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SURGICAL TECHNIQUE

Innovative Use of Posterior Vertebral Wall Impactor in Tibial Plateau Depressed Fractures

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Abstract

Depressed articular fractures of tibial plateau are treated by elevation of the fracture fragments to maintain the articular congruity and filling the void with any bone substitutes, followed by screw or plate fixation. This elevation of the fragments to maintain articular congruity poses a surgical challenge even in experienced hands. Many techniques have been described for the same, as the use of the metallic-bone-tamps, elevators and more recently inflatable-balloon-tamps. But due to the lesser cross-section area, these often led to comminution of the fragile articular bone fragments. The inflatable-balloon-tamp caused extrusion of contrast-dye or unintentional posterior-wall displacement. We treated a series of 25 patients with tibial plateau depressed fractures by a novel technique using posterior-vertebral-body-wall-impactor. This helped in a uniform dissipation of force over a large cross-sectional area under the fracture fragment, leading to minimal comminution of the depressed fragment, maintaining the articular congruency. Rest of the fixation was done in the standard manner. There were no intra-operative or post-operative complications. All patients had good knee function according to Rasmussen Knee Function Grading System and achieved radiological union of fracture at follow-up (with a range of 12–18 months). Hence, this technique may be a safer and effective alternative for the elevation of depressed articular fractures of tibia.

Keywords Tibial plateau fracture · Depression · Posterior vertebral body wall impactor · Pedicle subtraction osteotomy

Introduction

In the 2018 Orthopaedic Trauma Association (OTA) fracture and dislocation classification compendium, tibial plateau depression fractures are included in 41B2, and split-depression fractures in 41B3 [1]. While in Schatzker classification of tibial plateau fractures, types II, III, and V involves depression of articular surface of tibia [2]. In these fractures, anatomic reduction with restoration of the articular surface is necessary; or else it may lead to persistent incongruity due to the knee flexion instability or posttraumatic arthritis [3]. Traditionally, bone tamps (curved or straight) were used to elevate the depressed articular fragment (Fig. 1), which often led to splitting and comminution of the depressed articular bone chunk even in non-osteopenic bone [4, 5]. This manuscript reviews the innovative technique used by the authors, wherein a posterior vertebral body impactor is used to elevate the articular depression (Fig. 2).

Methods

Twenty-five cases of tibial plateau fractures with significant articular depression were treated by the authors using the technique described below. Of these, six cases were of Schatzker type II, ten were of type III and nine belonged to type V tibial plateau fracture (Table 1).

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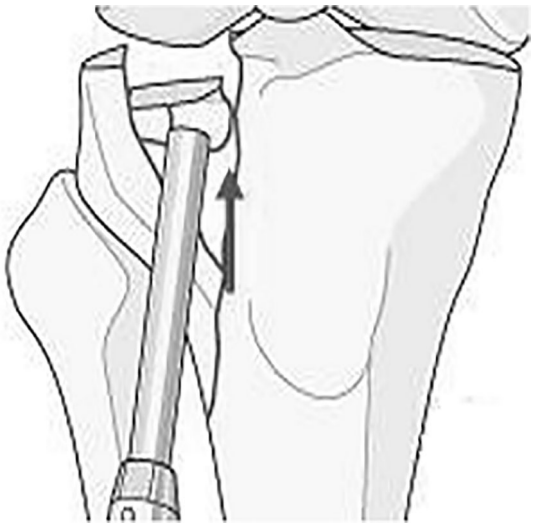

Fig. 1 Bone tamp being used for elevation of fracture fragment

Fig. 2 Posterior vertebral body wall impactor

Surgical Technique

In Schatzker types II and V, as per conventional surgical technique, the split wedge fracture fragment was booked open and a chisel was used to cut a slot 2–3 mm below the depressed articular fragment until half the breadth of the tibia. This left a safe width of cancellous bone under the depressed piece. The thin arm of the posterior vertebral body impactor was then insinuated in the cut slot under the depressed fragment with its angle facing outside the bone cortex and its arm facing towards the joint (Fig. 3). The impactor was then hammered, which elevated the depressed articular fragment to its native position. The void left underneath was filled with autogenous tri-cortical iliac crest bone graft, and the fracture was fixed in a standard manner with appropriate plates and screws.

