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Arthroscopically Assisted Management for Schatzker Type I & II Tibial Plateau Fractures

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Abstract: Background: Tibial plateau fractures have always been a challenge for orthopedic surgeons. These fractures may be difficult to manage and, although these lesions are relatively rare representing approximately 1% of all fractures, the consequences of an inadequate treatment can be serious. **Objective:** To review the arthroscopically assisted management for schatzker type (I – II) tibial plateau fractures and to determine the factors that influence the overall clinical and radiological results. **Patients and methods:** In the period between August 2018 and August 2019, 20 consecutive patients (12 males & 8 females) with closed tibial plateau fractures who had undergone arthroscopic assisted surgery were enrolled in this prospective study. All of them underwent the same treatment protocol for arthroscopic-assisted surgery with percutaneous screw for closed tibial plateau fractures in Al-Azhar University Hospitals & Naser Institute hospital. **Results:** Mean Clinical Score was 26 range (21-30) as; 60.0% were excellent, 30.0% were good and 10.0% were fair. Mean Radiographic Score was 17 as; excellent were 12 cases (60.0%), good were 6 cases (30.0%) and fair were 2 cases (10.0%). **Conclusion:** Standards of Arthroscopic reduction and internal fixation (ARIF) technique have been shown to be widely used all over the world since 1991. From this time researchers are hardly working to modify or develop this technique to achieve better results to reach optimum fixation and alignment for early mobilization and protect against stiff joint or postoperative osteoarthritic changes.

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Keywords: ARIF; Schatzker, Arthroscopy; Tibial plateau fracture, Technique.

1. Introduction

The tibial level crack is trying for orthopedic surgeons due to its seriousness and related delicate tissue wounds [(1)]. Tibial level cracks represent 1% everything being equal and happen generally much of the time in the knee correspondingly with wounds to meniscus and tendons [(2)].

The rate demonstrates a bi-modular appropriation, with a first pinnacle experienced in the second to fifth decade guys with high-vitality injury, for example, engine vehicle mishaps and a second crest in the fifth to seventh decade ordinarily females, during low-vitality injury as in osteoporotic break [(3)]. In osteoporotic old patients, this break speaks to as much as 10 % [(4)].

Specifically, the recurrence of horizontal tibial level cracks that reason metaphyseal split or wretchedness of articular surface is higher (55% - 70%) than average and reciprocal tibial level breaks (10% - 23% and 11% - 31% individually) [(3)].

It has been accounted for that sidelong tibial level fractures are essentially connected with parallel meniscal pathology (schatzker type II 45%, type III 18%) [(4)]. Subsequently, distinguishing proof and treatment of the sores in the horizontal meniscus and tendons are relied upon to influence the clinical result of the treatment of sidelong tibial level cracks [(5)]. Non-employable administration has generally been the favored treatment for such cracks [(6)].

Notwithstanding, to stay away from delayed immobilization and unsteady decrease, careful treatment is presently the favored treatment for dislodged crack. The objective of usable treatment of tibial level is reproduction of the articular surface pursued by restoration of tibial tendon [(5)].

Past careful techniques accomplished palatable outcomes in just 70 – 80% of cases. Open decrease and inner obsession has a huge confusion rate including loss of decrease, stick tract contamination, profound disease and septic joint pain and this has empowered enthusiasm for percutaneous strategies [(7)]. Careful treatment has evolved and arthroscopy helped negligible intrusive medical procedure that is presently the alluring alternative among accessible careful treatment [(8)].

Arthroscopically, helped administration for tibial level break, has been appeared to give an essentially improved perception of crack piece dislodging and affirms misery of the horizontal tibial level and the rise of the break fragment [(9)].

What's more, this procedure empowers the specialist to evaluate for delicate tissue wounds that could possibly go undiscovered through joint lavage and evacuate lose pieces to accomplish stable obsession with minimal measure of delicate tissues dismemberment [10].

