

ORIGINAL ARTICLE

# Functional outcomes and quality of life in adult ipsilateral femur and tibia fractures

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## KEYWORDS

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**Abstract** *Objective:* The aim of our study is to evaluate the functional outcomes and quality of life in adult ipsilateral femur and tibia fractures.

*Methods:* 26 patients (21 male, 5 female; mean age 30 years, range: 18 to 66) treated for adult ipsilateral femur and tibia fractures were evaluated retrospectively. For femur fractures, intramedullary nails were used in 15 patients (12 antegrade, 3 retrograde), plate in 11 patients (10 locked-plate, and 1 blade-plate with a 95 degree angle). For tibia fractures, locked-plate were used in 13 patients, intramedullary nails in 9 patients, external fixator in 3 patients and multiple screws in 1 patient. According to Blake and McBryde classification, 17 fractures were type I, 9 fractures were type II (7 type 2A and 2 type 2B). The functional outcomes were evaluated by Karlström and Olerud criteria, and quality of life was evaluated by Short Form-36. The mean follow-up duration was 4.4 years (range: 1.1 to 7.3 years).

*Results:* The functional outcomes were excellent in 6 patients, good in 8 patients, acceptable in 6 patients and poor in 6 patients. The mean values of quality of life scales were; physical function: 64.8, physical role limitation: 60.5, pain: 68.2, general health: 63.3, vitality: 58.4, social function: 68.2, emotional role limitation: 62.7, and mental health: 65.8.

*Conclusion:* Adult ipsilateral femur and tibia fractures are severe injuries and adversely affect the quality of life and functional outcomes. The quality of life scales should be used along with functional outcome scores in evaluating these injuries.

*The translational potential of this article:* Adult ipsilateral femur and tibia fractures cause severe morbidity. Functional outcomes and quality of life scales should be used together to

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evaluate these fractures. Karlström and Olerud criteria for functional outcomes and Short Form-36 scales for quality of life are suitable methods to evaluate these fractures.

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## Introduction

Adult ipsilateral femur and tibia fractures (floating knee) are rare injuries that occur as a result of high-energy trauma. These injuries can cause serious morbidity or mortality due to the high incidence of the associated injuries and complications [1–4].

There are many factors such as the type of fracture (open, intraarticular involvement and comminution) or associated injuries that affect functional outcomes in adult ipsilateral femur and tibia fracture [5]. Contemporary methods allowing early rehabilitation are preferred in the treatment of adult ipsilateral femur and tibia fractures [5,6]. However, optimum surgical method still remains controversial due to different patterns of these fractures. Intramedullary nailing (IMN) is a commonly preferred method for fixation of both femur and tibia fractures without involvement of the knee joint [5,7–9], whereas IMN and plating or plating and plating or IMN and external fixation (EF) or plating and EF combinations may be preferred for fixation of fracture with knee joint involvement [5].

Previous studies [2,5,10,11] have reported functional outcomes after adult ipsilateral femur and tibia fractures. However, to the best of our knowledge, there is no study reporting the quality of life. The aim of this study is to retrospectively evaluate the functional outcomes and quality of life in the adult ipsilateral femur and tibia fractures.

## Material and methods

After obtaining approval from the local ethics committee, 26 consecutive patients (21 male and 5 female; mean age 30 years, range: 18–66) who had undergone surgical treatment for ipsilateral femur and tibia fractures between 2004 and 2011 were evaluated retrospectively. The patients with pathological fractures and previous knee injury and children were excluded. The mean follow-up duration was 4.4 years (range: 1.1–7.3 years).

Open fractures were classified according to Gustilo classification [12]. Seven femur fractures (2 Grade 1, 4 Grade 2 and 1 Grade 3A), and nine tibia fractures (1 Grade 1, 7 Grade 2 and 1 Grade 3C) were open fractures. Five patients had open fractures in both the femur and tibia. In patients with open fractures, the wound was closed with sterile dressing after the infection prophylaxis. Debridement was performed in the operating room if vital signs were normal or in the emergency room if vital signs were abnormal. Blake and McBryde criteria [13] were used for classification of all fractures ( $n = 26$ ) (Table 1).