In Schatzker Type III (pure depression) fractures of the tibial plateau, a window of 6 mm was cut 3–4 mm distal to the depressed fragment (confirmed on C arm) and the hole was undercut inferiorly. After that, a suitable sized posterior vertebral body impactor was tunneled through this window underneath the depressed tibial articular fragment, keeping a safe margin of 2–3 mm of cancellous bone between its arm and the articular bony fragment (Fig. 4). The depressed articular fragment was then elevated (Fig. 5), cancellous bone grafted in the void and fracture fixed with a plate.

Rehabilitation was started in the next day with quadriceps strengthening exercises. From the second post-operative day, patient was mobilized with the support of walker and non-weight bearing of the affected limb. All patients were given rigorous physiotherapy for attaining good range of motion for the affected knee. Weight bearing of the limb was initiated once radiological union was confirmed, which was usually after 6–8 weeks of the surgery.

There were no intra-operative or post-operative complications like loss of fixation or subsidence of fragments (Fig. 6). All patients have good knee function according to Rasmussen Knee Function Grading System (Table 2) and achieved radiological union of fracture at follow-up of an average of 15 months (with a range of 12 months to 18 months).

Table 1 Patient characteristics

n = 25	*n* (%)
Age (in years)	
Mean = 36 Range = 20 to 71 Standard deviation = 15.02	
Sex	
Male	19 (76)
Female	6 (24)
Fracture type (according to Schatzker classification	
II	6 (24)
III	10 (40)
V	9 (36)

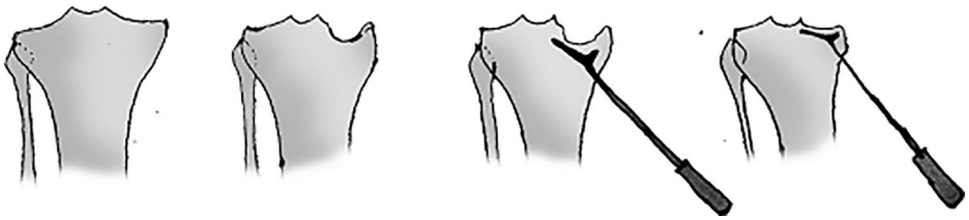

Fig. 3 Technique for elevating medial depressed fragment using vertebral body wall impactor

Fig. 4 Technique for elevating lateral depressed fragment using vertebral body wall impactor

Fig. 5 Elevation of depressed articular fragment

Discussion

The tibial plateau depression fractures pose a surgical challenge and many techniques have been described for elevating the articular depression [6]. The most practiced method involves cutting a slot with a chisel and hammering at 90 degrees to elevate the fragments. But this technique has been shown to have no control and no precision [6]. AO (Arbeitsgemeinschaft für Osteosynthesefragen) advocates use of straight or curved bone tamp for elevating the depressed tibial bone fragment, but due to lesser cross-sectional area, it often led to comminution of the fragile articular bone fragment (Fig. 1) [5]. Furthermore, due to a rounder profile, it often created the impact only over a localized area thus damaging the fragment and elevating the articular depressed fragment piecemeal. Another technique used by one of the authors in the initial stages was the use of a tri-cortical iliac crest bone fragment stationed on DHS guide wire like a toothpick. It was then inserted through a priced open split wedge fragment and a cannulated measuring device was threaded over the wire and fragment elevated by direct hammering. This was a tedious task, as often the guidewire or the direct measuring device cut through the depressed articular fragment preventing the elevation of the depressed tibial articular fragment. More recently, inflatable balloon tamps have been described in many studies [7, 8]. However, most of them were limited to case reports and technical notes without any mention of postoperative outcomes [4, 5]. Ollivier et al. first reported clinical and radiological results for this tibioplasty technique with a minimum follow-up of 1 year [9]. They included Schatzker types II and III fractures with good clinical and radiological results. Mauffrey et al. studied the technical limitations and complications with balloon-guided osteoplasty, which showed 65% of patients with intra-operative complications like bursting of balloon with extrusion of contrast dye, unintentional posterior wall displacement during balloon inflation, intra-articular injection of calcium phosphate in the knee joint, and the inability to elevate the depressed articular fragment with the inflatable bone tamp [10]. Arthroscopic-assisted techniques for reduction of depressed articular fracture fragment have also been increasing in the present era of minimally invasive surgery, but it requires a steep learning curve as well as the technique has limitations of increased compartment pressure due to fluid extravasation, limitation in instrument options, and cannot be used in osteoporotic and those without intact cortical envelope [4]. Our technique uses the available posterior vertebral body wall impactor (which is usually used for breaking the posterior vertebral body wall, while completing pedicle subtraction osteotomy of the spine for correction of deformities). The

