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Original Article

The effectiveness of arthroscopy assisted fixation of Schatzker types I-III tibial plateau fractures: our experience at a tertiary centre

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Abstract: Background: Tibial condyle fractures are high energy injuries which require anatomical reduction and stable fixation for early mobilisation of the knee joint. Arthroscopy assisted fixation of these fractures provide additional benefits of minimal dissection, accurate visualisation of the articular surface and faster rehabilitation. The present study describes our experience with this technique. Materials & Methods: Patients in the age group 15-65 years, presenting with closed tibial plateau fractures (Schatzker types I, II, III) at the advanced trauma centre of our institute within 3 weeks of injury, were recruited for this prospective case series. Open fractures, fractures of types IV, V and VI, fractures with associated knee dislocation, fractures presenting after 3 weeks and polytrauma patients with head injuries and/or blunt trauma to chest/abdomen, were excluded. Patients were evaluated according to Rasmussen numerical subjective evaluation chart at a minimum follow up of 6 months. Results: There were 5 fractures of Schatzker type I, 8 of type II and 2 of type III, which were scoped and fixed percutaneously. The mean age of the 15 patients was 34.2 years with male to female ratio of 4:1. Diagnostic arthroscopy detected co existent lateral meniscal tears (peripheral) in 2 cases, while 1 case had a contused anterior cruciate ligament. Fixation of the fractures were done by 1 or 2 percutaneous screws in 9/15 cases; buttress plating in 4/15 cases and combination of plate and screw in 2/15 cases. The average overall Rasmussen score was 28.2/30 (range 22-30) and there were 1 patient each with postoperative stiffness and screw prominence while 3 cases had extensor lags. Conclusion: The aim of this combination procedure is stable fixation by minimally invasive methods; this reduces surgical insult, improves articular surface visualisation, allows management of concomitant ligament injuries, and patients can be rapidly mobilised. Case selection is extremely important for good results.

Keywords: Schatzker, tibial condyle fracture, arthroscopy assisted, rasmussen score

Introduction

Displaced or unstable tibial plateau fractures occur as results of high energy trauma and require early appropriate surgical interventions to achieve stable and mobile joints, with acceptable limb alignment and minimal long term complications of joint dysfunction and arthritis [1]. The required approach, choice and number of implants and post operative mobilisation protocols depend on the soft tissue injuries and the fracture patterns; Schatzker classification classically has been the most commonly used system to formalise the treatment, however newer computed tomography (CT) based classifications have also been described [2, 3].

Surgical methods vary from closed reduction with percutaneous screw fixation to open reduction and internal fixation (ORIF) with anatomical plates; depending upon the location of fracture fragments, 1 or more approaches are often needed, which tend to devitalise the soft tissues. The visualisation of the articular surface is required for anatomical reduction and significant dissection through the injured soft tissue is often needed [4]. Another method to visualise the articular margin is arthroscopy and arthroscopy assisted procedures have been described for some selective fractures of the tibial plateau [5, 6]. Fractures types I-III have been the most commonly described for these assisted surgeries [5]. Arthroscopy enables the surgeon to directly visualise the articular margin with a less invasive method, and there are reports of excellent outcomes, faster rehabilitation and lesser complications

with this method, in comparison to the conventional open surgeries [7]. Additionally arthroscopy enables the surgeon to manage co-existent soft tissue injuries to the ligaments and menisci [8].

We present our experience with arthroscopy assisted fixation of tibial plateau fractures at a tertiary care hospital in North India.

Materials and methods

Inclusion and exclusion criteria

Patients of either gender in the age group of 15-65 years presenting with closed tibial plateau fractures (Schatzker types I, II, III) within 3 weeks, at the advanced trauma centre of our institute were recruited for this prospective study.

Open fractures, fracture types IV, V and VI, fractures with associated knee dislocations, fractures older than 3 weeks and polytrauma cases involving other systems were all excluded.

Pre operative protocol

Complete clinico-radiological assessment was done for every patient recruited after written informed consent. Plain radiographs and CT scans were done to classify the fractures and assess the fragments' location, depression and separation. Routine blood work up was done for every patient as per the institute protocol.