Accordingly, 17 fractures were Type I and nine fractures were Type II (7 Type 2A and 2 Type 2B) fractures. In patients with Type 1 fractures, five of the femur fractures (1 Grade 1 and 4 Grade 2) and seven of the tibia fractures (6 Grade 2 and 1 Grade 3C) were open fractures. In patients with Type 2 fractures, two of the femur fractures (1 Grade 1 and 1 Grade 3A) and two of the tibia fractures (1 Grade 1 and 1 Grade 2) were open fractures. A total of 32 associated injuries were observed in 14 patients (Table 2). The mean time from trauma to surgery was 6.3 days (range: 2–21 days) in Type 1 fractures and 4.3 days (range: 2–8 days) in

**Table 1** Blake and McBryde classification for floating knee injuries.

Type 1 (True floating knee)	The knee joint is involved with neither the femur nor the tibia fracture
Type 2 (Variant floating knee)	One or more joints is involved with femur and tibia fracture
Type 2A	Only the knee joint is involved
Type 2B	The hip or ankle joints are involved

**Table 2** Associated injuries in Blake and McBryde Type 1 and 2 fractures.

Associated injuries	Type 1	Type 2
Hemopneumothorax	2	1
Head injury	1	4
Abdominal injury	3	
Pelvic fractures	2	1
Vertebral fractures	1	1
Contralateral femoral fractures	1	1
Contralateral bimalleolar fractures	-	1
Contralateral femoral neck fractures	1	-
Ipsilateral patellar fractures	1	-
Ipsilateral humeral proximal fractures	-	1
Ipsilateral humeral distal fractures	-	1
Ipsilateral ulnar fractures	1	-
Contralateral radial distal fractures	-	1
Bilateral clavicle fractures	2	-
Ipsilateral phalanx fractures (hand)	1	-
Contralateral phalanx fractures (foot)	1	-
Contralateral metacarpal fractures	1	-
Ipsilateral anterior cruciate ligament rupture	1	-
Ipsilateral laceration of extensor tendon (hand)	1	-
Total	20	12

**Table 3** The distribution of open/closed fractures and treatment methods, together with p-values from comparisons regarding time to union between the fracture types.

Fracture type	Femur			Tibia		Duration of healing
	Open/Closed	Treatment (IMN*/PS†)	Time to union	Open/Closed	Treatment (IMN/PS/EF‡/MS§)	
Type 1	6/11	9/8	24.1 weeks	7/10	7/8/2	25.4 weeks
Type 2	1/8	6/3	30.7 weeks	2/7	2/5/1/1	31.8 weeks
p value			p = 0.341			p = 0.393

EF‡ = external fixator; IMN\* = intramedullary nailing; MS§ = multiple screw; PS† = plate screw.

**Table 4** Karlstrom ve Olerud criteria for functional assessment after treatment of ipsilateral femur and tibial fractures.

Criterion	Excellent	Good	Acceptable	Poor
Subjective symptoms from thigh or leg	None	Intermittent slight symptoms	More severe symptom, impairing function	Considerable function impairment: pain at rest
Subjective symptoms from knee or ankle joint	None	Same as above	Same as above	Same as above
Walking ability	Unimpaired	Same as above	Walking distance restricted	Uses cane, crutch or other support
Work and sports	Same as before the accident	Given up some sport; work same as before accident	Change to less strenuous work	Permanent disability
Angulation, rotational deformity or both	0	<10°	10–20°	>20°
Shortening	0	<1 cm	1–3 cm	>3 cm
Restricted joint mobility	0	<10° at ankle; <20° at hip and knee or both	10–20° at ankle; 20–40° at hip and knee or both	>20° at ankle; >40° at hip and knee or both

Type 2 fractures. The type of surgical method was determined according to Blake and McBryde classification, localisation of the fracture, condition of the soft tissues and associated injuries.

