Original article

A comparative study of arthroscopy assisted reduction and internal fixation with open reduction and internal fixation for tibial plateau fracture

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Abstract

30 cases of Tibial Plateau fractures were randomised in two groups and were treated either by Open Reduction & Internal Fixation or by Arthroscopy Assisted Reduction & Fixation. Observations with respect to Duration of Surgery, Pain, Hospital Stay, Range of motion were made. Functional and radiological results were analysed according to Rasmussen Clinical & Radiological Score and outcomes were rated according to Rasmussen Clinical & Radiological Outcome criteria. Data was analysed statistically. From our observations we conclude that arthroscopic assisted internal fixation (ARIF) is better than open reduction and internal fixation (ORIF) in the treatment of tibial plateau fracture especially in Schatzker type 2 and type 3 because it has statistically significantly better results, with respect to, smaller hospital stay, lower pain scores, shorter duration of surgery, allows treatment of concomitant soft tissue injuries, leads to lesser complications and results in superior radiological and clinical scores.

Introduction

Fractures of the tibial plateau constitute approximately 1% of all fractures[1] and generally occur as result of trauma such as a fall, motor vehicle accident, pedestrian accidents, occupational accidents like railway worker accidents etc. By far the most common injury is to the lateral plateau (55-70%). Isolated injuries occur to the medial plateau in 10-23% of cases, whereas involvement of both plateaus, called Bicondylar fractures, is found in 10-30%. As early as 1920, Sir Robert Jones[2] noted the importance of realigning the intra-articular fractures of proximal tibia by open reduction, elevating the depressed fragments from the tibial shaft and fixation by bone pegs and long screws. Schatzker et al[3] opined that open reduction with anatomical restoration of articular cartilage produced best results. Blokkeret et al[4] demonstrated that 86% of patients with an anatomic reduction had a satisfactory result, satisfactory results were reduced to 75% in patients with a 1 to 4-mm step-off and to 0% in patients with a step-off of ≥5 mm. They considered that the single most important factor in predicting the outcome in a patient with tibial plateau fracture was adequacy of reduction. The method of achieving the reduction and the length of immobilization period of the knee was not crucial.

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Open surgical procedures[6,7], despite their good reduction results, cause additional insult to the soft-tissue envelope. Soft Tissue envelope in this injury is compromised to variable degree and sometimes critically, leading to skin or muscle necrosis and high rates of infection and prolonged immobilization, joint stiffness, postoperative arthritis. To overcome one or more of these pitfalls, in recent years, there is an increasing use of arthroscopy assisted surgery as an option[1,7] for management of Tibial Plateau fractures.

Arthroscopic assisted Reduction and Internal Fixation (ARIF) has been stated to be associated with lower morbidity, less extensive surgical dissection and less needs of long-term immobilization[1,5,7,8]. Associated meniscal and ligamentous injuries, efficiently assessed and diagnosed in ARIF, can be treated either arthroscopically or through secondary accessory incisions with few complications[8]. Cassard et al[9] concluded that results of arthroscopic management were as good as or better than what might be expected from ORIF.

Material & Methods

Study was conducted in Department of Orthopaedics, Northern Railway Central Hospital, New Delhi from August 2012 to May 2015. This study is a prospective cohort study including 30 patients with closed tibial plateau fracture. Inclusion criteria[10] was Tibial plateau depression >5mm, tibial condylar widening > 5mm, valgus or varus instability exceeding 10° in full extension. Exclusion Criteria was 'Patients of age group <15 and >60 year', patient with pathologic fracture, open fracture, significant pre-existing degenerative joint disease, severe head injury (initial Glasgow coma scale score of < 8), severe systemic illness (active cancer, chemotherapy, or a medical contraindication for surgery).

Sample size is calculated by sample size formula for experimental study and using power analysis[11] with the help of values of variables from previous studies[12,13].

Study population was divided into two groups, one group operated with arthroscopy assisted reduction and internal fixation (ARIF); and other by open reduction and internal fixation (ORIF). Groups were randomized by simple random table. Ethical committee`s and scientific committee`s permission was taken.

All subjects in the study were assessed by clinical examination, X ray and 3D CT scan. Reduction of fracture and elevation of depressed fracture was achieved under arthroscopic visualization in First group and by direct open arthrotomy or submeniscal approach (applicable for Lateral compartment only) in the second Group. C-arm Image intensifier guidance was used as needed. Fracture fixation was undertaken by implants like cannulated screws, specialised locking plates and other suitable methods depending upon the fracture anatomy and reduction achieved. Autogenous bone grafting & Synthetic Bone Substitutes were used to fill the defect when deemed necessary.