Operative protocol

Position and preparation: All the patients were operated by a single experienced surgeon trained in both arthroscopy and fracture fixation, under regional anaesthesia in supine position, on a standard operating table, using tourniquet. Side posts were attached to the table to allow intra-operative varus and valgus manipulation of the surgical knee. Anterior iliac crest was prepared for possible cancellous bone graft, and image intensifier was used to aid the placement of the percutaneous screw.

Procedure: An inflow cannula was placed into the suprapatellar pouch and gravity insufflation was used to irrigate out hemarthrosis and intra articular debris; infusion pump was not used in any of the cases. Anteromedial and anterolateral portals were used for diagnostic arthroscopy, to recognise injuries to the collateral ligaments, menisci, anterior/posterior cruciate ligaments (ACL/PCL), and chondral surface. Type I fractures were reduced either by manipulation with bone clamps from outside with simultaneous utilisation of an intra-articular probe (for split fractures where fragments had displaced inferiorly), or with a K-wire placed into the fragment percutaneously and used as a joystick, while assessing fracture reduction by arthroscopic visualisation (for split fracture with a intact inferior hinge) (**Figure 1**). In some cases intra-articular bone hook placed from anterior portal opposite the fracture site was used for manipulation. Once reduction was confirmed, the fractures were fixed with one or two large fragment (6.5 mm) cannulated partially threaded cancellous screws (PTCS) placed parallel to the joint line. Where needed, a buttress plate was placed by minimally invasive method.

For Schatzker types II & III the rim fragments were reduced first and fixed provisionally with K-wires. Standard ACL tibial tunnel guide was used for placement of a guide pin into the articular depression and a tunnel was made into the tibia communicating with the area of depression. Curved pusher was used to elevate the depressed fragments and reduction was confirmed under direct vision via the arthroscope. Cancellous bone graft harvested from anterior iliac crest was used to maintain the elevation if needed. In type III fractures one or two PTCS were used but in type II fracture buttress plates were utilised for stabilisation. Associated meniscal tears were repaired using mini-arthrotomy incisions; after thorough lavage of the joint the portal wounds were sutured.

Postoperative protocol

Postoperatively Robert Jones bandage were applied to the operated limbs; were kept elevated and ankle and toe movements were started immediately. Patients were put on customised schedules of physiotherapy followed by progressive weight bearing depending upon the fracture types and the reduction quality obtained. Patients with types II and III fracture were given knee braces till fracture union.

Figure 1. A 34 year old female with fracture of the lateral condyle (type I) due to a road traffic accident. A: Preoperative X-rays showing the split; B: Axial cuts in the CT scan showing the fracture line; C: Intra-operative image showing the method of percutaneously clamping the fracture and dual checking the reduction via the arthroscope and the C-arm; D: X-rays showing complete union of the fracture; E: Clinical pictures depicting normal range of knee movements.

Follow up

All patients were regularly followed up at 6, 12, 18 and 24 weeks postoperatively; they were evaluated according to Rasmussen evaluation chart and outcomes were categorised as excellent, good, fair or poor, depending upon the response to the specific variables i.e. freedom from pain, walking capacity, knee stability, range of movement and degree of extension of the knee. The patients satisfaction was also taken into consideration.

Statistical analysis

The study data was expressed using descriptive statistics. Results were analysed using Microsoft Excel 2019 and Statistical Package for the Social Sciences 2019 (SPSS v26). The software was used to calculate mean values of age, interval between injury and surgery, surgical duration, and the Rasmussen subjective scores.

Results

15 patients with proximal tibial condyle fractures were included in this study. The mean age of the patients was 34.2 years (range 18-54) and there was a strong male predilection (4:1). All the cases occurred due to high energy trauma resulting from road traffic accidents. There were 5 cases of Schatzker type I, 8 cases of type II and 2 cases of type III (**Figure 2**). 3/15

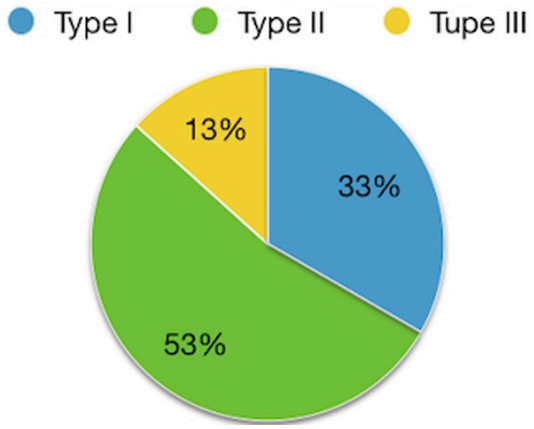

Figure 2. Pie Chart depicting the Fracture patterns (Schatzker types) included in the study.