Blade plate with a 95° angle (Hipokrat, Izmir, Turkey) for subtrochanteric femur fracture, antegrade IM nails (Sanatmetal, Budapest, Hungary and Tipmed, Izmir, Turkey), locked plate (Sanatmetal and Tipmed) and retrograde IMN (Tipmed and Biomet, South Wales, UK) for diaphyseal femur fractures and locked plates (Sanatmetal and Tipmed) and retrograde IMN (Tipmed and Biomet) for distal femur fractures were used according to the preference of the surgeon.

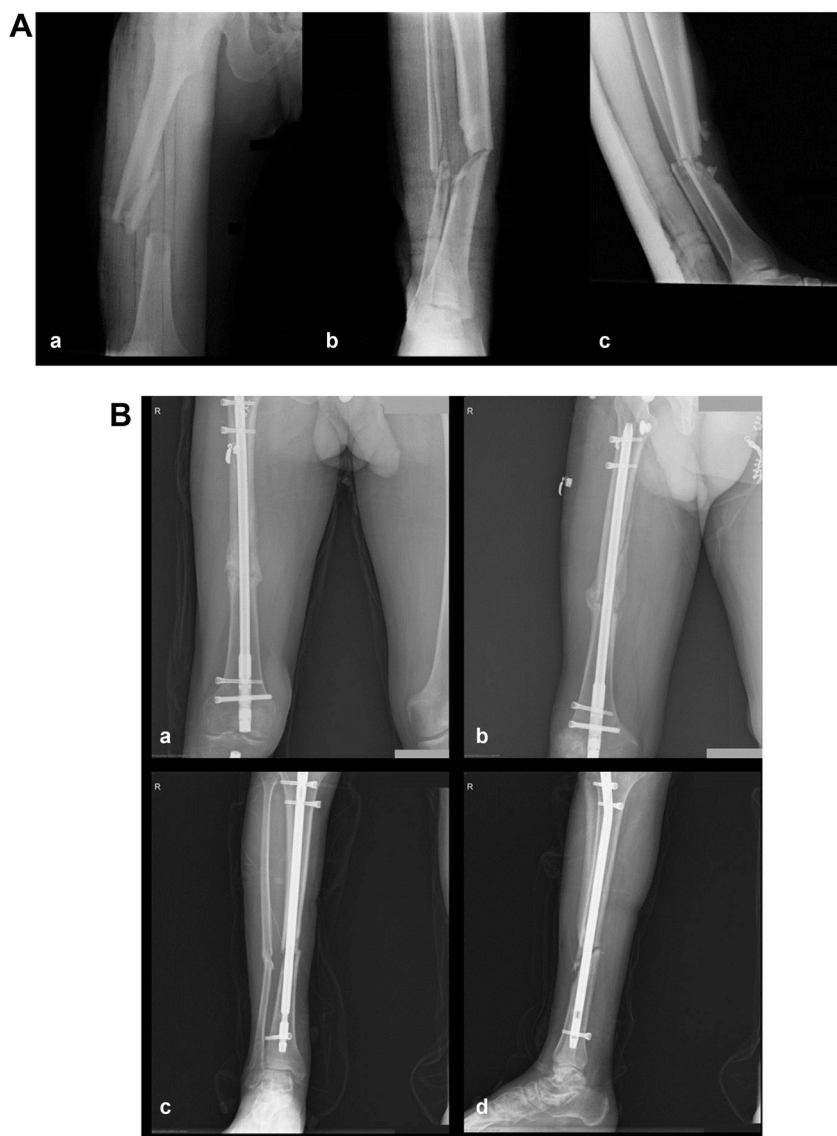
Locked plate (TST, Istanbul, Turkey and Sanatmetal) and multiple screw (TST) for proximal tibia fractures, IMN (Sanatmetal and Tipmed), locked plate (TST and Sanatmetal) and EF (TST and Tipmed) for diaphyseal tibia fractures and locked plate (TST) for distal tibia fracture were used according to the preference of the surgeon. Indirect reduction by bridge plating was frequently preferred when plating was used for comminuted fractures. External fixators were used for permanent fixation whenever they were used. According to this, IM nails were used for 15 femur fractures (12 were antegrade and 3 were retrograde), plate was used for 11 fractures (10 were locked plate) and blade plate with a 95° angle was used for one fracture. IM nails were used for nine tibia fractures, locked plate for 13 fractures, external fixator for three fractures and multiple screws for one fracture (Table 3).