The duration of surgery, pain, hospital stay, range of motion, fracture healing time, radiological findings and Rasmussen Clinical & Radiological Score[14] were analysed and compared between two groups. Patients follow up was done at 6 weeks, 12 weeks then every bimonthly till 12 months after surgery. Rasmussen Clinical Outcome[14] at one year and Rasmussen Radiological Outcome[14] at 1 year were compared according to Rasmussen's criteria. Severity of osteoarthritis based on Ahlb¨ack[15] description of the narrowing of joint space was assessed. No patients were lost to follow-up.

RESULTS AND OBSERVATIONS

Average duration of follow up was 20 months (12-26 months). Age wise distribution in the two groups is shown in Table 1. Mean age in ARIF group was 46.60±8.24 and ORIF group was 44.73±11.88. There was one female in each group and 14 in each group were males. "Schatzkar Fractures Types" distribution of cases in both the

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groups is shown in Table 2. Associated Injuries were detected in both groups (arthroscopy or arthrotomy) and are shown in Table 3. Fibula head fracture which is outside Tibiofemoral articulation of knee is clubbed with "None" being diagnosed from Xrays and its detection therefore not affected by the technique of Surgery chosen. As many as many as 10 of 15 cases were found to have associated IA injury in ARIF group against only 4 in ORIF group.

Duration of surgery (Skin to Skin: Shown in Table 4) was significantly (p value <0.001) lesser @ 77.33 ±10.50 in ARIF group against 91.87±8.07 in ORIF group. Hospital Stay, Shown in Table 5 was also significantly (p value = 0.001) lesser in ARIF group @ 11.13 ±2.07 against 14.20±2.43 in ORIF group. Pain Score as assessed by Visual Analogue scale remains significantly lower in ARIF group at all periods up to one year as shown in Table 6 and Figure 1.

Gain in flexion range at all intervals was also better in ARIF group though statistically significant difference is noticeable only after 6 months as depicted in Table 7 Figure 2. There was no extension lag of 10 degree or 5 degree in any of patients in ARIF group. There was none in ORIF group also who had an extension lag of 10 Degree or more. Three patients however had extension lag of 5 degrees (Table 8).

Rasmussen Clinical score and Rasmussen Radiological Scores were better in ARIF group at all intervals and are shown in Table 9 & table 10 Respectively. Figure 3 & Figure 4 depict the progress of Score over a follow up. The difference in scores was statistically significant at all intervals.

However Net Rasmussen clinical outcome (Excellent to Poor) assessed at 1 year as shown in Table 11 was not statistically significant between two groups. Likewise However Net Rasmussen clinical outcome (Excellent to Poor) assessed at 1 year as shown in Table 12 was also not statistically significant.

DISCUSSION

Management of Tibial Plateau Fracture poses challenge because of a)depression of articular fragments below the joint level, b)condylar widening and consequent subluxation of tibial condylar surface from underneath femoral condyles c) instability resulting from laxity of Ligaments (because of loss of Normal bony height between Ligament attachment sites besides actual rupture sometimes) and finally d) malalignment because of asymmetric bone height loss between medial and lateral knee compartments. There is often an associated compromise in soft tissue envelope which make all surgical interventions potentially risky. An associated Internal Derangement of Knee comprising of meniscus, ligaments and cartilage damage is receiving increasing attention in recent studies.

It is now well established that optimal knee function depends on a stable knee with a congruous and healthy articular surface that permits balanced load transmission across the joint. The goals of tibial plateau fracture treatment, therefore, are to re-establish joint stability, alignment and articular congruity while preserving full range of motion, to provide freedom from pain and prevention of post traumatic osteoarthritis[3,7,16,17].

A conventional open surgical approach[4,18,19] with arthrotomy under Image Intensifier guidance with objective to restore normal anatomy with respect to both articular surfaces & normal alignment leads to high rate of soft tissue complications[5,9] including devitalization of flaps and infection and therefore often poor short, medium & long-term results. Indirect reduction methods[4,20,21,] Locked plates[22,23] and MIPPO methods[23] have been an inspiring landmark in the management of these fractures but multiple incisions all around the knee are needed to manage medial-lateral-posteromedial components of these complex fractures and are still a concern.

