majority of these fractures occur in the distal femur, with an incidence of 0.3% to 5.5% after primary TKA. Periprosthetic fractures of the tibia and patella are uncommon, with an incidence of 0.3% to 0.5% and 0.1% to 2.5%, respectively [4].

Treatment of these fractures is a significant challenge, mainly because of the insufficient bone stock and old age of the patients [5]. Non-operative treatment is generally associated with a high rate of complications. However, there is no consensus regarding the best choice of surgical treatment. Although various fixation methods, including dynamic compression plate [6], blade plate [7], locking condylar plate [8], and retrograde intramedullary nail [9], have been used for the treatment of these fractures, none has yielded acceptable results [10], and a complication rate of 25% to 75% has been reported following the fracture treatment [11]. Therefore, further studies are required to achieve a consensus regarding the optimal treatment of such fractures.

Anatomic distal femur Locking Compression Plate (LCP) is generally used to fix distal femur fractures [12-14]. However, in the TKA setting, these plates impinge with the prosthesis. To avoid this adverse effect, the surgeon had no choice but to shift the plate posteriorly, which leads to the protrusion of the proximal part of the plate from the proximal part of the femur, irritating adjacent soft tissue (Figure 1). We hypothesized that low-profile proximal tibial LCP would be a suitable alternative for short anatomic distal femur LCP for periprosthetic femoral fractures. Actually, its thinner and narrower design prevents impingement with the prosthesis, and therefore, does not need a posterior shift with its consequences.

Objectives

In this study, we reviewed the outcome of periprosthetic femoral fracture following TKA in a series of patients mainly fixed with a long low-profile proximal tibial LCP.

2. Methods

This study was approved by the Review Board of our institute. Medical profiles of patients who underwent TKA for end-stage primary knee osteoarthritis were reviewed at our center between 2012 and 2018. Patients with a periprosthetic femoral fracture above prosthesis and follow-up of at least one year were included in the study. Patients with an inadequate data set, those who were managed conservatively, patients who lost to fol-

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Figure 1. Lateral (a) and anteroposterior (b) radiographs of a periprosthetic femoral fracture fxed with anatomic distal femur LCP, leading to the impingement with prosthesis and anterior protrusion

Table 1. Characteristic of the patients wth periprosthetic fracture after TKA

Variables		Mean±SD or No.(%)
Age (y)		74.5±9.3
Gender	Male	1(8.3)
	Female	11(91.7)
Body mass index (kg/m²)		25.6±2.1
Fixation device	Short plate	3(25)
	Long plate	9(75)
Time from TKA to fracture (mo)		4.3±3.2
Follow-up after fracture treatment (y)		2.8±1.3

low-up, and patients with pathologic fractures were excluded from the study. Finally, 12 patients were included in the study. According to the Su et al. classification, all fractures were type II, originating from the femoral component with proximal extension [15].

Surgical procedure

The patients were placed supine on a radiolucent table, and the fracture was reduced with open reduction. Then, through a lateral approach and under fluoroscopic guidance, the plate was slipped into the submuscular, extraperiosteal position. The plate choice was either a long low-profile proximal tibial LCP (Kanchi, China) or a short plate (8-hole dynamic compression plate or anatomic distal femur LCP). When using a long plate, the fracture fixation was bridged so that only proximal and distal locking screws were implemented. After intraoperative assessment of fixation, the wound was closed.

The patients were instructed to remain non-weight-bearing for four weeks after the surgery. After that, partial weight-bearing was started until three months after the surgery. Full weight-bearing was initiated afterward. The first follow-up of the patients was 3 weeks after the surgery. The subsequent follow-ups were at 6 weeks, 12 weeks, 3 months, and 6 months after surgery. The functional outcome of the patients was assessed 6 months after the surgery using the Knee Society Score (KSS), in which a higher score indicates lower disability [16].

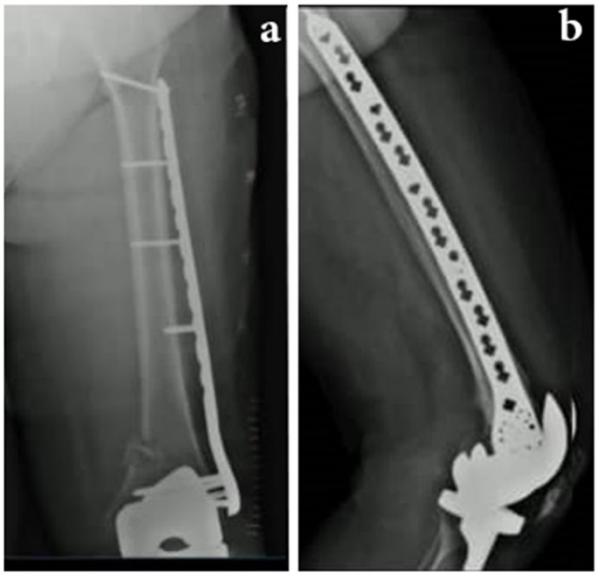

Figure 2. Anteroposterior (a) and lateral (b) radiographs of a periprosthetic femoral fracture fixed with a long low-profile proximal tibial LCP

