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Research Paper

Hybrid external fixator with or without minimal internal fixation: effective alternative for proximal tibia fractures, review of 25 cases

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Abstract

Background: Open or minimally invasive plating is the most commonly used surgical method to treat proximal tibia fractures. However unhealthy soft tissue or unusual fracture anatomy at times force a surgeon to look for alternative surgical methods.

Materials and Methods: The study was conducted between January 2014 to December 2017. 25 patients were operated for proximal tibia fractures using a hybrid external fixator in a single institute and results evaluated.

Results: By the end of 1 year after surgery Rasmussen score as excellent in 16, good in 6, fair in 3 and poor in 0 patients. The mean range of knee motion at the final follow up was 4 to 120. 2 cases of varus malunion and case of nonunion were observed in our study.

Conclusion: Hybrid external fixator is a viable and effective alternative to conventional locked plates in selected patients.

Keywords: tibia, proximal, external fixator, fracture

Abbreviations: CCS: Cannulated Cancellous Screws; ROM: Range of Motion; HSS: Hospital for Special Surgery; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; ORIF: Open Reduction Internal Fixation

INTRODUCTION

Proximal tibia fractures are complex fractures which often pose a challenge to treating surgeon usually due to precarious soft tissue envelope around the proximal tibia. Plating with pre-contoured locking plates using open or minimally invasive techniques are the most commonly used methods of fixation for proximal tibia fractures [1]. However a number of times situation doesn't allow a surgeon to go for routine method of fixation. In proximal tibia high energy fractures with bad soft tissue, open fractures or severe comminuted fractures often force a surgeon to look for alternative methods of fixation the fracture like ring fixator or tubular external fixator as soft tissue stripping in not feasible under such circumstances due to high chances of wound break down and infection [2].

A hybrid external fixator with minimal internal fixation is a very good alternative for proximal tibia fractures when open reduction and plating is not feasible. A periarticular ring is connected with the shaft using monoaxial fixator. This provides a very stable construct and allows early range of motion which is critical for cartilage nutrition. Minimal soft tissue damage causes little post-operative pain. Besides a varus or valgus collapse in the immediate post-operative period can also be addressed.

MATERIALS AND METHODS

This study was conducted between January 2014 to January 2017 at the post-graduate department of Orthopaedics after approval from ethical committee. During this period we got 25 patients, 17 males and 8 females with proximal tibia fractures where standard method of fixation in our institute (single/dual plating) was not possible because of various reasons. 6 patients had open fractures, 19 patients had bad soft tissue like blisters or gross swelling. 19 patients had intra-articular fractures and 6 patients had extra-articular comminuted fractures. All the intra-articular proximal tibia fractures/tibial plateau fractures were classified as of Shatzkar classification [3]. Patients with healthy soft tissue around proximal tibia, patients with neurovascular injury of the involved limb and patients with extensive soft tissue damage who needed flap coverage were excluded from the study.

All the fractures were fixed under C arm control in spinal anesthesia. Fractures were reduced using longitudinal traction and AO clamps. Articular surface reconstruction with bone grafting and Minimal internal fixation with Cannulated Cancellous Screws (CCS) fixation was done through small windows whenever needed. The proximal ring was aligned parallel to articular and fixed with two crossed olive wires. Metaphysio-diaphyseal alignment was corrected under C arm and secured with shanz pins and tubular rods which were connected with the proximal ring. The final reduction was confirmed under C arm.

The patients were regularly followed up in the post-operative period. X rays were taken on first post-operative day, then sequentially at 3 weeks, 6 weeks, 3 months, 6 months and 1 year. Patients were encouraged to start range of motion exercises on first post-operative day. Partial weight-bearing was allowed from 4th to 6th week and full weight was allowed as per the status of fracture union. Patients were explained to take care of pin sites with regular antiseptic dressings and to keep them clean. Signs and symptoms of pin tract infections were explained to the patients.

The patients with compartment syndrome and vascular injuries were excluded from the study due to irregular follow up as patients had to attend plastic surgery and cardiovascular and thoracic surgery follow up regularly.