Aim of the Work

The aim of this work was to review the arthroscopically assisted management for schatzker type (I – II) tibial plateau fractures and to determine the factors that influence the overall clinical and radiological results.

2. Patients and Methods

Prospective observational study that was performed in AL-Azhar University Hospitals & Naser Institute Hospital from August 2018 to August 2019 after obtaining approval of Ethics Committee, Orthopedic Departmental Scientific Committee. A written informed consent were obtained from all participants before enrollment in the study. 20 consecutive patients (12 females & 8 males) with closed tibial plateau fractures where enrolled in this prospective study. All of them underwent the same treatment protocol for arthroscopic-assisted surgery with percutaneous screws. The average age at operation was 29.48 years (range, 19 to 63 years), follow up period ranged from (6-12) months with an average of 10 months. Using the Schatzker classification, there were 4 patients type **I** & 16 patients type **II.** The mechanism of injury was as the following:

Eleven breaks were the consequence of a street auto collision (R.T.A.), six patients were the aftereffect of a tumble from various statures and three patients of them various games wounds pursue curving injury.

Patients:

Patients selection:

This study involved management of (20) adult patients with Schatzker type I & II tibial plateau fractures.

Inclusion criteria: Recent trauma, skeletally mature and closed lateral tibial plateau fracture.

Exclusion criteria: Open fracture dislocation, associated neurovascular injuries, severely debilitated patients, highly comminuted plateau and proximal metaphyseal fracture (type V & VI) and patients with previous infection of knee joint.

Sex distribution:

Our study group included 12males and 8 females.

Age distribution:

Adult patients ranged from 19 to 63 years old.

Indication of surgery:

The indications of operative fixation included lateral plateau fractures that have valgus instability greater than 10° and articular step-off greater than 3 mm or tibial condylar widening greater than 5 mm [11].

Preoperative Diagnosis:

20 patients with closed lateral tibial plateau fractures (type I & type II) using the Schatzker classification.

Clinical and radiological evaluation of patients:

This was done preoperatively; two, six weeks and six months postoperatively and last visit using evaluation sheet below.

The results are rated as follows:

Excellent: 18 points (minimum). Good: 12 to 18 points. Fair: 6 to 11 points Poor: less than 6 points.

The **Rasmussen** system was intended to improve upon the **Hohl** and **Luck** system by making it more quantitative. The advantage of the **Rasmussen** system is its analysis of both functional and anatomic end results for tibial plateau fractures after treatment. So, this scoring system was widely used in related studies of tibial plateau fractures [12].

Methods:

Preoperative planning:

Preoperative planning allows formulation of alternative plans and anticipation of intra-operative challenges in cases that are unusual in any way. Appropriate method of fixation can be selected and need for special equipment & /or implants can be predicted preoperatively.

Patient counseling:

That was a crucial part of the procedure, it must be explained that the decision of per-forming this procedure was based on the benefits of the technique rather than the traditional one, besides clarifying its suspected complications like extravasation and compartment syndrome. If the patient accepted and is medically stable and meets objective clinical and radiological criteria, then the procedure is probably in his/her best interest. Accordingly we had fifty patients with meeting criteria for arthroscopically-assisted operative treatment of lateral tibial plateau fracture. Patient's counseling was essential to achieve the maximum cooperation and convenience.

Patient evaluation

Clinical assessment:

Each patient in this investigation was painstakingly surveyed clinically as point by point clinical history and through assessment.

Clinical history:

We were pointing in this part to deliberately distinguish the itemized history that prompted the present of inadmissible circumstance. We got some information about method of damage, first aids (If it was done) at site of damage, the length among

damage and medical clinic confirmation, impermanent moves and medications that were utilized from time of damage till the task time. Likewise, we got some information about incessant restorative sicknesses like cardiovascular, hepatic, renal, DM, blood illnesses….. and so on. Immunosuppressive medications, past medical procedures, blood transfusion and any patient factor guaranteed with rate of disappointment in proposed medical procedure.