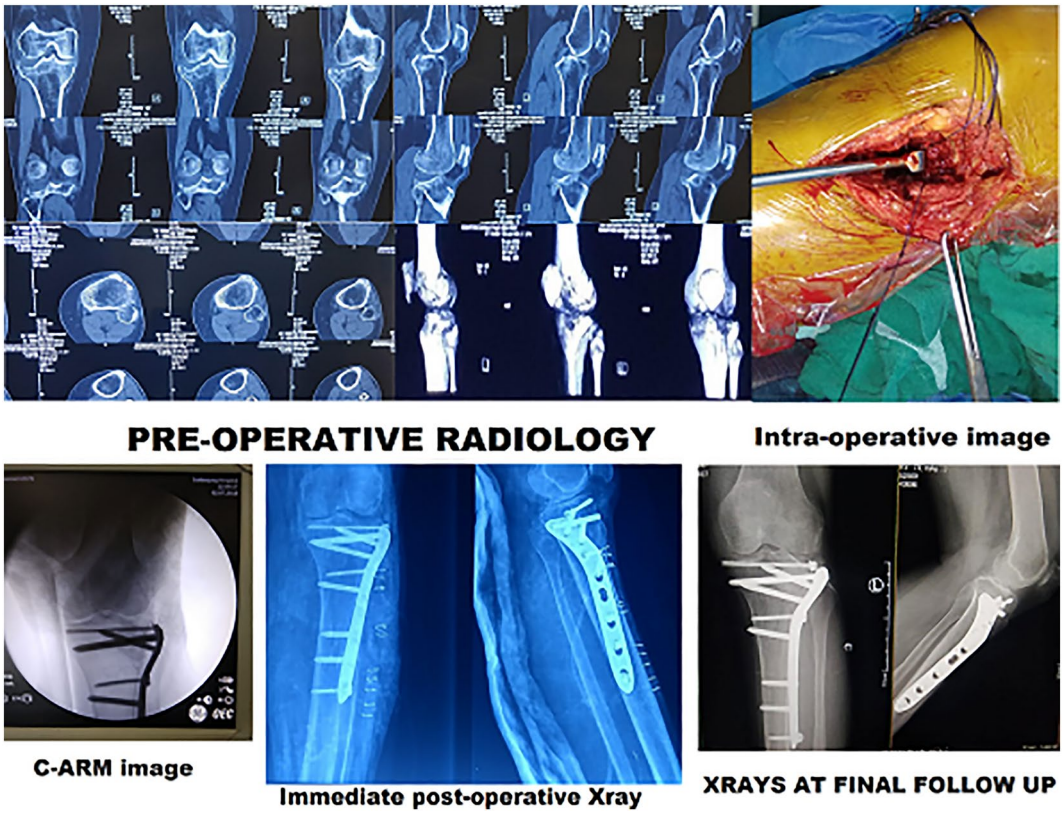

Fig. 6 Clinical pictures

use of this instrument in tibia plateau fracture is an unlabeled one. It is an L-shaped or dorsi-flexed hand-shaped instrument with a shaft handle, angled at a right angle or acute angle and an arm of various lengths and widths (Fig. 7). Also, the arm of different widths and lengths can be customized to the patient's tibia dimensions accordingly. It has a rectangular cross-section and the hammering force used for elevating the articular tibial fragment is dissipated over a large area of the arm. This results in uniform dissipation of force over a large cross-section area under the articular bone fragment, leading to minimal comminution of the articular depressed fragment. The instrument can be directed to different directions and fragments elevated to a precise level as seen on C arm (Fig. 8). Its arm is like a dorsi-flexed hand elevating the depressed bony fragment. We found it easier and effective to elevate the fractured fragment and achieve articular reduction in all 25 of our patients. However, a bigger sample size and longer follow-up may be required to define its efficacy. Also, the reproducibility of this technique with our peers is essential to justify its usefulness.

Table 2 Rasmussen knee function grading system at 1-year follow-up

(*n* = 25)	Schatzker types	Points	No. of patients with corresponding points		
			II	III	V
A. Subjective complaints	*a. Pain*				
	No pain	6	2	3	3
	Occasional ache, bad weather pain	5	2	4	3
	Stabbing pain in certain positions	4	2	3	3
	Afternoon pain, intense, constant pain around the knee after activity	2	0	0	0
	Night pain at rest	0	0	0	0
	b. Walking capacity				
	Normal walking capacity (in relation to age)	6	4	6	5
	Walking outdoors at least 1 h	4	2	4	4
	Short walks outdoors > 15 min	2	0	0	0
	Walking indoors only	1	0	0	0
	Wheel-chair/bedridden	0	0	0	0
B. Clinical signs	*a. Extension*				
	Normal	6	3	5	5
	Lack of extension (0–10 degrees)	4	3	5	4
	Lack of extension > 10 degrees	2	0	0	0
	b. Total range of motion				
	At least 140	6	4	7	6
	At least 120	5	2	3	3
	At least 90	4	0	0	0
	At least 60	2	0	0	0
	At least 30	1	0	0	0
	0	0	0	0	0
	c. Stability				
	Normal stability in extension and 20 degrees of flexion	6	6	10	9
	Abnormal instability 20 degrees of flexion	5	0	0	0
	Instability in extension < 10 degrees	4	0	0	0
	Instability in extension > 10 degrees	2	0	0	0
Mean of total scores			27	26.9	26.89