Patients were assessed clinically and radiologically in the follow up for fracture union, tenderness, knee ROM (Range of Motion), pin site infection, soft tissue status, wound infection, osteomyelitis and neurovascular complications.

RESULTS

PATIENT PROFILE

Out of 25 patients, 17 were males and 8 females. The mean age of the study group was 37 years with range from 21 to 57 years (Table 1).

FRACTURE CHARACTERISTICS

Out of 25 patients 6 had extra-articular (Fig. 1a-1c) and 6 had intra-

Table 1. Patient and fracture profile, complications and final outcome

S. no	Soft tissue status	Shatzkar type	Complications	Radiological outcome	Knee ROM	Sports activity
1	Open	IV	-	Union	5-115	Resumed
2	Open	IV	Pin site infections	Union	0-125	Resumed
3	Open	V	-	Union	5-130	Resumed
4	Bad soft tissue	Extra-articular	-	Union	0-120	Not resumed
5	Bad soft tissue	V	-	Union	0-110	Resumed
6	Bad soft tissue	VI	-	Union	0-100	Resumed
7	Bad soft tissue	VI	Pin site infection	Varus mal union	8-130	Not resumed
8	Closed	Extra-articular	-	Union	0-110	Resumed
9	Closed	V	-	Union	0-117	Resumed
10	Closed	VI	-	Union	10-120	Resumed
11	Closed	V	Pin site infection	Union	0-115	Resumed
12	Bad soft tissue	V		Union	5-110	Resumed
13	Bad soft tissue	V	-	Varus mal-union	0-125	Resumed
14	Bad soft tissue	Extra-articular	-	Union	0-130	Not resumed
15	Bad soft tissue	VI	-	Union	10-120	Resumed
16	Bad soft tissue	VI	Pin site infection	Union	5-115	Resumed
17	Bad soft tissue	Extra-articular	-	Union	0-130	Resumed
18	Bad soft tissue	V	-	Union	6-125	Resumed
19	Bad soft tissue	VI	-	Union	0-120	Not resumed
20	Bad soft tissue	VI	-	Union	5-130	Resumed
21	Open	Extra-articular	-	Union	0-125	Not resumed
22	Bad soft tissue	V	Pin site infection	Union	6-135	Resumed
23	Bad soft tissue	V	-	Union	0-115	Not resumed
24	Bad soft tissue	Extra-articular	-	Union	0-125	Resumed
25	Open	V	-	Union	0-135	Resumed