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Recently, therefore, there is a progressive preference for the treatment of these fractures by arthroscopic assisted reduction and internal fixation (ARIF). It is described[5,8,13,22,24,25] that ARIF may afford not only better understanding of the fracture patho-anatomy including diagnosis and management of Internal derangements of knee permitting a more holistic treatment of this complex injury, but may also aid in achieving reduction & fixation under direct vision with much lower morbidities. Combined with latest techniques of less invasive internal fixators & MIPPO it may satisfactorily address the dual need of anatomical reduction & stable internal fixation of various articular components of fracture as well as reduced & minimalised exposures.

Use of arthroscopy for assistance in reduction, however is not new. In 1985, Caspari et al[5] managed 20 cases of tibial plateau fracture with arthroscopy ranging from diagnostic examination to debridement, partial meniscectomy, closed reduction & ARIF and he reported that diagnostic arthroscopy revealed information not otherwise available and in 15 out of 20 cases adequate reduction and stabilization and/or grafting was achieved arthroscopically. The concern regarding wash-off of fracture hematoma has not been found to impact fracture healing[26]. An unparalleled advantage of arthroscopy is that it allows thorough washing out the joint content, including chondral debris and hematoma[27,28,29], removal of loose fragments, rapid recovery, and accurate diagnosis and treatment of associated intraarticular pathology synchronously, with reduced pain[7,8].

A review of literature points to the increasing applications of arthroscopic assisted treatment of these fractures. Most authors have recommended ARIF for Schatzker type I, II, III, IV while a few suggest for type V and VI fractures as well[30,31,32,33]. The purpose of our study was to understand the advantages, if any, of arthroscopic assisted internal fixation (ARIF) over open reduction and internal fixation (ORIF) treatment in Tibial Plateau Fracture. However, we could find only three studies[13,26,34] which have taken up the comparison between Arthroscopic Assisted reduction & Internal Fixation with Open reduction and internal fixation. Closest resemblance was found to the study by C.Dall'Oca et al[34] who conducted a prospective study on 100 patients of tibial fracture (all Schatzker's types) with follow up of 11 to 116 month. The patients were evaluated both clinically and radiologically according to the Rasmussen and HSS score. This study is similar to our study except that, we have smaller sample size, shorter follow up (20 month) and we evaluated pain score as well which this study did not. Second study reported in 2003, Ohdera T et al[13] was retrospective study (our study is prospective) and results evaluated by the Hohl & Delamarter scoring system. In 2011, Zhong FH et al[26], again a retrospective study, followed up 63 patients at a duration ranged from 6 to 12 months (average = 10.3 months).

Our study is a prospective cohort study including 30 cases of tibial plateau fracture. Study population was divided into two groups by simple random table, one group operated with arthroscopy assisted reduction and internal fixation (ARIF); and other by open reduction and internal fixation (ORIF). Mean follow up period was 20 months. The operation time, pain, hospital stay, range of motion, associated soft tissue injuries, radiological findings and complications were analysed and compared between two groups. Clinical parameters and radiological parameters were compared according to Rasmussen's criteria.

Most of the patients were in the age group of 40 to 60 years with male predominance (93%). most common mode of injury was RTA (53.3%) mainly fall from motorcycle. Most common type of fracture was type 2 (53.3%) followed by type 3 (46.7%) similar to studies in literatre[35,36].

Two Findings are very evident by the data collected by us. One is that Arthroscopic assisted technique has definite advantages with respect to less time required for surgery compared to open traditional technique (ARIF

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77.33 minutes ORIF 91.87) and secondly that ARIF is more efficient in detection of IA significant meniscal/ligament injuries than ORIF (11 out of 15 in ARIF compared to 4 out of 15 in ORIF).

Average duration of hospital stay in ARIF group was 11.13 (range, 8-15) days and that of ORIF group was 14.20 (range 10-20). Duration of stay is longer compared to similar studies in literature[26,37,38,39] because this study is conducted in a Hospital of Industrial organisation offering completely free services to the beneficiaries. In our set up, longer stay on request of patient is allowed very readily and patient often desire to stay on till removal of stitches. Despite this, patients of ARIF did agree to get discharged earlier compared to ORIF group.