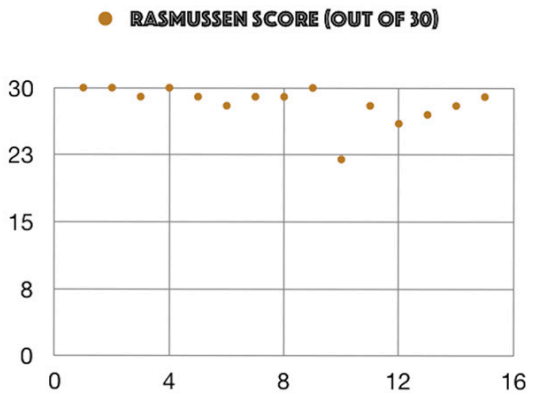

Figure 3. Individual Rasmussen scores of the patients.

patients had associated ipsilateral bony injuries; 1 case each of 2nd metatarsal fracture, posterior dislocation of hip and shaft femur fracture respectively. 4/15 cases were associated with coronal plane knee instability.

The average interval between injury and surgery was 5.3 days (1-14). All the cases were done under regional anaesthesia and tourniquet with an average time of 55.1 minutes (35-90). Diagnostic arthroscopy detected co existent lateral meniscal tears (peripheral) in 2 cases, while 1 case had a contused anterior cruciate ligament. Fixation of the fractures were done by 1 or 2 PTCS in 9/15 cases; buttress plating in 4/15 cases and combination of plate and screw in 2/15 cases. 6/15 cases with depressed fragments were supplemented by bone graft after elevation.

Weight bearing was started after a mean period of 9.1 weeks (6-12).

Outcomes

Rasmussen Subjective Score: The average score was 5.7/6 for pain; 6/6 for walking capacity, 5.5/6 for clinical signs, 5.7/6 for range of motion and 5.5 for stability. The average overall score was 28.2/30 (22-30) (**Figure 3**).

Complications: There were no cases of loss of reduction, infection, nonunion, neurovascular injury or compartment syndrome. 1 patient each had postoperative stiffness and screw prominence while 3 cases had extensor lags, which persisted for 2 months.

Discussion

The management of articular fractures is based on principles of anatomical reduction, rigid stabilisation, and early rehabilitation [9]. Arthroscopy assisted osteosynthesis for selective tibial plateau fractures offers fulfilment of these principles with added advantages of minimal soft tissue dissection and preservation of blood supply of the associated fracture fragments [10]. In the 21st century, there is rapid increase (4-fold) in usage of arthroscopy assisted internal fixation (ARIF) for tibial plateau fractures and addition of arthroscopy has not been reported to increase risk of complications, re-operations and number of emergency visit within 3 months of surgery [11].

In terms of demography, the mean age in the present study was 34.2 years. The age profile of proximal tibia fractures treated by ARIF has been previously reported to be between 35-45 years [5, 12-14]. Younger patients have stronger bones so indirect reduction technique and adequate screw holds are possible, which might be a limitation of ARIF in older patients with osteoporosis.

In terms of gender difference Chen et al found that there is a male preponderance to these fractures with 7/12 included studies having more than 50% males (overall range 10-75.6%) [5]. In the present series there were 12/15 males and Malla et al reported a ratio of 5:2 [13]. This male preponderance could probably be because conventionally in most parts of India females are home makers while males travel more for work and get involved in more road side accidents [15].

Overall these fractures cater more to young middle aged males which form the major work

force and could have socio-economic implications; therefore adequate management and early rehabilitation are necessary [16].

ARIF is commonly indicated for Schatzker types I to III, nevertheless some studies have even included types IV and V with variable outcomes. Duan et al operated 39 patients of types I to V, where in 36 had satisfactory results with 90% of patients having no pain on ambulation. 77% recovered to their pre-injury activity levels with no range of motion issues or osteoarthritis [17]. However in a study by Chan et al who included only types IV and V fractures, 3/18 developed osteoarthritis (16.7%) and excellent clinical Rasmussen scores were seen only in 22% cases [18].