Total scores of 30–27: excellent; 27–20: good; 20–10: fair; 10–4: poor

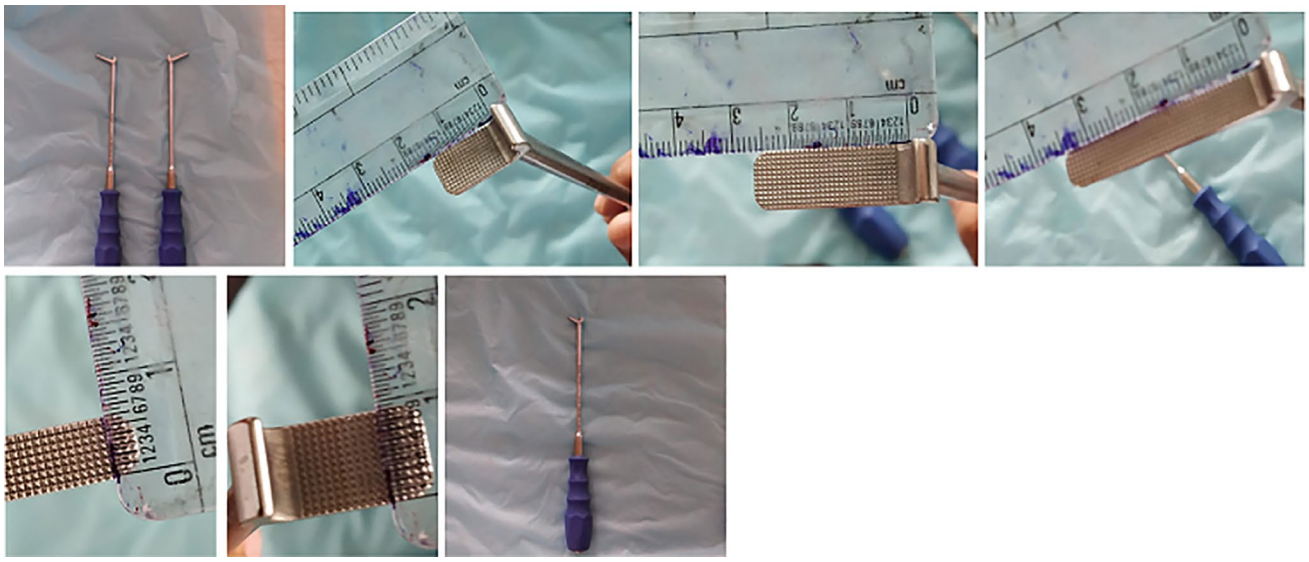

Fig. 7 Posterior vertebral wall impactor used for breaking the posterior vertebral body wall while completing pedicle subtraction osteotomy of spine for correction of deformities. L-shaped or a dorsiflexed-hand-shaped instrument with shaft handle angled at right or acute angle and an arm of various lengths and widths. The arm of different widths and lengths can be customized to the patient's tibial dimensions also

Fig. 8 C-arm image

Compliance with ethical standards

Conflict of interest Each author certifies that he or she has no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

Ethical standard statement This article does not contain any studies with human or animal subjects performed by the any of the authors.

Informed consent For this type of study, informed consent is not required.

References

1. Meinberg, E., Agel, J., Roberts, C., Karam, M., & Kellam, J. (2018). Fracture and dislocation classification compendium—2018. *J Orthopaed Trauma, 32*, S1–S10.
2. Schatzker, J. (1987). Fracture of the tibial plateau. In J. Schatzker & M. Tile (Eds.), *The rationale of operative fracture care* (pp. 279–295). Berlin: Springer-Verlag.
3. Rasmussen, P. S. (1973). Tibial condylar fractures. Impairment of knee joint stability as an indication for surgical treatment. *J Bone Jt Surg, 55*(7), 1331–1350.
