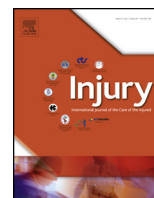




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## Incidence and risk factors of knee injuries associated with ipsilateral femoral shaft fractures: A multicentre retrospective analysis of 429 femoral shaft injuries

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### ABSTRACT

A femoral shaft fracture is usually a high-energy injury and, thus, is likely to be accompanied by an injury of adjacent joints such as a knee ligament injury. However, these associated injuries are often neglected because of severe pain and deformity. The purpose of the current study is to evaluate the incidence, type and risk factors of ipsilateral knee injuries associated with femoral shaft fractures.

A total of 429 femoral shaft fractures were included in this study from January 2010 to September 2015. There were 320 males and 109 females, with mean age of 40.7 years (range, 15–88). Exclusion criteria were skeletally immature patients and patients with metabolic bone disease such as osteoporosis, atypical femoral fractures, and pathologic fractures. The incidence and type of knee injury were identified, and the injury mechanisms, AO/OTA classification of the femoral shaft fractures, were analysed for assessment of risk factors for knee injuries combined with femoral shaft fractures.

Knee injuries were found in 131 cases. Knee ligament injuries were identified in 87 cases. There were 20 posterior cruciate ligament injuries, 11 anterior cruciate ligament (ACL) injuries, 16 medial collateral ligament (MCL) injuries, 8 lateral collateral ligament (LCL) injuries, and 32 multi-ligament injuries. In 24 cases, ligament injuries were not detected before internal fixation of femoral shaft fractures. Average time of diagnosis for ligament injury after fixation in these neglected cases was about 10.6 weeks (range, 1–32).

Fractures around the knee joint were identified in 69 cases; there were 32 patellar fractures, 14 distal femoral intra-articular fractures, 14 tibia plateau fractures, 3 proximal fibular fractures, and 6 combined fractures.

Male sex, type C fracture of AO/OTA classification, and motor vehicle accidents were identified as risk factors for associated ipsilateral knee injuries in femoral shaft fractures.

Knee injuries were identified in approximately 30% of femoral shaft fractures. About 30% of ligament injuries were not detected before internal fixation of femoral shaft fractures. Care should be taken since knee injuries can be accompanied by ipsilateral femoral shaft fractures.

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### Introduction

A femoral shaft fracture is usually a high-energy injury and, thus, is likely to be accompanied by injuries of adjacent joints. In

the literature, knee injuries were associated with 5–55% of femoral shaft fractures [1–4].

Since Pedersen and Serra [5] reported ligamentous injury of ipsilateral knee joint associated with femoral shaft fracture, careful physical examination and awareness of the possibility of associated injury during treatment of femoral shaft fracture was emphasised. However, because of the severe pain and deformity caused by femoral shaft fractures, associated knee injuries were

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often neglected [6,7]. Associated knee injuries that are not properly diagnosed and treated can cause sequelae such as instability or posttraumatic osteoarthritis, and therefore affects a patient's quality of life.

The purpose of the current study was to evaluate the incidence and type of knee injury associated with ipsilateral femoral shaft fracture and to identify the risk factors for associated knee injuries.

## Materials and methods

From March 2010 to September 2015, the medical records of 516 femoral shaft fractures that were operated on at seven institutions were retrospectively analysed. A femoral shaft fracture was defined as a fracture located between 5 cm distal to the lesser trochanter and the distal femur. The rule of squares was used to define distal femur as the length of the side of the square determined by the widest mediolateral width of the distal femur on an AP radiograph.

Patients who were skeletally immature (10 patients) were excluded from the analysis. Those with metabolic bone diseases such as osteoporosis (35 patients), atypical femoral fracture (18 patients), and pathologic fracture (eight patients) were excluded, because in these patients low-energy trauma may have led to femoral shaft fractures, and associated knee injuries would hardly be expected in low-energy trauma. In addition, 26 patients with <6 months of follow-up were also excluded. Therefore, 429 femoral shaft fractures were included in the final analysis. A flowchart of the patients included in this study is presented in Fig. 1.

