

Assessment of Functional Outcome in Open Knee Fractures -A Retrospective and Prospective Study

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Abstract:

Background: This study was conducted to examine how functional outcomes are assessed in cases of open knee fractures.

Methods: This was a retrospective and prospective study carried out in a hospital setting among 25 patients who presented with open knee fractures treated in various ways at a tertiary care teaching hospital.

Results: In our analysis of twenty patients, the most frequent fracture patterns were grade 3B fractures (40%), simple fractures (75%) and proximal tibia fractures (35%). According to the Rasmussen score, 80% of open knee fractures treated with various fixation techniques had fair to good results, while 20% had poor results. According to the subjective score, good results made up 35% and fair to poor results made up 65%. Poor outcomes occur from open grade 3B fractures, osteochondral fractures, intra-articular fractures, and fractures with flap covers.

Conclusion: There are a variety of factors that affect the functional outcome of various open knee fractures treated with different fixation techniques. This includes long immobilisation times, porotic bones, severe soft tissue injuries, severely comminuted fractures, grade 3B fractures, intraarticular fractures, and associated injuries. When the procedure for managing open wounds, fracture repair techniques, early wound coverage, and effective rehabilitation is strictly followed, good outcomes can be obtained in various types of fractures.

Keywords: Functional Outcome, Open Knee Fractures.

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Introduction

Due to the concomitant soft-tissue damage, musculoskeletal injuries, and neurovascular injuries, open lower limb fractures are frequently difficult injuries to treat and call for combined surgical experience and knowledge from plastic, orthopaedic, and vascular specialists. An excellent prognosis for open lower limb fractures necessitates prompt assessment, stabilisation, systemic antibiotics, debridement, and irrigation, followed by phased soft tissue covering and comprehensive rehabilitation. [1]

Home accidents and highway accidents frequently result in lower limb injuries. High intensity trauma occurs in RTAs, potentially posing a threat to one's life or limb. These injury groupings are incredibly diverse. These are invariably linked to elevated morbidity rates. The majority of these injuries leave their victims permanently disabled. The management is not subject to any particular guidelines. The type of fracture and soft tissue injuries must be taken into consideration while

selecting an implant. Identifying a particular management pattern is frequently impossible. [1,2]

Lower limb open fractures can have disastrous consequences due to delayed wound and fracture healing, increased risk of infection and recurrent surgeries, decreased functional outcome, longer hospital stay, longer follow-up, overall higher costs, extended absence from work, and ensuing financial loss. Femoral or tibial condyle malunions. [3] can cause lower limb deformity, decreased knee flexion, instability, knee discomfort, and altered gait. Injuries with open intra-articular fractures are rare. The likelihood of an unsatisfactory outcome is increased when open and intra-articular components are combined. With open injuries the traditional therapy for intraarticular fractures-rigid fixation and early joint mobilization-may not be feasible or may have to wait. [4] Treatment for such complex injuries requires the use of either internal or external fixation alone, in combination with wound closure care, or as an isolated procedure. It may be necessary to consult with

specialists in plastic surgery and vascular surgery in addition to orthopaedic or trauma surgeons. The hospital needs to have the right tools and technology to accommodate various specialisations. Physical therapy and rehabilitation play a critical role in ensuring a positive result for injuries in this complex. [5]

According to Veith, these injuries are linked to potentially fatal injuries such as head, chest, stomach, and intra-articular ligament injuries of the knee.^[6] These patients also have additional skeletal damage. Many times, injuries are the result of combining various fracture patterns. The limb also has a significant soft tissue injury. Additionally, soft tissue injuries can range from small scrapes to grade III open wounds. Damage to the neurovascular structures introduces a risk factor into the whole scenario. Even the most skilled medical professionals frequently struggle with this while making management decisions. Skeletal injuries to the upper extremities have been referred to as "side-swipe injuries."

Currently under investigation is a case of lower limb side-swipe injuries from a traffic collision that involved damage to the knee. The need for studying open knee fractures is emphasised because there has never been a description of a side-swipe injury to the lower extremities in the literature. In this work, we examine the fracture pattern's personality as well as the functional results of these fractures repaired using various techniques.