Patient examination:

General assessment:

This was done to assess the patient general fitness for such surgery. A detailed physical examination of patient's overall medical status, age and functional and economic demands are necessary to detect an additional injuries. These might be other ipsilateral or contra-lateral skeletal injuries and injuries to other systems that may influence how the plateau fracture is managed.

Local assessment:

Complete and meticulous local examination of the involved knee and leg was our routine with particular emphasis on some issues like:

Neurovascular condition of the affected limb:

In all injured limbs, but particularly in patients with certain fracture patterns, a thorough neurovascular examination is mandatory by assaying vascular status in terms of pulsation over the dorsalis pedis and posterior tibialis arteries. An arteriogram should be obtained in fractures with suspected vascular injury or in patients with fracture-dislocations. Patients with obvious vascular injuries should be taken promptly to the operating room for vascular exploration and revascularization. It was done for one female patient with left tibial plateau fracture (type V) who had past history of left lower limb vascular insufficiency. This patient was complicated by postoperative transient popliteal artery spasm and completely improved conservatively within 2 days.

Soft-tissue envelope and sensorimotor function of the limb:

In all patients, but particularly when an intervention is planned, the soft tissue envelope around the knee must be carefully examined. The timing and, in some fractures, the type of surgical approach was dictated by this examination. Important features of the soft tissues like; the severity of swelling, visible contusions and the size, character, and location of fracture blisters. The readiness of the soft-tissue envelope was determined by resolution of swelling marked by the return of skin wrinkles, re-epithelialization of fracture blisters and reduction of edema. The average delay before surgery to allow swelling to subside ranged from 2 to 12 days [(12)].

Compartment syndrome exclusion:

The compartments of the lower leg should be evaluated with serial examinations for signs of compartment syndrome. Presence of the well-recognized signs, including tense compartments and pain with passive stretching, should raise the suspicion of an associated compartment syndrome and measurement of compartment pressures is indicated. If the diagnosis is clear on physical examination, fasciotomy may be performed without pressure measurements [(13)]. In our study, there were two cases complicated with compartment syndrome, both cases were managed conservatively by close observation, elevation of the affected limb, strong anti-edematous & pain killer drugs. Lastly, it is critically important to diagnose associated injuries and complications, to plan for surgical treatment and to decide on optimal timing of interventions.

Radiological evaluation:

All our patients underwent plain films study in anteroposterior and lateral views as well as computed tomography of the affected knee as these radiographs are necessary to evaluate these fractures. Assessment of the degree and the size of depressed articular fragments may be possible only with CT. Often the classification of the fracture made from standard radiographs is changed to another type after the CT scans were evaluated. Axial CT scans are routinely obtained for most tibial plateau fractures. They provide excellent patho-anatomy details of the fracture and serve as a critically important aid for preoperative planning for operative approaches and fixation techniques [(14)]. We can assess preoperative arthritic state particularly in old patients with history and radiographic study of osteo-arthritic changes of the affected knee joint.

Measurement of depressed articular surface:

Figure (1): Study Case (type II) tibial plateau fracture associated OA.

We can measure the amount of articular depression from the anteroposterior and lateral radiographs using the fibular head as a reference. The amount of articular depression was measured from the

opposite remaining articular surface. A line was drawn at the level of the normal articular surface and extended across the depressed area. A measurement was made from this line to the point of maximum depression.

This was as reproducible a measurement as that described by **Kumar** and **Whittle 2000** [34] because all of our radiographic projections were similar, the measurement could be compared [15]. So, computed tomography (CT) was the standard for imaging of intra-articular fractures and was used in cases in which additional assessment of intra-articular injuries was needed, particularly in cases with articular depression or comminution.