4. Liang, J., Zhang, Q., Liu, P., Wang, B., Zhou, X., Chen, G., et al. (2018). Arthroscopic-assisted inflatable bone tamp reduction for treatment of posterolateral tibial plateau fractures. *Injury, 49*(11), 2061–2067.
5. Pizanis, A., Garcia, P., Pohlemann, T., & Burkhardt, M. (2012). Balloon tibioplasty: a useful tool for reduction of tibial plateau depression fractures. *J Orthopaed Trauma., 26*(7), e88–e93.
6. Pountos, I., & Giannoudis, P. (2017). Articular impaction injuries in the lower limb. *EFORT Open Rev, 2*(5), 250–260.
7. Chang, H., Yu, Y., Ju, L., Zheng, Z., Chen, W., & Zhang, Y. (2018). Percutaneous reduction and internal fixation for monocondylar fractures of tibial plateau: a systematic review. *Orthopaed Surg, 10*(2), 77–83.
8. Prat-Fabregat, S., & Camacho-Carrasco, P. (2016). Treatment strategy for tibial plateau fractures: an update. *EFORT Open Rev, 1*(5), 225–232.

9. Ollivier, M., Turati, M., Munier, M., Lunebourg, A., Argenson, J., & Parratte, S. (2015). Balloon tibioplasty for reduction of depressed tibial plateau fractures: preliminary radiographic and clinical results. *Int Orthopaed., 40*(9), 1961–1966.
10. Mauffrey, C., Fader, R., Hammerberg, E., Hak, D., & Stahel, P. (2013). Incidence and pattern of technical complications in balloon-guided osteoplasty for depressed tibial plateau fractures: a pilot study in 20 consecutive patients. *Patient Saf Surg, 7*(1), 8.