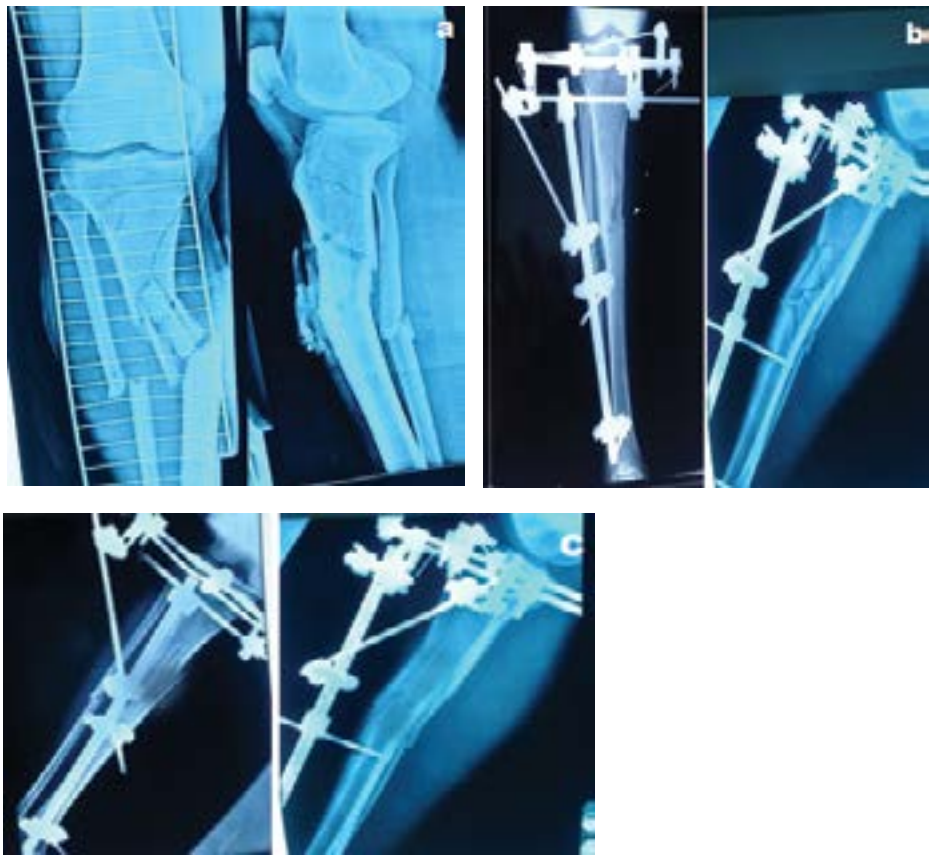

Fig. 1. Case 1: Extra-articular proximal tibia fracture; **a:** Pre-operative X-rays showing comminuted extra-articular proximal tibia fracture; **b:** Post-op X-ray showing well-reduced fracture with hybrid fixator in situ; **c:** 3 months post-op X-ray showing fracture well united

Fig. 2. Case 2: Intra-articular proximal tibia fracture with unhealthy soft tissue; **a:** Anteroposterior and lateral knee x rays showing intra-articular proximal tibia fracture; **b:** Post-op X-ray showing well reduced fracture; **c:** Final X-ray after implant removal showing well united fracture; **d:** unhealthy soft tissue around proximal tibia; **e:** Good range of knee movements

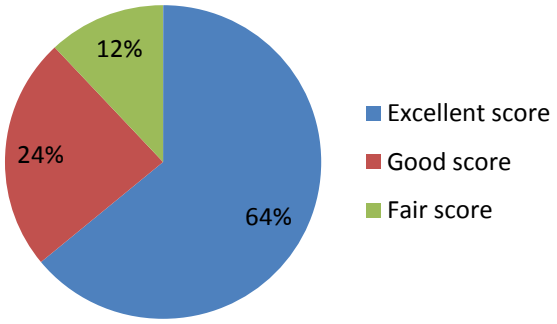

Fig. 3. Pie chart for functional outcome/Rasmussen score

articular fractures (Fig. 2a-2c). Among 19 intra-articular fractures, 2 were Shatzker type IV and 10 were Shatzkar type V and 7 of Shatzkar type VI. 7 were open fractures (Gustilo and Anderson type 1 to 3a) and 18 with bad soft tissue (Fig. 2d) (blisters, gross swelling, small lacerations), knee movements were good (Fig. 2e).

FUNCTIONAL OUTCOME

The mean duration of the application of fixator was 12 weeks (10 to 22 weeks). The average time of fracture union was 15 weeks. In 2 patients time taken for fracture union was more than 20 weeks. Functional outcome after 1 year was observed by Rasmussen Score as excellent in 16, good in 6, fair in 3 and poor in 0 patients (Fig. 3). The mean ROM at final follow up was 4 to 120 (Fig. 2e). No patient had nonunion, 2 patients have varus malunion of 4 and 7 degrees respectively but did well functionally. All the patients achieved pre-injury activity status however only 13 patients resumed sports activities.

COMPLICATIONS

No systemic complications were reported in any of the patients during the study. 4 patients developed pin site infections in the follow up which was managed with pin site dressing and oral antibiotics which resolved in all the patients (Table 1). No patients developed deep infection or nonunion. 2 patients had varus malunion but the functional outcome was satisfactory in both the patients. No patient had any neurovascular injury.