3. Results

Table (1): Clinical outcome of study with 96% satisfactory results

		Frequency (cases)	Percent (%)
Valid	Excellent	12	60.0%
	Good	6	30.0%
	Fair	2	10.0%
	Total	20	100

Table (2): Clinical results regarding fracture type

			Clinical Result (cases)			Total
			Excellent	Good	Fair	
Type of Fracture	I	Count	4	0	0	4
		% within Type of Fracture	33.3%	0.0%	0.0%	20.0%
	II	Count	8	6	2	16
		% within Type of Fracture	66.7%	100.0%	100.0%	80.0%
Total		Count	12	6	2	20
		% within Type of Fracture	60.0%	30.0%	10.0%	100.0%

Table (3): Sex with type of fractures according to Schatzker classification

Group		Sex		Total	Test value	P. Value
		Female	Male			
I	Count	3	1	4	0.469	0.493
	% within group	25.0%	12.5%	20.0%		
II	Count	9	7	16		
	% within group	75.0%	87.5%	80.0%		
Total	Count	12	8	20		
	% within group	60.0%	40.0%	100.0%		

P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS) *: Chi-square test

Table (4): Descriptive Statistics of age in the study groups (years)

Groups	N. (cases)	%	Min	Max	Mean	S.D	Test value	P. Value
I	4	20.0%	19.0	49.0	35.0	9.52	1.824	0.085
II	16	80.0%	27.0	63.0	47.23	12.43		

P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS) •: Independent t-test

Table (5): Mechanism of injury with type of fracture according to Schatzker classification

Group		Mechanism of injury (cases)			Total	Test value	P. Value
		RTA	FFH	TT			
I	Count	0	1	3	4	5.069	0.079
	%	0.0%	12.5%	50.0%	20.0%		
II	Count	5	8	3	16		
	%	100.0%	87.5%	50.0%	80.0%		
Total	Count	5	9	6	20		
	%	25.0%	45.0%	30.0%	100.0%		

P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS) *: Chi-square test

Table (6): Number of patients using the Schatzker classification

Groups	N		%
I	4		20.0%
II	16		80.0%

Table (7): Associated soft tissue injury with Type of fractures according to Schatzker classification

Schatzker classification		Associated soft tissue injury (cases)				Total	Test value	P. Value
		Non	Lateral meniscus	Medial meniscus	Complete ACL avulsion			
I	Count	3	1	0	0	4	0.000	1.000
	%	20.0%	20.0%	0.0%	0.0%	20.0%		
II	Count	12	4	0	0	16		
	%	80.0%	80.0%	0.0%	0.0%	80.0%		
Total	Count	15	5	0	0	20		
	%	75.0%	25.0%	0.0%	0.0%	100.0%		

P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS) *: Chi-square test

Table (8): Type of fixation with Type of fractures cross tabulation

Schatzker classification		Type of Fixation (cases)		Total	Test value	P. Value
		PCS	P & S			
I	Count	4	0	4	2.143	0.143
	% within group	28.6%	0.0%	20.0%		
II	Count	10	6	16		
	% within group	71.4%	100.0%	80.0%		
Total	Count	14	6	20		
	% within group	70.0%	30.0%	100.0%		

P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS)
*: Chi-square test

Table (9): Complications of the cases among study

		Frequency	Percent (%)
Valid	Compartment syndrome	0	0.0%
	Infection	1	5.0%
	None	18	90.0%
	Parethesia over Lat. calf of leg	1	5.0%
	Total	20	100.0%

Table (10): Radiological results with the fracture type

			Radiographic Result (cases)			Total
			Excellent	Good	Fair	
Type of Fracture	I	Count	4	0	0	4
		% within Type of Fracture	33.3%	0.0%	0.0%	20.0%
	II	Count	8	6	2	16
		% within Type of Fracture	66.7%	100.0%	100.0%	80.0%

4. Discussion

As with any other intra-articular fracture, the tibial plateau fracture is always challenging for orthopedic surgeons. Because of its widely varying trauma and associated soft tissue injures [(17)]. **Part-Fabregat [(17)]** defined the main goals in the treatment of these fractures as appropriate articular surface reduction, rigid fixation and early management of soft tissue injures.