Antibiotics prophylaxis were administered at emergency room for all open fractures and tailored according to the

type of fractures postoperatively. Isometric quadriceps-strengthening exercises were started on the first postoperative day. On the second day, all patients, except six patients with associated injuries, were mobilised with double crutch without weight-bearing, and exercises increasing the knee-hip-ankle range of motion were started. The mean length of hospital stay was 14.3 days (range: 5–58 days). During the postoperative follow-up, according to the stability of the fracture, partial weight-bearing was recommended after at least 6 weeks. Full weight-bearing was allowed when radiological union was observed.

Patients were evaluated according to the time to union, complications, functional outcome, quality of life and type of fractures. Union was assessed radiographically. The presence of bridging callus at least in three cortices in anteroposterior and lateral radiographs was accepted as union. The absence of union after 9 months was defined as nonunion [14]. The functional outcomes were evaluated with the seven criteria defined by Karlström and Olerud [15] (Table 4). The quality of life was evaluated by Short Form-36 (SF-36) [16]. SF-36 includes 36 questions that evaluate eight scales (physical function, physical role limitation, pain, general health, vitality, social function, emotional role limitation and mental health). All of the eight scales evaluate the health between 0 and 100, and the high values demonstrate a better quality of life.

The statistical data were analysed by SPSS (Statistical Package for Social Sciences) 15.0 (IBM SPSS, Chicago, IL, USA). The Kolmogorov–Smirnov test was used to screen for normality of the data distribution. The Chi-square test was



**Figure 1** (A) Preoperative X-ray images of the 29-year-old male patient with Blake and McBryde Type 1 fracture; (B) the X-ray images of femur (healed) and tibia (nonhealed) at the postoperative 5.5<sup>th</sup> month; (C) the X-ray images of femur (healed) and tibia (in which IMN change was applied due to nonhealing) at the postoperative 9<sup>th</sup> month; (D) the X-ray images of femur and tibia (healed) at the postoperative 18<sup>th</sup> month.

used in the comparison of categorical variables (if at least one expected value was smaller than 5, Fischer's exact test was used). For comparison of paired numerical variables (parameters of quality of life and time to union), the student *t* test was used when the distribution was normal, and the Mann–Whitney U-test was used when the distribution was not normal. A *p* value less than 0.05 was considered statistically significant.

## Results

Radiological union was observed in all patients at the latest follow-up (Figs. 1 and 2). The mean time to union for femur and tibia fractures was 26.4 weeks (range: 14 weeks to 23 months) and 27.6 weeks (range: 14 weeks to 28 months),