Aims and objectives

- To evaluate the fracture patterns.
- To evaluate these fractures' functional results throughout the medium term.

Materials & Methods

This was a retrospective and prospective study carried out in a hospital setting among 25 patients who presented with open knee fractures treated in various ways at a tertiary care teaching hospital.

Inclusion Criteria

- 20-50 years of age.
- Both male and female.
- All surgically treated open knee fractures (patella, distal femur, and proximal tibia, both intra- and extra-articular).
- Cases with a minimum follow-up time of six months.

Exclusion Criteria

- Extreme age ranges from less than 20 to more than fifty years.
- Delayed presentations for more than 24 hours.
- Polytrauma (head, abdominal, chest injuries and associated fractures).
- Ligament injuries of the knee (ACL, PCL, PLC, collaterals).
- Co-morbid conditions.

Statistical Methods: Data was entered in MS Excel and analyzed using SPSS software. The results were presented as tables.

Results

Table 1: Study Group

		Male	Female	Total
1.	No. of Patients	17	3	20
2.	Average Age (in years)	25	25	
3.	Fracture pattern- Simple	12	3	15
	Wedge	0	0	0
	comminuted	5	0	5
4.	Patella	2	1	3
	Supracondylar Fracture	2	1	3
	Lateral Femoral Condyle	4	0	4
	Tibial Condyle	6	1	7
	Combined	3	0	3
	Osteochondral Fractures	All	All	All
5.	Type of Accident RTA	17	2	19
	Fall from Height	0	1	1
6.	Severity of Wound Grade I	0	0	0
	Grade II	3	2	5
	Grade III A	7	0	7
	B	7	1	8

Table 2: Rasmussen Functional Grading

		Acceptable			Unacceptable	
		Points	Excellent	Good	Fair	Poor
A.	Subjective Complaints					
	A. Pain					
	No pain	6	5	4	2	0
	Occasional ache, bad weather pain	5				
	Stabbing pain in certain positions	4				
	Afternoon pain, intense, constant pain around the knee after activity	2				
	Night pain at rest	0				
	B. Walking Capacity					
	Normal walking capacity (in relation to age)	6	6	4	2	1
	Walking outdoors at least one hour	4				
	Short walks outdoor > 15 minute	2				
	Walking indoors only	1				
	Wheel-chair/bedridden	0				
B.	Clinical signs					
	A. Extension					
	Normal	6	6	4	2	2
	Lack of extension (0 to 10 degrees)	4				
	Lack of extension > 10 degrees	2				
	B. Total Range of Motion					
	At least 140	6	5	4	2	1
	At least 120	5				
	At least 90	4				
	At least 60	2				
	At least 30	1				
	0	0				
	C. Stability					
	Normal stability in extension and 20 degrees of flexion	6	5	4	2	2
	Abnormal instability 20 degrees of flexion	5				
	Instability in extension < 10 degrees	4				
	Instability in extension > 10 degrees	2				
	Sum (minimum)		27	20	10	6

Table 3: Functional Outcome in Different Fracture (Rasmussen Score)

Fractures	Proximal Tibia						Supra Condylar Femur				Femoral Condyle				Patella			Patella + Lateral Femoral Condyle		Proximal Tibia + Supra Condylar Femur	
Patients No.	7						3				4				3			1		2	
A. Subjective complaints																					
a. Pain	0	2	2	2	0	4	4	2	4	4	4	4	4	4	4	2	4	2		0	0
b. Walking capacity	1	2	2	2	1	4	4	2	4	4	4	4	4	4	4	2	4	2		1	1
B. Clinical signs																					
. Extension	2	2	2	2	2	4	4	2	4	4	4	4	4	4	4	2	4	2		2	2
b Total range of motion	1	2	2	2	1	4	4	2	4	4	4	4	4	4	4	2	4	2		1	1
c. Stability	2	2	2	2	2	4	4	2	4	4	4	4	4	4	4	2	4	2		2	2
Sum(minimum)	6	10	10	10	6	20	20	10	20	20	20	20	20	20	20	10	20	10		6	6
	P	F	F	F	P	20G	G	F	G	G	G	G	G	G	G	F	G	F		P	P