DISCUSSION

High energy proximal tibial fractures are complex bony injuries with unpredictable outcomes. Treatments methods used are conservative or operative depending on the type of fracture [4]. A number of methods of fixation are used for proximal tibia fractures however no method has absolute advantages over other methods [5]. The aim of surgical treatment is articular surface reconstruction for intra-articular fractures, axial and rotational alignment of fracture and stable fixation to allow early knee range of motion [6]. Numerous studies have shown satisfactory results with Open reduction and internal fixation with Single or dual plating for proximal tibia fractures [7,8]. However due respect has to be given to soft tissue envelope as many studies have shown very poor results in cases with bad soft tissue around proximal tibia [9].

Open reduction allows a better reduction of articular cartilage which is expected to show better functional outcomes. However the drawback of this method is extensive soft tissue stripping which can lead to wound dehiscence, infection, nonunion joint stiffness and risk of septic arthritis. In patients with already compromised soft tissue or open fractures plating can have disastrous consequences. High energy fractures Shatzkar type V and VI usually have compromised soft tissue. Though many studies have shown soft tissue problems even in low energy unicondylar fractures [10]. Various studies have shown significant complications with open plating with respect to infection and soft tissue healing [11-14]. Also many studies have shown that axial and rotational alignment of fragments is more important than absolute articular surface reconstruction [15,16].

With a better understanding of anatomy and importance of posteromedial and posterolateral fragments minimally invasive posteromedial and posterolateral plates are being used with satisfactory results [17-20].

Arthroscopy assisted internal fixation has shown better results in intra-articular knee fractures with respect to knee functions and return to sports activity [21-23] Staged management with temporary external fixation with an external fixator and delayed definitive management have shown satisfactory results in various studies [24]. However many studies have shown significantly higher rates of deep infection with staged fixation [25,26].

Various external fixation modalities that have been used when internal fixation is not feasible are ring fixator, joint spanning or joint sparing tubular external fixator. However, with joint spanning fixator knee ROM is not possible and is not considered a good option. Many studies have shown good results in proximal tibia fractures with joint sparing external fixator and ring fixator [27-29].

A hybrid external fixator combines the advantages of ring fixator and tubular fixator. Ring fixator with k wires makes the construct very stable proximally and prevents fracture collapse or displacement. The monoaxial tubular part makes it less bulky and lighter which makes early knee ROM and early patient mobility easier for the patient. Besides adjustments can be made is the post-operative period if needed which is not possible in plating.

Mahadeva et al. in their study reported significant advantages regarding soft tissue related complications with hybrid external fixation over open reduction and no advantage over accurate fracture reduction [30,31]. In our study we had a satisfactory reduction in all the cases however one case ended up in collapse and varus malunion.

In our study, we had 5 patients (18%) with superficial pin site infection which was managed with pin site dressing with H_2O_2 and oral antibiotics, no deep infection and septic arthritis. Hutson et al. in their meta-analysis on external fixation in proximal tibia fractures observed pin site infection of 10%, deep infection of 4% and septic arthritis in 1% patients [22,32]. Hall et al. in their study observed better results regarding soft tissue related complications and comparable results regarding fracture reduction and in Knee ROM (Range of Motion), HSS (Hospital for Special Surgery) scores, WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index) and SF-36 between ORIF (Open Reduction Internal Fixation) and external fixation [33,34].

There are very few studies are in the literature on the results of plating on high energy (Shatzkar type V and VI) fractures. Nikolaou et al. in their study on complex proximal tibia fractures treated with locking plates had 94.5% union rate, 3.7% cases of superficial infection [35-37], 3.7% cases of deep infection and 3.7% cases of nonunion. In our study we had 100% union rate and no case of nonunion. The number of cases with superficial infection was more (16%) in our study but infection resolved well in all the cases and no patient ended up with deep infection.

CONCLUSION

Under certain circumstances when ORIF with plating fox proximal tibia fractures is not feasible like open fractures or unhealthy soft tissue hybrid external fixator with minimal internal fixation is an effective alternative method of fixation with distinct advantages regarding soft tissue complications.

CONFLICT OF INTEREST

None

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AUTHORS' CONTRIBUTION

Towseef Ahmad Bhat designed the study and drafted the manuscript. Towseef Ahmad and Zameer Ali participated in the design of the study. Mudasir Rasool and participated in design and coordination and helped to draft the manuscript. All authors read and approved the final manuscript.

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