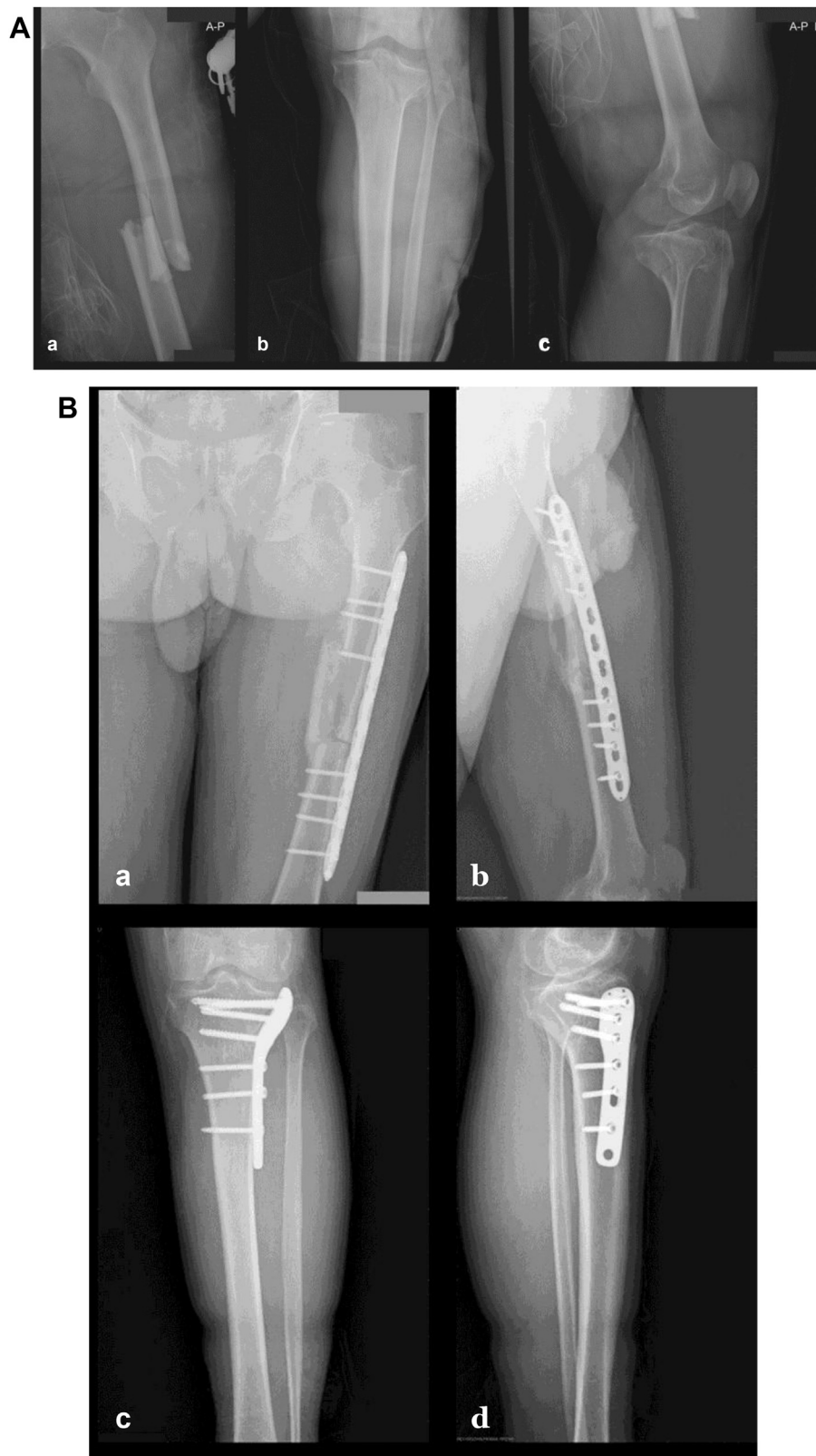
respectively (Table 3). Although the mean time to union in femur and tibia in Blake and McBryde Type 1 fractures was shorter than that in Type 2 fractures, this difference was not statistically significant ( $p = 0.341$  and  $p = 0.393$ , respectively). A total of 29 complications were observed in 16 patients (Table 5).

The functional outcomes according to Karlström and Olerud criteria were excellent or good in 14 patients (53.8%) (6 excellent and 8 good) and acceptable or poor in 12 patients (46.2%) (6 acceptable and 6 poor) (Table 6). Although there are more excellent or good results in Blake and McBryde Type 1 fractures than in Type 2 fractures, the difference was not statistically significant ( $p = 0.218$ ).

The mean values of quality of life scales according to SF-36 were physical function, 64.8 (range: 25 to 100); physical role limitation, 60.5 (range: 0 to 100); pain, 68.2 (range: 31



Figure 1 (continued).



**Figure 2** (A) Preoperative X-ray images of the 53-year-old male patient with Blake and McBryde Type 2 fracture; (B) the X-ray images of femur (healed) and tibia (healed) at the postoperative 4.5<sup>th</sup> month. (C) the X-ray images of femur and tibia at the postoperative 43<sup>th</sup> month after the removal of the implants.