Note --- G-Good; F-Fair; P-Poor

Table 4: Subjective Functional Outcome Score

	Muscle Strength	Range of Motion	Occupational Disability
Excellent	Grade V	>90%	Same occupation
Good	Grade V	>75%	Same occupation
Moderate	Grade IV	>50%	Same occupation with little change
Poor	Less than Grade IV	<50%	Change of occupation

At the time of the most recent follow-up, a patient-based, subjective SF-36 questionnaire was used to determine the functional outcome score. All patients had their isometric strength of the limb muscles as a unit, their knee joint's range of motion, and their impact on occupation measured and compared to that of the contralateral limb. Scores were used to represent the results. Nine had intermediate results, seven had good results, and four had bad results.

Discussion

The functional prognosis of open knee fractures treated with varying surgical techniques has not been the subject of any comparative studies.

Serious high-velocity injuries like open knee fractures are frequently linked to osseous and soft tissue damage. [7] The management of open knee fractures presents significant treatment obstacles throughout the history of fracture treatment, making it a difficult responsibility for the surgeon. Although there isn't a single, widely recognised method of treating these fractures, adequate care and the best possible rehabilitation are essential to getting positive outcomes. [8,9,10]

One of the most common forms of incidents at intersections in India involves a side-swipe collision involving two-wheelers and other motorised vehicles that results in injuries to the knee joint. Two-way traffic on a single road may contribute to collisions between vehicles crossing in opposite directions, according to research on side-swipe injuries to the knee. When a car passes them directly from the front or side, pillion riders are more vulnerable than two-wheeler drivers. Side swipe injuries caused by direct impacts to the knee from lamp posts, road barriers, or stationary objects also happen often at night. The literature has a dearth of studies that investigate the factors that influence the severity of side swipe collision-related injuries to the knee and joint function in two-wheelers. Due to the increased frequency of knee injuries, as previously noted, our investigation was necessary to determine the extent and consequences of these injuries. The following variables affect the prognosis for high energy open knee fractures: age, fracture mechanism, soft tissue damage extent, fracture communication, osteoporotic bone, fixing technique, soft tissue procedure, extended immobilisation duration, infection, and bone loss.

Age Incidence: Patients who were older than 50 or

younger than 20 were not included in our study. The age distribution ranged from 20 to 30 years, with an average age of 25 years. This age distribution was similar to the age incidence found in a study conducted by Sharma C. et al. [11] Younger people were more likely to have open knee fractures, most likely as a result of their increasing physical activity and increased participation in outdoor activities, which led to high energy injuries.

Sex Incidence: There were twenty patients in the study, with three girls and seventeen males (85%) making up the majority. This was comparable to other research that found a similar gender distribution in the literature (James P. Stannard et al., [12]; Mehmet Subhasi et al., [13]. The majority of men indicate that they are frequently the victims of trauma and high-velocity injuries, while the majority of women limit their activities to the home.

Mechanism of Injury: When compared to the research conducted by numerous authors (Jon-Woo Kim et al. [14] Mehmet Subhasi et al., David P. Barei et al., [15] Ryan J. Krupp et al., [16] Sharma et al., Sudhir et al. [17], the most frequent mechanism of injury in our study was road traffic accidents (95%). The bulk of the instances involved patients who were drivers, with the remainder typically being domestic. This is most likely due to the high number of traffic accidents in our country, which are a result of both poor road conditions and poor road traffic sense.

Anatomical Location of the Fractured Bones and Mode of Fixation

Proximal Tibia Fracture: Proximal tibia fractures accounted for 7 patients (35%), or 7 out of 20 patients in our series. Of these, 5 patients (71.5%) received treatment with an external fixator, and 2 patients (28.5%) received treatment with a buttress plate. Results were fair to good in 71.4% of cases and poor in 28.6%. In 2 patients (3b) with proximal tibia fractures treated with an external fixator and flap cover, only superficial infections were seen. This was contrasted with a research by Joon Woo Kim et al. that used MIPO to treat 30 open proximal tibia fractures and discovered that the results were excellent in 76.6% of cases, good in 23.4%, and high in infections (10% in superficial infections and 16.7% in deep infections). The higher number of open proximal tibia fractures that have been recorded can be attributed to the bone's anatomical stiffness and subcutaneous location, which make it more susceptible to external force.

