Review article

ARIF an Alternative to ORIF in the Management of Tibial Plateau Fractures: A Narrative Review

Dr Sushrut Babhulkar*, Dr Chetan Pradhan**, Dr Bishnuprasad Patro***, Dr Samir Dwidmuthe****#

Received: 14 February 2024 / Accepted: April 2024 / Published online: August 2024

Abstract

Tibial plateau fractures, caused by valgus or varus impact with axial compression or torque force, result in complex injuries of the intra-articular and metaphyseal aspect of tibia. These fractures can lead to intra-articular chondral damage, meniscal tear, ligament rupture etc. Treatment choice depends on fragment displacement, subchondral bone involvement, injury severity, associated injuries, and patient characteristics. Successful treatment mandates anatomical reduction, stable fixation, minimal invasiveness, and restoration of postoperative range of motion. Inadequate treatment may lead to pain, joint instability, restricted motion, and substantial disability. Comprehensive understanding of the fracture is crucial for effective management. Surgical strategies aim to achieve for meticulous fracture reduction while minimizing morbidity and avoiding additional damage. Traditionally, open reduction and internal fixation (ORIF) using plates and screws has been a standard treatment. However, ORIF is associated with complications such as infections, stiffness, pain etc. Arthroscopically assisted reduction with percutaneous internal fixation (ARIF) has emerged as a promising alternative, offering lower morbidity, precise reduction assessment, improved intra-articular lesion treatment, shorter hospital stays, lower infection rates, and better functional scores compared to ORIF.

Keywords: Tibial plateau; fractures; Surgical treatment; ORIF; ARIF; arthroscopy

Tibial plateau fractures: An overview

Tibial plateau fractures are complex injuries involving the intra-articular and the metaphyseal segments proximal tibia. They typically result from either a valgus or varus force, along with axial compression. These forces are frequently accompanied by torque, adding to the complexity of the injury, or can occur due to forces of multiple direction [1–3]. In most cases, either the medial or lateral femoral condyle acts as an anvil, applying a combination of both shearing and compressive force to the underlying tibial plateau [3]. In young adults, tibial plateau fractures are often a result of high-energy trauma, whereas in the elderly population, particularly those with osteoporosis, these fractures may occur due to low-energy injuries [4]. Splitting and depression fractures are more common in patients after the fifth decade. Tibial plateau fractures often affect proximal tibial metaphysis and articular surface [5]. Due to the injury mechanism, these fractures are often associated with intra-articular lesions such as chondral damage, meniscal tear, and ligament rupture [6].

* Sushrut Institute of Medical Sciences, Nagpur, ** SIOR, Pune, *** AIIMS, Bhubaneshwar , **** AIIMS, Nagpur

Prevalence of tibial plateau fractures

Incidence of tibial plateau fractures associated with proximal tibial metaphysis comprise 1.2% of all the tibial plateau fractures [5]. The prevalence of tibial plateau in adults is approximately 1%–2%, compared to 8% in the elderly population fractures [5,7].

Classification of tibial plateau fractures

While tibial plateau fractures make up only 1% of all fractures, they encompass a wide range of injuries that could have severe consequences if not treated appropriately [2]. Inadequate treatment may result in pain, joint instability, restricted range of motion, and severe disability with a significant negative social impact [2,6]. The successful treatment of tibial plateau fractures relies on a comprehensive understanding of the fracture pattern [2]. Orthopedic surgeons commonly utilize the Schatzker classification system for tibial plateau fractures in clinical practice (Table 1) [2].

Management of tibial plateau fractures

The goal of tibial plateau fracture treatment

While each fracture is different from the others, the main goals of the treatment remain the same: anatomical reduction, stable fixation, loose body removal, minimal invasiveness, repair of soft tissue injuries, postoperative unrestricted range of motion, etc [2,10]. The crucial element in treating these fractures is not only restoring the mechanical axis of the lower limb and achieving an anatomically reduced articular surface but also minimizing complications and having the ability to attain functional capability [4]. The surgical strategy should aim for a meticulous reduction of the fracture, minimizing morbidity, and avoiding additional damage, particularly to the local blood supply. Simultaneously, the approach must facilitate optimal visualization for the repair. The implants should be able to provide a stable construct allowing proper tissue closure and healing [5].