Figure 2 (continued).

to 100); general health, 63.3 (range: 35 to 92); vitality, 58.4 (range: 20 to 80); social function, 68.2 (range: 37.5 to 100); emotional role limitation, 62.7 (range: 0 to 100) and mental health: 65.8 (range: 32 to 100) (Table 7). Although the quality of life scales in patients with Blake and McBryde Type 1 fractures were higher than those in Type 2 fractures, there was no statistically significant difference ( $p \geq 0.05$ ).

## Discussion

In recent years, with the increase in motor vehicle accidents, the increased incidence of ipsilateral femur and tibia fracture cases [5] increase the importance of reports on the outcomes of this kind of complicated injuries.

Functional outcomes of adult ipsilateral femur and tibia fractures are frequently evaluated with seven criteria defined by Karlström and Olerud. Karlström and Olerud criteria evaluate the functional outcomes in the most

comprehensive way. But, according to this, if all criteria are excellent, it is accepted as excellent; if one of them is good, it is accepted as good; if one of them is acceptable, it is accepted as acceptable and if one of them is poor, it is accepted as poor. Hung et al [10] and Yokohoma et al [11] criticised that these criteria may increase the number of poor functional outcome more than actually it is. Karlström and Olerud criteria and SF-36 quality of life scales were used in our study. The SF-36 quality of life scale provides an evaluation of the health status of the individual in different aspects with the assistance of the parameters such as physical function, physical role limitation, pain, general health, vitality, social function, emotional role limitation and mental health, which are not present in the Karlström and Olerud criteria.

The excellent or good functional outcome were reported between 24 and 81% in the literature [1,4,10,17–19] after ipsilateral femur and tibia fractures. In our study, 14

**Table 5** The complications encountered in Blake and McBryde Type 1 and 2 fractures and associated bones.

Complications	Type 1		Type 2	
	Femur	Tibia	Femur	Tibia
Nonunion	2	2	2	2
Deep infection	0	0	0	1
Superficial infection	0	0	0	1
Amputation	0	1	0	0
Angular deformity ( $\geq 10^\circ$ )	0	2	0	0
Shortening ( $>3$ cm)	0	0	1	0
Implant failure	0	1	0	1
Sinostosis	0	1	0	0
Gonarthrosis		0	0	0
Coxarthrosis	0	0	1	0
Fat embolism	1		0	
Restricted joint mobility ( $\geq 10^\circ$ )				
Hip	1		2	
Knee	1		3	
Ankle	1		1	
Total	13		16	

**Table 6** Distribution of functional outcomes, together with p-values from comparisons regarding functional outcomes between the fracture types.

	Excellent/Good	Acceptable/Poor	p
Type 1	4/7	4/2	p = 0.218
Type 2	2/1	2/4	
Total	14	12	

**Table 7** The mean values of quality of life scales, together with p-values from comparisons regarding quality of life scales between the fracture types.

Quality of life scales	Type 1 (n = 17)	Type 2 (n = 9)	p
Physical function	68.2 (25–100)	58.3 (40–100)	p = 0.238
Physical role limitation	64.7 (0–100)	52.7 (0–100)	p = 0.323
Pain	71.9 (31–100)	61.3 (31–100)	p = 0.261
General health	66 (35–92)	58.4 (42–87)	p = 0.323
Vitality	60.5 (20–80)	54.4 (25–80)	p = 0.375
Social function	72 (37.5–100)	61.1 (37.5–87.5)	p = 0.154
Emotional role limitation	66.6 (0–100)	55.5 (33.3–100)	p = 0.304
Mental health	67.2 (32–100)	63.1 (36–88)	p = 0.589

patients (53.8%) had excellent or good functional outcome which is in line with the literature. We consider that the differences in the literature may be due to high variation in this type of injuries. In our study, we observed that the quality of life scales were decreased when compared with the normal values of the Turkish urban population [20]. We

believe that evaluating functional outcomes together with the quality of life in ipsilateral femur and tibial fractures will provide more accurate information about the health status of patients.