Lateral Femoral Condyle: The next most frequently reported fracture was a lateral femoral condyle fracture (20%), which was 100% successfully treated with cannulated cancellous screws. There was no comparison of independent study series for this.

Supra Condylar Fracture: In comparison to studies by Viswanath Yaligod et al., Sudheer et al., Iftikar et al., [18] and Manohar G. et al., [19] who had excellent to good results in 74.2% with superficial infection in 2.85%, we had three open supracondylar fractures of the femur (15%), treated with a locking plate, and had fair to good results in 100% with no infection.

Patella Fracture: When compared to the study conducted by Catalano et al. [20] which had good to excellent results in only 27.8% of cases, we had 3 patella fractures (15%) treated with cannulated cancellous screws and had good to fair results in 100% of cases with no infection.

Combination Fracture: We also had three (15%) mixed fractures. Two of them involved the proximal tibia and supracondylar femur and were treated with a cannulated cancellous screw and an external fixator, but both cases had bad outcomes.

One patient underwent cannulated cancellous screw treatment for both patella and lateral femoral condylar, with good to fair outcomes in all cases. There were no independent research series to compare with these combination fractures.

Fracture Pattern: The most frequent fracture pattern found in 15 patients (75%) was a simple fracture, while 5 patients (25%) had a comminuted fracture. These findings were similar to those of a study by Joon-Woo Kim et al., which found 70% of simple fractures. Communicative fractures do not accurately predict functional outcome.

Open Wound Grade: When grade 3B wounds were assessed, 8 patients (40%), grade 3a wounds (75%), and grade 2 wounds (25%) were found. These results were compared to studies conducted by Joon-Woo Kim et al., Ayman M. Ali et al. [21] and Ahmed Ali et al. [22] that had similar grade wounds. When it comes to open knee fractures, the incidence of grade 3B fractures points to high velocity injuries.

Wound Coverage/Healing Time: In our study, every patient had complete wound debridement, prophylactic antimicrobial therapy, surgical fracture stabilisation, and early wound coverage. Of these, six wounds (30%) were covered predominantly, nine required SSG (45%), and five required flap cover (25%) at some point. When compared to studies by James P. Stannard et al. that had the same percentage of flap cover completed for wound coverage, the average soft tissue healing period was 17 days (range: 10 to 21 days). This

indicated that there were more 3B fractures that were caused by high velocity injuries.

Fracture Healing Time and Weight Bearing Time

We compared the results of our study's mean fracture healing time-which ranged from 12 to 18 weeks-and average complete weight bearing time-which was 15 weeks-with those studies conducted by Viswanath Yaligod's that had similar findings. In all investigations, a higher frequency of simple fracture patterns was the cause of the normal healing time.

Complications: When the complications in our study were compared to those in studies by Joon-Woo Kim et al., Ahmed Ali et al., Ibrahim et al., [23] Nicholas et al., [24] who had the same frequency of infection rate, only two patients (10%) had superficial infection noticed in a Type 3B proximal tibia fracture treated with an external fixator and flap cover and no deep infection or osteomyelitis, non-union, deformities, shortening of the limb, or instability. Early clinical presentation, rapid debridement, early open fracture repair with adequate IV antibiotic treatment, and timely wound and pin care all contributed to less complications.

Follow-Up Time: The study by James P. Stannard et al., David P. Barei et al., Sudhir et al., and Manohar G. et al. revealed similar follow-up times, with a mean of 10 months (range: 6 to 18 months).