Surgical approach in the management of tibial plateau fracture

Management of tibial plateau fracture is challenging due to the complex fracture pattern and associated complications. The choice of surgical treatment depends on the displacement of the bony fragments, the pattern of involvement of subchondral bone, the severity of the lesion, associated soft-tissue damage, knee instability, meniscal lesions, the possibility of compartment syndrome, bone quality, patient's age, lifestyle, etc [1].

Different surgical approaches have been developed and used for the treatment of tibial plateau fractures, these include minimally invasive plate osteosynthesis (MIPO), closed reduction and internal fixation (CRIF) open reduction and internal fixation (ORIF), fluoroscopy-assisted procedures, and arthroscopic and arthroscopically assisted reduction, internal fixation (ARIF) anterolateral approach and posteromedial inverted L-shape approach [2,4,7,10,11].

ORIF in the management of tibial plateau fracture

ORIF with plates and screws, have been used for decades for the management of tibial plateau fractures [12]. However, complications such as infections, hematoma formation, surgical wound dehiscence, knee stiffness, neurovascular injury, thrombosis, soft tissue injuries, severe postoperative pain, and the presence of scar-related complications are common with ORIF [4,11,13]. The outcomes of the treatment are impaired by the restriction of articular motion, lack of articular congruence, stability, or alignment restoration [5]. A retrospective study collected 214 cases of tibial plateau fractures and found that infection occurred in 12% of patients after ORIF. Of the 12%, 9% of the patients suffered from deep infections [13].

ARIF in the management of tibial plateau fracture

The last decades' literature has shown the effectiveness of arthroscopically assisted treatment [12]. ARIF is the minimally invasive technique that has recently been recognized as an alternative to ORIF, with a lower morbidity rate, precise reduction assessment, and treatment of additional intraarticular lesions for patients with Schatzker type I–III fractures [2]. It provides direct visualization of the joint space, allowing for improved control of articular surface reduction and the opportunity to assess and address associated intra-articular lesions [6]. In comparison to open treatment, arthroscopy does not require meniscal detachment and repair. It allows for the evacuation of hemarthrosis

and fracture debris. Furthermore, it leads to rapid recovery, reduction in pain, early regain of full range of motion, improved fracture healing, and more complete and functional recovery [3]. Moreover, ARIF enables surgeons to address both plateau fractures and intra-articular soft tissue concurrently [13]. Complications of ARIF like compartment syndrome, fluid extravasation, etc cannot be overlooked, though it can be minimized with progress in learning curve.

Clinical overview of ARIF and ORIF for the management of tibial plateau fracture

The studies including Schatzker I–III fractures found equal or superior results of ARIF compared to ORIF with a lower rate of complications, shorter hospital stay, lower infection rate, better knee society score, and Rasmussen's radiological score [9]. A systemic review compared complication rates in ORIF vs. ARIF group for plateau fractures. The study reported that the complication rates were higher in the ORIF group compared to the ARIF group (9.1% vs 5.6%) [13]. Research findings have indicated favorable functional and radiological outcomes in the short to medium term following ARIF [8]. The detailed outcomes of the studies are mentioned in Table 2.