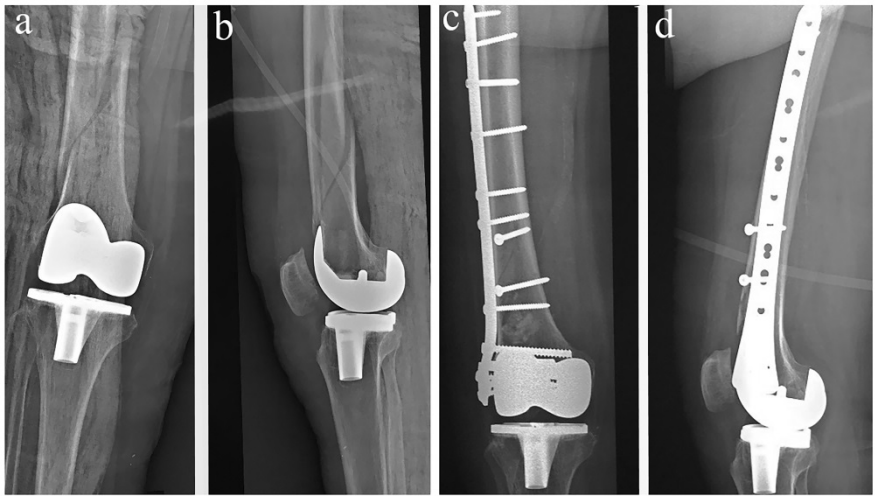

Figure 3. Anteroposterior and lateral radiograph of a periprosthetic femoral fracture before (a and b) and after (c and d) fixation with a long low-profile proximal tibial LCP

3. Results

The study population included 11 (91.7%) women and one man (8.3%) with a Mean±SD age of 74.5±9.3 years (range: 66-94 years). All fractures were located above the proximal edge of the prosthesis. Surgical fixation was done with a short plate in 3 patients and long locking in 9 patients. The mechanism of injury was low-energy trauma (falling during walking) in all patients. The Mean±SD time interval from the primary TKA to fracture was 4.3±3.2 years (range: 3-6.5 years). Table 1 presents the characteristics of the patients.

The Mean±SD follow-up of the patients after fracture treatment was 2.8±1.3 years (range: 2-4 years). The follow-up of nine patients in whom a long plate was used

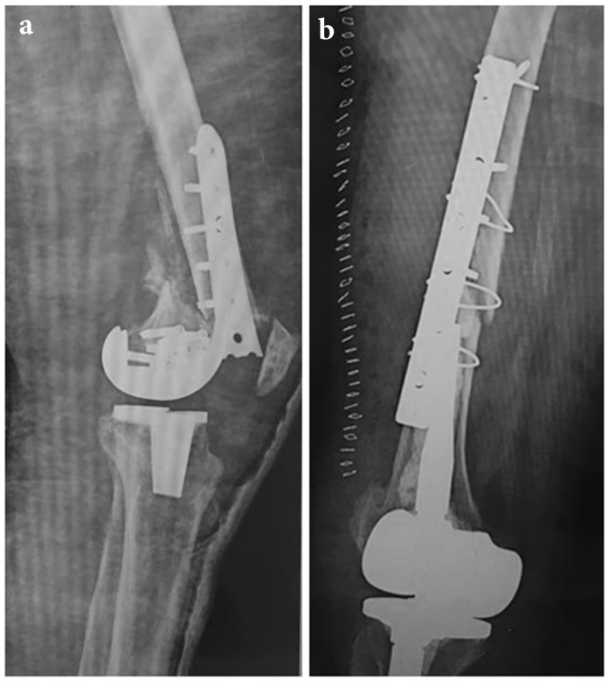

Figure 4. (a) Failure of a periprosthetic femoral fracture just above the prosthesis after fixation with an anatomically-shaped short distal femoral LCP, (b) Failure of a periprosthetic femoral shaft fracture after fixation with an 8-hole dynamic compression plate

for fracture fixation was event-free, as well (Figures 2 and 3). In these patients, the union of fracture was observed during a Mean±SD period of 3.1±2.1 months (range: 2-5). Fixation failed in all three patients who were managed with a short plate (Figure 4). In these patients, the fracture site started a curve about 3 months after the surgery, which progressed during the following months. The increased angulation of the knee led to the revision surgery at a Mean±SD period of 6.1±1.2 weeks (range: 5-7) after the surgery. These patients underwent revision surgery in which the fracture was fixed with a long proximal tibial plate. In two of these patients, the fracture was united without complication. In the remaining patient, the plate was fractured and complicated with infection. This patient was finally managed with a tumor prosthesis.