Although ORIF is the classically acceptable method for the treatment of plateau fracture, several other methods have also been introduced. However, arthroscopy and open reduction of the articular surface increases the risk of prolonged stiffness and is

associated with increased pain and wound complications [18]. The philosophy underlying arthroscopic-assisted reduction and internal fixation (ARIF), initially recommended by **Jennings [19]** is to prevent additional surgical trauma to the knee joint by using a minimally invasive approach. The advantages of ARIF included better visualization of joint surface reduction, short hospital stay and faster postoperative rehabilitation. Moreover, ARIF enables lavage and removal of hematoma and loose bodies and treatment of concomitant ligamentous and meniscal injuries. However, the ARIF technique is complex, requires greater surgeon experiences and it may lead to compartment syndrome due to fluid extravasation during arthroscopy [20].

There have been a number of reports describing treatment of tibial plateau fractures. **Metcalfe et al.** [21] suggested that ORIF and external fixation are both acceptable strategies for managing bi-condylar tibial plateau fractures, with no statistically significant differences found in the rates of complications between the two methods. **Rademakers et al.** [22] reported that traditional ORIF requires extensive soft tissue dissection, which may lead to numerous negative outcomes such as slow wound healing, infection and post traumatic arthritis. Due to limited exposure, intra-articular lesions, such as meniscus or anterior cruciate ligament injuries could not be diagnosed and treated properly. **Ruffolo, et al.** [23] reported that non-union and deep infection occur commonly after ORIF due to long surgical duration.

With the development of arthroscopic techniques, ARIF has been widely adopted in the treatment of tibial plateau fracture. **Ohdera, et al.** [24] evaluated retrospectively, the value of arthroscopy for tibial plateau fractures by comparing the clinical results of arthroscopic treatment with the traditional open reduction method. They concluded that there were no significant differences between both treatments in terms of duration of operation, postoperative flexion and clinical result. However, with arthroscopic-assisted group, the postoperative rehabilitation was easier and faster and more patients (84%) obtained an anatomical reduction. Also, with arthroscopic-assisted management accurate diagnoses and treatment of any associated joint pathology was possible as opposed to the closed management. **Dall's oca, et al.** [25] reported that the ARIF technique improved the clinical outcomes in schatzker II – IV.

Mohammad Hossein, et al. [26] assessed the medium term functional and radiological outcomes of the treatment of tibial plateau fractures using the ARIF and ORIF technique. They recommend the use of arthroscopic techniques as an alternative method for the treatment of a wide spectrum of intra-articular tibial plateau fractures to obtain good functional and radiologic mid term results, without serious complications. **Wong et al.** [27] compared junctional outcome and complications between ARIF and ORIF for the treatment of low energy tibial plateau fracture. They reported that ARIF provided no substantive advantage over ORIF in treating schatzker I to III tibial plateau fractures except in reducing the risk of perioperative complications. Also, **Marco et al.** [28] explored if ARIF technique is superior to the traditional ORIF technique in the treatment of tibial lateral plateau fracture. They found that both ARIF and ORIF can provide a good clinical and radiological outcome in the treatment of schatzker type I, II and III tibial plateau fracture. However, ARIF patient showed better results in terms of length of hospital stay, clinical scores and time of full weight bearing recovery. **Sun et al.** [29] showed that arthroscopic reduction and percutaneous fixation for tibial plateau fractures compared to open reduction and internal fixation could demonstrate a decreased risk of pre-operative and post-operative complications and improved clinical outcome in operative time, incision length, hospital stay, per-operative complications, full weight bearing and Rasmussen score.

The aim of our study was to review the arthroscopically assisted management for Schatzker type (I – II) tibial plateau fractures and to determine the factors that influence the overall clinical and radiological results.