Pain in Post-operative & Follow up period was used as a proxy of degree of tissue insult and patient friendliness of the the procedure. Pain as assessed by VAS score up to 6 weeks was considered as a proxy for tissue insult and VAS score at 3 months, 6 months and 1 year was used as proxy of patient friendliness**.** The scores and test for statistical significance is shown in Table 6 and comparison shown in Figure 6. P values at < 0.05 at all periods right up to 1 year indicated the difference to be statistically significant. The patients of ARIF group were having less pain both early in postop period as well as later in follow up period as compared to ORIF group and difference is statistically significant at all periods. It is remarkable that lesser pain in ARIF group was present even at 6 months when the patient was undergoing rehabilitation for restoration to pre-injury level of activity and we believe that this may have played role in better clinical scores in the patients of ARIF group. Buchko GM et al[7], Jennings JE[8] and Cassard et al[9] also showed less pain in patients treated with arthroscopic technique. But Dall'Oca et al[34] while agreeing that ARIF technique caused lesser pain to patients, particularly within 12 months after surgery asserted that the difference was not statistically significant.

Functional Outcomes were also better in ARIF group. Range of motion was superior in ARIF compared to ORIF group [1 year of follow up: ARIF average flexion =127.67º ± 12.66 (range, 100º-140º); ORIF group =117.67º ± 12.37 (90-140)]. No lack of extension was seen in any patient of ARIF group. In ORIF group, 3 out 15 patients (type 5, type 3 and type 6) showed lack of extension of 5°at 1 year of follow up. Also, at 1 year of follow up, there was statistically (P value of 0.029) significant difference in clinical score between ARIF and ORIF group. In ARIF group, average Rasmussen's clinical score was 25.93 ± 1.91 (range, 23-29) while in ORIF group, it was 24.20 ± 2.21 (range, 19-28). Radiologically also, the results in ARIF group were better. At 1 year of follow up, there was statistically significant difference in radiological score between ARIF and ORIF group [ARIF group 16.13 ± 1.30 (range, 14-18); ORIF group 15.13 ± 1.18 (range, 11-15) @ P value=0.036]. These results compare well with similar studies in literature[22]

According to Rasmussen`s clinical criteria, clinical outcome was excellent in 5(33%), good in 8(53.3%) and fair in 2 (13.3%) and poor in 0 patient In ARIF group;. While in ORIF group, It was excellent in 2(13.3%), good in 10 (66.7%), fair in 2(13.3%) and poor in 1 (6.7%) patient. Rasmussen`s radiological outcome in ARIF group was excellent in 3 (20%), good in 11 (73.3%) and fair in 1 (6.7%) patient. poor in 0 patient. While in ORIF group, It was good in 10 (73.3%), fair in 3 (20.0%) and poor in 1 (6.7%) patient. No patient showed excellent radiological outcome in ORIF group. These outcome results apparently appear better in ARIF group but the difference in clinical and radiological outcomes between two groups was statistically not significant (P value was 0.474 & 0.119).

So, although there were statistically significantly superior clinical and radiological score in ARIF group, the difference in outcomes was statistically not significant. The implications of this disconnect– Statistically

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Significant better clinical & radiological scores but clinical & radiological outcomes despite being better; not statistically significant; is not clearly understood.

Complication rates were also lower in ARIF patients[23,26]. There was no superficial or deep infection in ARIF group. While in ORIF group, 2 patients (13.3%) showed infection, one superficial in Schatzkar type 4 fracture and one deep infection in Schatzkar type 6. In ARIF group, only 2 cases (13.3%) were having mild osteoarthritis changes. In ORIF group, 7 out 15 (46.7%) showed osteoarthritis changes at 1 year. Out of these 7 cases, 2 (type 6 and type 5) cases were having moderate osteoarthritis and remaining 5 were having mild osteoarthritis [according to Ahlb¨ack's[15] scoring]. We observed no complication directly associated with arthroscopy. Nor any patients suffered from deep vein thrombosis, compartment syndrome or peroneal neuropraxia in either group.

Treatment of tibial plateau fractures has evolved from conservative treatment: to extensile open reduction and internal fixation; to MIPPO with submeniscal arthrotomy, but many issues are still not settled. Less invasive methods of internal fixation and indirect reduction by distraction have solved many soft-tissue concerns but intraarticular anatomical reduction continues to require open joint invasion and Radiation exposure. Usually employed sub-meniscal approach of joint inspection and open reduction permits mostly a tangential view with limited opportunity for manoeuvring free articular fragments from articular side and that too only in lateral compartment. Creating a window below in metaphyseal flare of plateau and tapping the fragment up for elevation remains the principal techniques in reduction of depressed fragment. While agreeing that arthroscopy affords all advantages described by various authors mentioned above[5,7,8,13,22,24,25,26,27,28,29] the advantage offered in guiding the elevation of depressed fragment from joint side while tapping it from below needs more emphasis. In this regard, the advantage of a bird eye magnified view with ability to ease the depressed fragment up while permitting the placement of metaphyseal window strategically right beneath the depressed fragment by using various Arthroscopy Ligament reconstruction guides can not be overemphasised.