The Mean±SD functional score (KSS) of the patients at the final follow-up was 71.6±3.8 (range: 67-74). No patient had substantial limitations in the knee range of motion.

4. Discussion

There is no consensus regarding the optimal surgical procedure and choice of fixation for the management of periprosthetic fracture after TKA [10, 17, 18]. Before 2016, we used to use the anatomical distal femoral plate for the fixation of these fractures. However, because of the small size of the distal femur in most of our patients, using these plates was associated with impingement and pressure on the lateral tissues of the knee, resulting in a poor fixation. Therefore, we used long low-profile proximal tibial LCP for the fixation of these fractures after 2016.

In this study, we reviewed the outcome of post-TKA periprosthetic fracture in a cohort of 12 patients. According to our results, a long low-profile proximal tibial LCP provides an efficient and secure fixation, while short plates are associated with a high failure rate.

Hou et al. reported the outcome of periprosthetic femoral fractures above TKA in 34 patients fixed with a locking plate. Postoperative complications included three nonunion (9%), three malunion (9%), and two (6%) surgical site infections. They concluded that locking plate fixation could provide favorable results in treating patients with periprosthetic femoral fractures [17].

Ricci et al. reported the outcome of locking plate fixation combined with minimally invasive insertion technique to treat periprosthetic supracondylar femur fractures above a TKA in 22 patients. The failure rate was 14% (n=3), which included two infected nonunions and one aseptic nonunion. All patients who developed nonunion were insulin-dependent patients with diabetes. Two patients had postoperative malalignment. Screw fracture in the proximal fragment occurred in four patients [19].

Several other studies have also investigated the role of locking plates in treating periprosthetic fracture after TKA [20-23]. Wallace et al. performed a review study to find some of the factors that should be considered in the fixation of periprosthetic fractures about a TKA. According to their review, infection and nonunion are the most common postoperative complications after fixation of periprosthetic fracture about a TKA, with a rate of 0%-9% and 0%-19%, respectively [24].

We used long low-profile proximal tibial LCP for the fixation of periprosthetic femoral fracture above the TKA. The fixation was successful in all fractures that were fixed with this plate. Even though the success of treatment in periprosthetic fractures depends on several factors such as type of fracture, bone quality, and site of the fracture [25-27].

Herrera et al. performed a review study to determine the best fixation method for periprosthetic distal femur fractures after TKA. According to their review, locking plates and retrograde intramedullary nailing were successful in the fixation of these fractures. However, retrograde intramedullary nailing was slightly superior to locking plates. They urged the need for continuing research to understand and treat better these types of fractures since the rate of periprosthetic fractures is growing owing to the continuous increase of the TKA performed procedures [28].

Although long low-profile proximal tibial LCP has not been designed for the fixation of periprosthetic fractures, our results reveal that this plate could be a suitable substitute for anatomic distal femoral LCP in this setting because it resolves the problems of anatomic distal femoral LCP, including impingement with prosthesis and anterior protrusion after posterior shifting. Meanwhile, the plate manufacturing companies should focus on designing distal femoral plates with narrower and thinner distal portions, termed anatomic distal femoral plate designed for periprosthetic femoral fractures above the prosthesis. The present study had several limitations. It was a retrospective study with a small number of patients. The small number of patients did not allow the statistical comparison of failure rate between the short and long plates. Moreover, the characteristics of patients, such as bone quality, should be matched when comparing the efficacy of different plates. The present report is a pilot study using long low-profile proximal tibial LCP

to fix displaced periprosthetic femoral fractures. So, future large-scale comparative studies are required to shed more light on the efficacy of these plates for the fixation of such fractures. Finally, it should be noted that the success of treatment in periprosthetic fractures depends on several factors such as type of fracture, bone quality, and site of the fracture. So many confounding factors interfere with the conclusion, and in this survey, the small number of patients is problematic.

5. Conclusion

According to this pilot study, in contrast to short anatomic distal femoral LCP, long low-profile proximal tibial LCP could be an appropriate fixation device for treating displaced periprosthetic femoral fractures as they are not impinged by the prosthesis. However, future large-scale comparative studies are required to provide a consensus regarding the implication of this plate for the fixation of periprosthetic femoral fractures after TKA because they are not designed for the fixation of these fractures.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of the Iran University of Medical Sciences (Code: IR.IUMS.REC.1400.199).

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Authors' contributions

Study concept and design: Mahmoud Jabalameli and Hooman Yahyazadeh; Drafting manuscript: Amirali Karimi; Data collection: Rahmatalah Jokar and Sina Talebi; Reviewing the manuscript critically: Mehdi Mohammadpour.

Conflict of interest

The authors have no conflict of interest.

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