The number of patients for Schatzker type I tibial plateau fracture (split fracture) in our study were 4, one patient had lateral meniscal tear (treated by partial meniscectomy). The clinical and radiological outcomes for all patients according to Rasmussen score were excellent. In agreement with our study, **Gill et al.** [30] used ARIF technique on two patients with type I fracture with lateral meniscal tear (treated by partial meniscectomy). they used ligamentotaxis technique for reduction under arthroscopic and fluoroscopic assistance and 2 cancellous screws and washers for fixation. Clinical results were excellent according to Rasmussen score [30]. In addition, **Glabbeck et al.** [31] used the same technique for management of the patients with the same fracture type associated with injured soft tissue management (2 lateral meniscal tear were treated by partial meniscectomy and conservative treatment for 2 partial ACL rupture) and the clinical results were excellent for all cases. Besides, **Pogliacomi et al.** [32] managed 4 patients arthroscopically of type I fracture using 6.5 cancellous or 7.3 cannulated screws and washers for fixation. They obtained an excellent results of the whole patients. **Chan & Yuan** [33] in their study achieved also an excellent result for the same type of fracture and management. In that work on 16 patient of type I fracture managed with ARIF technique

involved soft tissue injury, 14 non-associated soft tissue injury, 2 lateral meniscal tear (treated by partial meniscectomy). Joy stick technique for reduction and fixation was achieved by using of 2-3 cancellous screws and washers. They obtained excellent 14 cases and good 2 cases.

For **Schatzker type II tibial plateau fracture** (split depression fracture): The number of patients were 16; 4 patients with lateral meniscal tear (treated by partial meniscectomy) and 5 patients received autogenous iliac bone graft then fixation by either cannulated screws or buttress plate and screws. The clinical and radiological outcomes according to Rasmussen score were: 12 excellent, 6 good and 2 fair. **Gill et al.** [30] managed 5 cases of type II fracture among this study, 3 of them were associated with lateral meniscal tear (2 were treated by meniscal sutures and one by partial meniscectomy) and 2 cases with partial ACL rupture for conservative treatment. They created metaphyseal window to reduce impacted fragment and void filling (bone substitutes only) when needed. Under arthroscopic and fluoroscopic assistance, only 2-3 cannulated screws 7.3 mm and washers were used for fixation. Clinical results were 3 cases good, one case fair and one poor. In addition, **Glabbeek et al.** [31] used ARIF procedure in 10 cases of type II fracture. There were 4 lateral meniscal tear (3 of them were treated by partial meniscectomy and one by meniscal sutures). They used the same technique for reduction and fixation and his clinical results were excellent in 6 cases, good in 2 cases, one case fair and poor in one case. **Poglia Comi et al.** [32] treated 6 patients of type II fracture with ARIF. 4 of them associated with lateral meniscal rear (3 treated by partial maniscectomy and one by meniscal sutures). He used curved osteotomies to reduce the depressed fragment under fluoroscopic and arthroscopic assistance without using any bone grafting followed by only 2 cancellous screws 6.5 mm and washers for fixation for each. Clinical results of this study were: excellent one case, good 3 cases, fair one case and poor in one case. Moreover, **Chan & Yuan** [33] used ARIF technique in a study included 21 patients with type II fracture. He found 10 meniscal tear (7 were lateral and 3 were medial where 6 were treated by partial meniscectomy and 4 by meniscal sutures) and 4 cases with partial ACL tear. With fluoroscopic assistance, he reduced the depressed fragment with tamp. For void filling, he used either moutologus bone graft or bone substitutes also he used buttress plate and screws or cancellous screws and washers for fixation. Clinical results were excellent for all 21 patients.

Conclusion

Standards of arthroscopic reduction and internal fixation (ARIF) technique have been shown to be widely used all over the world since 1991. From this time researchers are hardly working to modify or develop this technique to achieve better results to reach optimum fixation and alignment for early mobilization and protect against stiff joint or postoperative osteoarthritic changes. In agreement with other workers we concluded that ARIF technique was highly suggested to do in tibial plateau fracture (Schatzker type I) and in non-comminuted type II, while it is not recommended in comminuted type II due to difficulty in reduction, high susceptibility of arthroscopy fluid extravasation and compartment syndrome.

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