Conclusion

ARIF in comparison to ORIF in the management tibial plateau fractures has consistently shown favorable

Table 2: Clinical overview of ARIF vs. ORIF

Study Method			Result (ARIF vs. ORIF)		Conclusion	Reference
Number of patients (ARIF vs. ORIF)	Schatzker type	Follow-up (months)				
50 vs. 50	I–VI	12 to 116	Rasmussen clinical score	27.62 vs. 26.81	ARIF and ORIF techniques have similar outcomes. However, ARIF is preferred due to the lower rate of infection.	[1]
			Rasmussen radiological score	16.56 vs. 15.88		
			Hospital for Special Surgery score	76.36 vs. 73.12		
			Superficial infection (n)	0 vs. 2		
			Deep infections(n)	0 vs. 2		
40 vs. 35	I–III	13.5	Duration of hospital stay	3.10 vs. 5.51 days (p = 0.0001)	ARIF and ORIF resulted in similar outcomes however treatment with ARIF reduced the duration of hospital stay.	[2]
			No statistically significant difference in average clinical and radiological Rasmussen scores between the two groups.			
33 vs. 35	II or III	36	Duration of hospital stay	3.58 vs. 4.57 days (p = 0.002)	ARIF was found to be safe, effective, reliable, and safe. ARIF resulted in more precise evaluation and reduced the duration of hospital stay compared to ORIF.	[8]
			International Knee Documentation Committee score, Hospital for Special Surgery score, Range of motion were similar in both the groups			
231 vs. 386			Better clinical function	SMD = 0.31; 95% CI, 0.14 to 0.48; I^2 = 15%; p = 0.0005	ARIF when compared to ORIF led to faster postoperative recovery, better clinical function, and could find and treat more intra-articular lesions.	[11]
			Shorter hospital stay	MD = –2.37; 95% CI, –2.92 to –1.81; I^2 = 0%; p < 0.001		
			More intra-articular lesions found intraoperatively	OR = 3.76; 95% CI, 1.49 to 9.49; I^2 = 66%; p = 0.005		
			Radiological evaluation of reduction and complications were similar in both groups.			
19 vs. 21	I–III	44.4	Mean duration of hospital stay	3.95 vs. 5.86 days (p < 0.05)	ARIF led to better clinical results than ORIF.	[12]
			Mean Knee Society Score	92.37 vs. 86.29 (p<0.05).		
			Rasmussen radiographic score	8.42 vs. 7.33 (p = 0.104)		
			No statistically significant differences were found in perioperative complications, radiological results, and post-traumatic knee osteoarthritis.			

Study Method			Result (ARIF vs. ORIF)		Conclusion	Reference
Number of patients (ARIF vs. ORIF)	**Schatzker type**	**Follow-up (months)**				
321 patients, treated with ARIF		74.8	The mean posterior slope angle increased from 9.3° to 9.6° (p=0.092).		Most patients achieve excellent and good clinical outcomes and low complication rates with ARIF.	[13]
			4.3% of patients experienced superficial or deep infection			
			Total knee arthroplasty was performed in 2.2%			
			97.8% of patients had good or excellent results in the Rasmussen radiologic assessment			
			96.7% of patients had good or excellent results in the Rasmussen clinical assessment			
57	I–IV	44.4	Rasmussen radiographic score	14.1 vs. 14.9 (p < 0.05)	ARIF and ORIF yielded satisfactory clinical results. ARIF led to better radiological results than ORIF.	[14]
			Superficial infection (n)	0 vs. 1		
			Knee Society Score	No significant difference		
			Rasmussen clinical score			
1272	I–III	≥ 24	Better post-operative functional outcomes	SMD=1.23, 95% CI, 1.08–1.38; p<0.00001	ARIF was associated with better functional outcomes, a lower risk of perioperative complications, and a lower risk of post-traumatic osteoarthritis.	[15]
			Lower post-traumatic osteoarthritis	OR=0.24, 95% CI, 0.08–0.72; p=0.01		
			Perioperative complications (n)	12 vs. 36		

ARIF - Arthroscopy assisted reduction percutaneous internal fixation; ORIF - Open reduction internal fixation; SMD - Standardized mean difference; MD - Mean difference; OR – Odds ratio.

outcomes. ARIF demonstrates similar or superior results in terms of clinical function, Knee Society Score, and radiological scores. The length of hospital stay and infection rates were lower in the ARIF group compared to ORIF. Notably, ARIF was associated with faster recovery, reduced pain, and improved overall functional recovery compared to ORIF. Meta-analysis results further support the superiority of ARIF in terms of postoperative functional outcomes, lower perioperative complications, and reduced risk of post-traumatic osteoarthritis. ARIF was considered a safe, effective, and minimally invasive alternative to ORIF for managing tibial plateau fractures that offered advantages of precise reduction assessment, treatment of intra-articular lesions, and improved patient outcomes.