Functional Outcome: The Rasmussen functional grading score method, which assigns numerical grades to discomfort, walking ability, knee joint mobility, and stability, was used to assess the results. According to the Rasmussen scoring system, of the 20 patients who had open knee fractures, 10 patients (or 50%) had good results (score 20), 6 patients (30%) had fair results (score 10), and 4 patients (20%) showed poor results (score 6). [24] An average score of 14 was found, which fell between good and fair results. However, nine patients (45%) had intermediate results, seven patients (35%) had good results, and four patients (20%) had bad results, according to the subjective functional score system. When compared to the similar outcomes of studies conducted by Joon-Woo Kim et al., Mehmet Subhasi et al., Ahmed Ali et al., Sushil H. Mankar et al. [25] and Viswanath Yaligod et al., patients with grade IIIB osteochondral fracture, intraarticular fracture, and flap cover had poor outcomes. Because the Rasmussen functional grade rating system did not account for skin loss, osteochondral fractures, or intra-articular fracture variability, there was a discrepancy in the results between the scoring systems. [26]

With just 10% (n = 2) of superficial infections in our series, we had good to fair outcomes due to radical debridement, anatomical reduction, and

early fracture stabilisation. Patients were not very happy due to some degree of handicap, even if the Rasmussen scoring system indicated good results. The subjective functional outcome score also revealed modest results. Patients with moderate to poor results experienced some degree of difficulty in doing daily tasks, but this had no bearing on their ability to perform their prior career.

The small patient population, mixed open fractures, and retrospective design of this study are its main limitations. We believe that in order to completely characterise the functional result, more large-scale prospective, randomised comparison investigations are required.

Conclusion

In our analysis of twenty patients, the most frequent fracture patterns were grade 3B fractures (40%), simple fractures (75%) and proximal tibia fractures (35%).

According to the Rasmussen score, 80% of our research series' open knee fractures treated with various fixation techniques had fair to good results, while 20% had poor results. According to the subjective score, good results made up 35% and fair to poor results made up 65%.

Poor outcomes occur from open grade 3 B fractures, osteochondral fractures, intra-articular fractures, and fractures with flap covers.

Because of the radical debridement, early fixation, early wound cover, and early mobilisation of the afflicted knee joint, we only experienced a 10% superficial infection.

The subjective functional outcome score revealed mediocre outcomes, despite the Rasmussen scoring method producing good results. Because the Rasmussen functional grade rating system did not account for skin loss, osteochondral fractures, or intra-articular fracture variability, there was a discrepancy in the results between the scoring systems. Despite being able to resume their pre-injury occupation, patients were not entirely content due to a degree of handicap in doing their daily activities.

The study concluded that the functional outcome of various open knee fractures treated with various fixation techniques is multifactorial; poor outcomes are observed in fractures grade 3B, intraarticular, severely comminuted, prolonged immobilisation, porotic bones, severe soft tissue injury, and associated injuries. Strict adherence to protocols for the management of open wounds, fracture fixation procedures, early wound coverage, and effective rehabilitation can lead to favourable outcomes in these types of fractures.