From observations in our study we conclude that arthroscopic assisted internal fixation (ARIF) fares better than open reduction and internal fixation (ORIF) in the treatment of tibial plateau fracture especially in Schatzker type 2 and type 3 because it has smaller hospital stay, less pain, shorter duration of surgery, allows treatment of concomitant soft tissue injuries, less complications and superior radiological and clinical scores. However one needs to remember Holzach et al[40] who cautioned that arthroscopic treatment of tibial plateau fractures has a protracted learning curve and is technically demanding. But he also concluded that these disadvantages are offset by improved diagnostic evaluation and safe and effective treatment.

In our study there was a disconnect between Resmussen Radiological & Clinical Scores vis-a-vis clinical and radiological outcome. The Scores were better statistically as well but there was no significant difference in clinical and radiological outcome, statistically speaking. We recognize that this disconnect may be because of the relative infrequency of each individual type of tibial plateau fracture in our cohort. We therefore recommend, multicentric, longer term, prospective clinical studies for individual Schatzkers types to make final conclusion with respect to better clinical outcomes.

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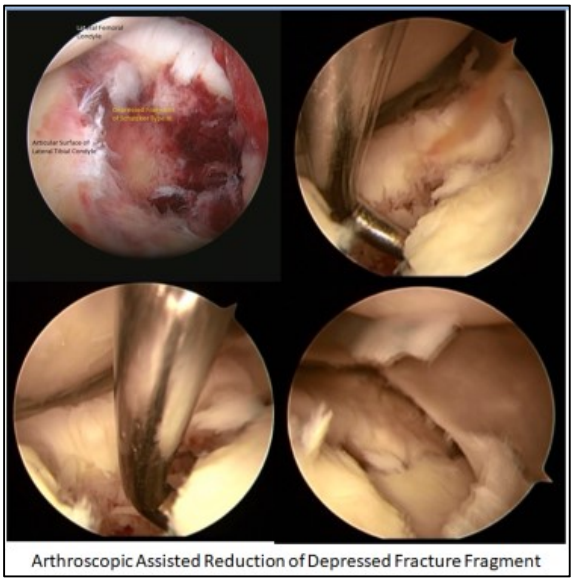
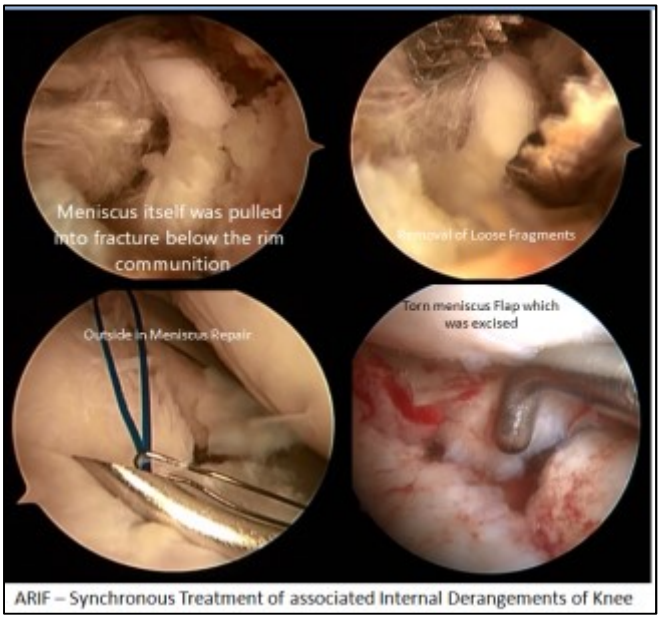
Arthroscopic assisted Reduction



Arthroscopic Assisted Reduction of Depressed Fracture Fragment



ARIF – Synchronous Treatment of associated Internal Derangements of Knee

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Arthroscopic Assisted Reduction and Synthetic Bone Substitute Grafting

ORIF by Sub-meniscal Approach

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