Malla et al managed 28 patients of types I to VI tibial plateau fractures, by plating and 75% of cases could have excellent Rasmussen clinical scores at 1 year of follow up with 7 complications [13]. Jyothiprasanth et al used ARIF in 35 cases of types III to VI fractures. They observed that with increasing severity of fractures the functional scores deteriorated, which highlights the importance of proper case selection and puts types IV to VI in the grey zone for ARIF. They reported no complications in 68% of cases [14].

The cases included in the present study were all types I to III, which is similar to the majority of patients in previous studies [5]. Overall, appropriate case selection is crucial for favourable results with ARIF.

The method of fixation most commonly described in literature on ARIF is screw fixation [5]. In our study all I & III type fractures were fixed using PTCS with washers and type II fractures with buttress plates. The buttress plates are particularly indicated for cases where the fragment is comminuted and does not have an intact inferior periosteal hinge. Although the follow up in our series was relatively short, no cases of loss of reduction or articular depression was noted after mobilization and weight bearing, and is definitely partly ascribed to the correct selection of stabilisation modality and appropriate implant use.

In terms of overall outcomes, in our study the average Rasmussen clinical score was 28.2/30, which was excellent and similar to the previously reported series by Zawam et al (26/30) [19]. They reported excellent results in 19/25 patients and good in remaining 6, while in our study 14/15 patients had excellent scores with only 1 case of type II fracture having score in the good range.

Shankar et al reported a 41 year old female with a central depressed lateral plateau fracture (type III) and managed by ARIF. They used an aimer (Athrex ACL aimer) and serial dilators over a wire were used to push cancellous bone of the tunnel towards the depressed fragment in order to elevate it and then fixed the fragment with 6.5 mm PTCS. Patient had full range of motion at 6 months and returned to her activities of daily living with union on radiographs [20].

In other studies as well the results have been described to be excellent or good in >80% of patients and ARIF is a proven addition to the armamentarium of trauma surgeons [5].

We did not see any complications like infection, loss of reduction, non unions or compartment syndrome. Overall the reported incidence of post operative complications in ARIF is also very less with Zawam et al reporting only 1 case of superficial infection and another of articular depression on early weight bearing [19]. In a review by Wang et al the peri-operative complications were reported in 1/239 cases across 7 studies [21]. Malla et al reported 7 complications in their series of 28 patients (3 infections, 2 wound dehiscence and 2 malunions) [13].

Therefore, in terms of complications, ARIF is a safe and effective procedure for these fractures.

Whether or not the effective results and minimal complications have an overall impact on the functional superiority of ARIF over ORIF is variably reported in literature. In a comparative study between ARIF (n-20) and ORIF (n-20) by Verona et al, although both methods gave satisfactory results, better clinical outcomes (Knee Society score and Rasmussen radiological score) were seen in the former after 1 year [7]. However the review by Wang et al did not find any substantial advantage in terms of functional outcomes after ARIF over ORIF, owing to the poor quality of evidence from

included studies [21]. However, they reported 13 complications in 238 patients of ORIF group which was significantly worse than the ARIF patients.

One advantage of ARIF over ORIF is the ability to diagnose and manage co existent soft tissue/ligamentous injuries [8]. We diagnosed 2 cases of lateral meniscal peripheral tears and 1 case of contused ACL. Zawam et al could diagnose and manage 10 cases of menisci lesions (repair or menisectomy) and 2 cases of partial ACL ruptures (conservative) [19]. Jyothiprasanth et al reported associated lateral meniscus injury in 2 and lateral collateral injury in 1 patient [14]. Overall, managing bony and ligamentous injuries together aid in adequately modifying the post surgery rehabilitation protocols for better results, and a single stage surgery can be utilised for optimal management of the soft tissue and bony injuries for such cases using ARIF.

The present series has reported excellent outcomes in the included patients. However lesser number of patients and shorter follow up times are its limitations. Moreover, evaluation of the superiority of the method over ORIF also needs further evidence in form of high quality randomised trials.

Conclusion

Our series, limited to 15 Schatzker types I-III tibial plateau fractures, has shown that ARIF is an excellent tool for young patients; the additional advantage of managing the co-existing injuries of intra articular soft tissues is a bonus. It allows fast rehabilitation and gives better patient satisfaction. Adequate training in both trauma and arthroscopic techniques are prerequisites for ideal execution.

Disclosure of conflict of interest

None.

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