References

1. Griffin M, Malahias M, Khan W, Hindocha S. Update on the management of open lower limb fracture. *Open Orthopaedics Journal* 2012;6 (Suppl 3):571-7.
2. Cross WW, Swiontkowski MF. Treatment principles in the management of open fractures. *Indian Journal of Orthopaedics* 2008;42 (4):377.
3. Gustilo RB, Merkow RL, Templeman D. The management of open fractures. *J Bone Joint Surg Am* 1990;72(2):299-304.
4. Mauffrey C, Bailey JR, Bowles RJ, Price C, Hasson D, Hak DJ, et al. Acute management of open fractures: proposal of a new multidisciplinary algorithm. *Orthopedics* 2012;35(10): 877-81.
5. Mauffrey C, Beazley JC. *Open fractures and limb salvage*. New York: Springer 2014.
6. Veith RG, Winquist RA, Hansen ST. Ipsilateral fractures of the femur and tibia: A report of fifty-seven consecutive cases. *J Bone Joint Surg Am* 1984;66(7):991-1002.
7. Katsenis DL, Dendrinis GK, Kontos SJ. High energy tibial plateau fractures treated with hybrid fixation: is knee bridging necessary? *Orthopedics* 2006;29(4):355.
8. Neer CS, Grantham SA, Shelton ML. Supracondylar fracture of the adult femur. A study of one hundred and ten cases. *J Bone Joint Surg Am* 1967;49(4):591-613.
9. Shatzker J, Lambert DC. Supracondylar fractures of the femur. *Journal of Clinical Orthopaedics* 1979; 138:77-83.
10. Stewart MJ, Sisk TD, Wallace SL. Fractures of the distal third of the femur. *J Bone Joint Surg* 1966;48(4):784-807.
11. Sharma C, Sharma A, Kalla R. Study of various treatment modalities and functional outcome for tibial plateau fractures. *IJRRMS* 20 13;3(3):27-30.
12. Stannard JP, Finkemeier CG, Lee J, Kregor PJ. Utilization of the less-invasive stabilization system internal fixator for open fractures of the proximal tibia: a multi-center evaluation. *Indian Journal of Orthopaedics* 2008;42(4):426.
13. Subasi M, Kapukaya A, Arslan H, Ozkul E, Cebesoy O. Outcome of open comminuted tibial plateau fractures treated using an external fixator. *Journal of Orthopaedic Science* 2007; 12(4):347-53.
14. Kim JW, Oh CW, Jung WJ, Kim JS. Minimally invasive plate osteosynthesis for open fractures of the proximal tibia. *Clinics in Orthopaedic Surgery* 2012;4(4):313-20.
15. Barei DP, Beingessner DM. Open distal femur fractures treated with lateral locked implants: union, secondary bone grafting, and predictive parameters. *Orthopedics* 2012;35(6):e843-6.

16. Krupp RJ, Malkani AL, Roberts CS, Seligson D, Crawford CH, Smith L. Treatment of bicondylar tibia plateau fractures using locked plating versus external fixation. *Orthopedics (Online)*. 2009;32(8):559.
17. Sudheer U, Sreejith T.G.A Prospective study on the functional outcome following open reduction and internal fixation in supracondylar intercondylar fracture femur. *Journal of Orthopaedics* 2007;4(2)30.
18. Vishwanath Yaligod, Siddarthmahesh. Dynamic condylar screw in the management of distal femur fractures - evaluation of our results. *International journal of medical and applied sciences issn: 2320-3137*.
19. Ali I, Shahbuddin. Surgical outcome of supracondylar and intercondylar fractures in femur in adults treated with DYNAMIC condylar screw. *JPMI* 2011;25(1):49-55.
20. Manohar G, Andrews S. Functional outcome following ORIF of supracondylar, intercondylar fracture femur. *Kerala Journal of Orthopaedics* 2012;25(1).
21. Catalano JB, Iannaccone WM, Marczyk S, Dalsey RM, Deutsch LS, Born CT, et al. Open fractures of the patella: long-term functional outcome. *Journal of Trauma and Acute Care Surgery* 1995;39(3):439-44.
22. Ali AM. Outcomes of open bicondylar tibial plateau fractures treated with Ilizarov external fixator with or without minimal internal fixation. *European Journal of Orthopaedic Surgery & Traumatology* 2013;23(3):349-55.
23. Ali AM. Outcome of complex fractures of the tibial plateau treated with a beam-loading ring fixation system. *J Bone Joint Surg Br* 2003;85(5):691-9.
24. Hassankhani EG, Kashani FO, Hassankhani GG. Treatment of complex proximal tibial fractures (types V & VI of Schatzker classification) by double plate fixation with single anterior incision. *Open J Orthop* 2013; 3:208-12.
25. Manidakis N, Dosani A, Dimitriou R, Stengel D, Matthews S, Giannoudis P. Tibial plateau fractures: functional outcome and incidence of osteoarthritis in 125 cases. *International Orthopaedics* 2010;34(4):565-70.
26. Mankar SH, Golhar AV. Outcome of complex tibial plateau fractures treated with external fixator. *Indian Journal of Orthopaedics* 2012;46(5):570-4.