Article information

Conflicts of interest

The authors have no conflict of interest to declare .

Funding

The authors did not receive any financial support for this study.

Data availability

Data of this study are available from the author/s upon reasonable request.

References

1. Dall'oca C, Maluta T, Lavini F, et al. Tibial plateau fractures: compared outcomes between ARIF and ORIF. Strategies Trauma Limb Reconstr. 2012;7(3):163–75.
2. Elabjer E, Benčić I, Ćuti T, et al. Tibial plateau fracture management: arthroscopically-assisted versus ORIF procedure - clinical and radiological comparison. Injury. 2017;48 Suppl 5:S61–S64.
3. Lubowitz JH, Elson WS, Guttmann D. Part I: Arthroscopic management of tibial plateau fractures. Arthroscopy. 2004;20(10):1063–70.
4. Deng X, Hu H, Zhang Y, et al. Comparison of outcomes of ORIF versus bidirectional tractor and arthroscopically assisted CRIF in the treatment of lateral tibial plateau fractures: a retrospective cohort study. J Orthop Surg Res. 2021;16(1):289.
5. Benea H, Tomoaia G, Martin A, et al. Arthroscopic management of proximal tibial fractures: technical note and case series presentation. Clujul Med. 2015;88(2):233–6.
6. Leigheb M, Rusconi M, De Consoli A, et al. Arthroscopically-assisted reduction and Internal Fixation (ARIF) of tibial plateau fractures: clinical and radiographic medium-term follow-up. Acta Biomed. 2020;91(4-S):152–59.
7. Le Baron M, Cermolacce M, Flecher X, et al. Tibial plateau fracture management: ARIF versus ORIF–clinical and radiological comparison. Orthopaedics & Traumatology: Surgery & Research. 2019;105(1):101-6.
8. Huang X, Zhao S, Jiang Y, et al. Comparison of Arthroscopic-assisted percutaneous internal fixation with a modified reducer versus open reduction and internal fixation for Schatzker type ii and iii tibial plateau fractures. Orthop J Sports Med. 2023;11(6):23259671221151159.
9. Gahr P, Kopf S, Pauly S. Current concepts review. Management of proximal tibial fractures. Front Surg. 2023;10:1138274.
10. Dei Giudici L, Di Muzio F, Bottegoni C, et al. The role of arthroscopy in articular fracture management: the lower limb. Eur J Orthop Surg Traumatol. 2015;25(5):807–13.
11. Jiang L, Chen E, Huang L, et al. Arthroscopy-assisted reduction percutaneous internal fixation versus open reduction internal fixation for tibial plateau fracture: A Systematic Review and Meta-analysis. Orthop J Sports Med. 2021;9(12):23259671211027838.
12. Verona M, Marongiu G, Cardoni G, et al. Arthroscopically assisted reduction and internal fixation (ARIF) versus open reduction and internal fixation (ORIF) for lateral tibial plateau fractures: a comparative retrospective study. J Orthop Surg Res. 2019;14(1):155.
13. Cheng YH, Yang CP, Chang SS, et al. Arthroscopic-assisted reduction and internal fixation for complex tibial plateau fracture: radiographic and clinical outcomes with 2- to 15-year follow-up. J Orthop Surg Res. 2023;18(1):448.
14. Wang Z, Tang Z, Liu C, et al. Comparison of outcome of ARIF and ORIF in the treatment of tibial plateau fractures. Knee Surg Sports Traumatol Arthrosc. 2017;25(2):578–83.
15. Wang Y, Wang J, Tang J, et al. Arthroscopy assisted reduction percutaneous internal fixation versus open reduction internal fixation for low energy tibia plateau fractures. Sci Rep. 2018;8(1):14068.