Many factors that may affect the results in adult ipsilateral femur and tibial fractures have been investigated in the literature [9–11,18,19,21,22]. Hung et al [10] reported the knee involvement as the most important factor that negatively affects functional outcomes and that knee involvement causes poor functional outcomes than the other joint involvements. In a series involving 65 patients, Yokohoma et al [11] reported that severe knee joint injury and soft tissue injuries in the thigh region have adverse effects on functional outcomes, but soft tissue injuries in the tibia, fracture patterns in both bones, neurovascular injuries, the time of the surgery, treatment method and multiple traumas have no significant contribution to this. Adamson et al [19] reported that intraarticular involvement is associated with higher systemic trauma, higher grade of open fracture and poor results. Arslan et al [21] reported that there are more insufficient and poor results in open fractures with the knee joint involvement. Tan et al [9] reported that the fixation of both fractures with IM nails using single incision in the knee is effective in obtaining good functional outcomes by causing less damage, less infection and good fracture healing. Piétu et al [18] reported that age, the presence of joint involvement in the distal 1/3 of the femur fracture and open fractures are associated with poor outcomes and that IMN with single incision does not cause a significant change in the functional outcomes; however, it shortens the duration of surgery. Retham et al [22] reported that there were 38 associated injuries in 29 patients. The functional outcomes were excellent or good in majority of associated injuries, but ligament injury and vascular injury were associated with poor outcomes. In our study, there were more excellent or good outcomes and higher values in all quality of life scales in patients with Type 1 fractures than in the patients with Type 2 fractures; however, the difference was not statistically significant. This may be due to the small number of patients. When we evaluate previous studies [10,11,18,19] along with our study, we believe that the knee joint involvement may be the important factor on functional outcomes and quality of life. In our study, we evaluated the relationship between Type 1 and Type 2 fractures and the condition of the soft tissues, associated injuries, time to surgery, treatment method, time to union and complications. Although the number of open fractures was higher in patients with Type 1 fractures, better results were obtained in Type 1 fractures than in Type 2 fractures. This condition suggests that the presence of soft tissue injury has no adverse effect on outcome. However, this may be due to the fact that most of our patients with open fracture were low grade. Higher grade open fractures may adversely affect outcomes in both fracture types. In our study, although the number of associated injuries was higher and time to surgery was longer in patients with Type 1 fractures, better results were obtained in Type 1 fractures than in Type 2 fractures. This condition suggests that associated injuries and the time to surgery have no adverse effects on outcome. However, the sequel that is caused by the associated injuries or when the time to surgery is too



long, the outcomes could be affected more notably. In the literature, better functional outcome have been reported with IMN of both bones [2,12,17,20]. In our study, only seven patients were treated with IMN for both bones. At least one bone was treated with an implant other than IMN due to the different patterns of fractures in 19 patients. In the light of the literature [23], we believe that IMN should be the first choice of treatment in adult femur and tibia fractures without involvement of the knee joint, which provides more rapid recovery and reduces complication rates. In our study, time to union was shorter, and complications were less in Type 1 fractures than in Type 2 fractures. We believe that better functional outcome and quality of life in cases with Type 1 fractures is due to the fact that total complication rate is lower and the time to union is shorter. However, it does not reach a statistically significant difference in a mean of 4.4 years follow-up.

This study has several limitations. First, it is a retrospective study. Second, it comprises a relatively small number of patients. Third, the subgroup types are heterogeneous. More accurate results may be obtained by studies with prospective design and a large number of patients with homogeneous subgroup types.

In conclusion, ipsilateral femur and tibia fractures are severe injuries adversely affecting the quality of life, as well as the functional outcomes. In evaluating these injuries, quality of life scales should be used along with functional outcome evaluation criteria.

## Conflicts of interest

The authors declare that they have no conflict of interest to declare.

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## Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.jot.2018.08.002>.

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