The mean age of the patients was 40.7 years (range, 15–88), and the average follow-up period was 22.1 months (range, 12–66). There were 320 males (74.6%) and 109 females (25.4%). The demographics of the patients are shown in Table 1.

The incidence and type of knee injury were identified, and injury mechanism, AO/OTA classification of the femoral shaft fractures, were analysed for assessment of risk factors for knee injury combined with femoral shaft fractures. The timing of detection of the knee injury was also investigated. Data regarding age, sex, and open fracture as well as associated fractures including hip fractures were recorded.

### Statistical analysis

SPSS version 19.0 (IBM Corp., Armonk, NY) was used for statistical analysis of all data. The incidence of associated knee injuries between the groups was compared using the chi-square

**Table 1**  
Demographic data.

Parameters	
Age (yr)	40.7 years (range, 15–88)
Sex	
Male	320 (74.6%)
Female	109 (25.4%)
AO/OTA classification	
A	222 (51.7%)
B	144 (33.6%)
C	63 (14.7%)
Injury mechanism	
TA	292 (68.1%)
Fall from height	53 (12.4%)
Ground-level fall	54 (12.6%)
Others	30 (7.0%)

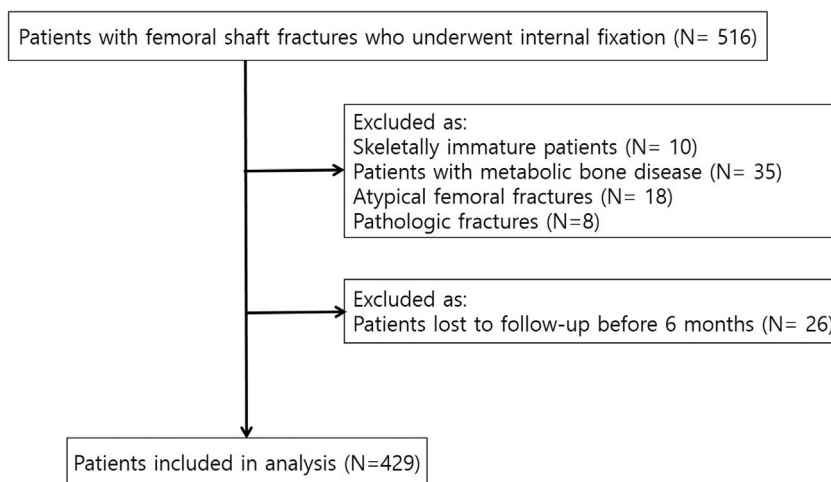
test or Fisher's exact test when one or more of the cells has an expected frequency of 5 or less. Binary logistic regression analysis was performed to evaluate risk factors of knee injuries associated with ipsilateral femoral shaft fractures. P-values less than 0.05 were considered statistically significant.

## Results

The associated knee injury was found in 30.5% (131/429) of all femoral shaft fractures. There were 87 knee ligament injuries and 69 fractures around the knee joint. In 25 cases, knee ligament injuries and fractures around the knee were combined.

There were no reported intraoperative complications. There were 16 cases (3.7%) of nonunion, 15 cases (3.5%) of delayed union, 3 cases (0.7%) of infection, and 5 cases (1.2%) of instability of the knee joint. Complication rate was significantly higher in patients with associated knee injury (18/131) with than patients without knee injury (20/298,  $p = 0.018$ ).

The mechanisms of the femoral shaft fractures were as follows: traffic accidents in 292 cases (68.1%), ground-level falls in 54 cases (12.6%), falls from height in 53 cases (12.4%), and others including sports injuries and crushing injuries in 30 cases (7.0%, Table 1). Femoral shaft fractures caused by traffic accidents included 93 motorcycle injuries, 78 driver's traffic accidents, 68 passenger traffic accidents, 48 pedestrian traffic accidents, and 5 bicycle accidents.



**Fig. 1.** Flow chart of the retrospective study.

This retrospective study was conducted by enrolling 516 patients who underwent internal fixation due to femoral shaft fractures between the years 2010 and 2015. After excluding patients inadequate for analysis, 429 patients were ultimately included in this study.

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