



E-ISSN: 2395-1958  
P-ISSN: 2706-6630  
IJOS 2020; 6(2): 486-492  
© 2020 IJOS  
[www.orthopaper.com](http://www.orthopaper.com)  
Received: 14-02-2020  
Accepted: 16-03-2020

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## Study of functional outcomes of juxta articular fractures around the knee and ankle joints managed by hybrid external fixators

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**DOI:** <https://doi.org/10.22271/ortho.2020.v6.i2h.2087>

### Abstract

**Background:** The compound juxta-articular fractures around the knee and ankle are associated with high energy trauma and difficulty in treating due to poor soft tissue conditions. They present a great therapeutic challenge to an orthopedic surgeon. The development of a hybrid external fixator and the constant improvements in the design of the constructs have led to a better outcome in the therapy since the periosteal blood supply is retained better than plate fixation.

**Method and materials:** We prospectively analyzed the functional and radiological outcomes of 20 surgically treated juxta-articular fractures around the knee and ankle. Preoperative radiographs and CT were taken. The hybrid external fixator was used as the definitive treatment modality. All the patients were followed for 36 months. The functional outcome was evaluated with modified Rasmussen's criteria.

**Results:** After treating with a hybrid external fixator, All patients were started with partial-weight bearing walking on POD 1 along with QSE and knee range of movement exercises and full weight-bearing by POD 7. The fractures of the proximal tibia united with an average of 16 weeks (14 - 18 weeks). The fractures of the distal tibia united with an average of 15 weeks (14 - 22 weeks). Functional scoring of the knee by Rasmussen's criteria shows excellent outcomes in 9 patients (45%), Good in 6 patients (30%), Fair in 3 patients (15%) and poor in 2 patients (10%). Overall 75% of patients have an acceptable outcome.

**Keywords:** Juxta articular fractures, hybrid external fixators, tibial plateau, tibial plafond

### Introduction

Juxta-articular fractures of the tibia are usually associated with severe soft tissue damage with or without compounding. The fracture that involves the proximal tibia affect the knee function and stability. The distal tibia fracture also affects the ankle joint function and stability. The management of such high energy fractures becomes a difficulty for orthopedic surgeons. The goals of management of the juxta-articular fractures are stable fixation of fragments, early wound healing, and early weight-bearing at a reduced cost of treatment. The use of a hybrid external fixator entails a minimally invasive technique of insertion that gives good fracture reduction and stability combined with minimal postoperative complications<sup>[1]</sup>.

Proximal tibial fractures are complex injuries, difficult to treat as they are associated with dissociation of comminuted metaphysis from diaphysis and open wounds and extensive degloving injuries. The distal tibial fractures are associated with fibula fracture, hence reduction is going to be difficult and fractures are almost compounding and comminuted.

For patients treated operatively, the residual disabilities are not only attributable to the severity of the injury but also the complication and side effects of the operative intervention. Open fractures, fracture accompanying a compartment syndrome and fracture associated with vascular compromise usually require immediate intervention. The specific definition of hybrid external fixation is quite ambiguous. The term hybrid denotes no single or universally accepted treatment strategy/device. It is called hybrid fixation because it combines wire fixation technique and pin fixation technique. The tensioned wires provide improved fixation in the cancellous fragment, whereas the pin fixator gives adequate stability to the diaphyseal fragments<sup>[2]</sup>.

The hybrid external fixator is simple and it is easy to apply [3]; it can even be applied in emergency operation theatre; it is minimally invasive and also reduces the surgical time. It provides space for plastic and post-operative procedures. Hence, the fracture can be realigned post-operatively as desired. Fracture reduction can be easily attained after frame assembly. A hybrid external fixator provides rigid fixation; it allows immediate mobilization of the joints and allows for early weight-bearing [4].

The hybrid external fixator technique minimizes the osseous and soft tissue devascularisation and reduces the rate of complications that result from treatment modalities [5]. In this study, we would like to assess the role of hybrid external fixator in treating juxta-articular fractures of the proximal and distal tibia.

### Method and materials

This is a retrospective and prospective study done in the Institute of orthopedics and traumatology in Madras medical college and Rajiv Gandhi Government General Hospital from January 2017 to January 2020. The total number of cases included in the study was 20 (proximal tibia - 14, Distal tibia - 6). Modified Rasmussen's Criteria for Clinical Assessment was used to evaluate the results of the treatment.

### Inclusion criteria

- Compound juxta-articular fractures of the leg with radiological evidence of comminution, significant fracture displacement with associated soft tissue injury.
- Proximal 1/3rd extra-articular tibial fractures (severely comminuted) and extra-articular comminuted distal tibial fractures.
- Proximal tibial fracture with compartment syndrome after Fasciotomy.
- High velocity proximal tibial fracture in impending compartment syndrome.

### Exclusion criteria

- Patient co-existing neurovascular damage.
- Pathological fractures.
- Patient with severe arthritic changes involving knee joint and ankle joint.
- Intraarticular fractures with severe comminution were excluded (Type C3 AO/OTA Classification).

As soon as the patient was received in trauma ward, resuscitation was done. After a detailed and complete clinical history and evaluation including routine blood investigations and both X – Rays of the leg with knee and ankle (AP and Lateral views) and CT Scans of the corresponding joint/long bone was taken. For compound fractures with massive soft tissue exposure and contamination, tetanus globulin and IV antibiotics were given.

### Surgical technique

In a modular operating theater, under strict aseptic precautions, under spinal anesthesia and tourniquet control, the operative procedures were performed. Fractures were reduced by manual traction/manipulation and then stabilized with the hybrid external frame (Fig 1.1, Fig 1.2). After the reduction of peri-articular fragment, it was secured using three Ilizarov wires (Fig 1.3). The first wire was passed parallel to the joint in a lateral to medial direction under fluoroscopic control. One wire each from posterolateral to anteromedial and posteromedial to anterolateral under fluoroscopic control keeping an angle of 30 to 60 degrees between the wires. After reconstituting the articular block, two or three 4.5mm cortical Schanz pins were placed into the diaphysis of the distal fragment anteromedially and connected with a tubular rod and hybrid frame. The metaphyseal fracture was then reduced accurately, and the metaphyseal and diaphyseal assemblies connected. If there is instability with a single rod, two more rods with one on either side were connected. The reduction of the fracture was done and confirmed under fluoroscopic guidance.



Fig 1.1



Fig 1.2

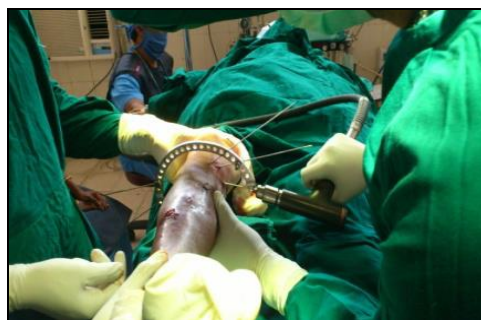


Fig 1.3

Fig 1.1, 1.2 and 1.3: showing intraoperative steps of construct placement after drilling with Ilizarov wires and debridement.

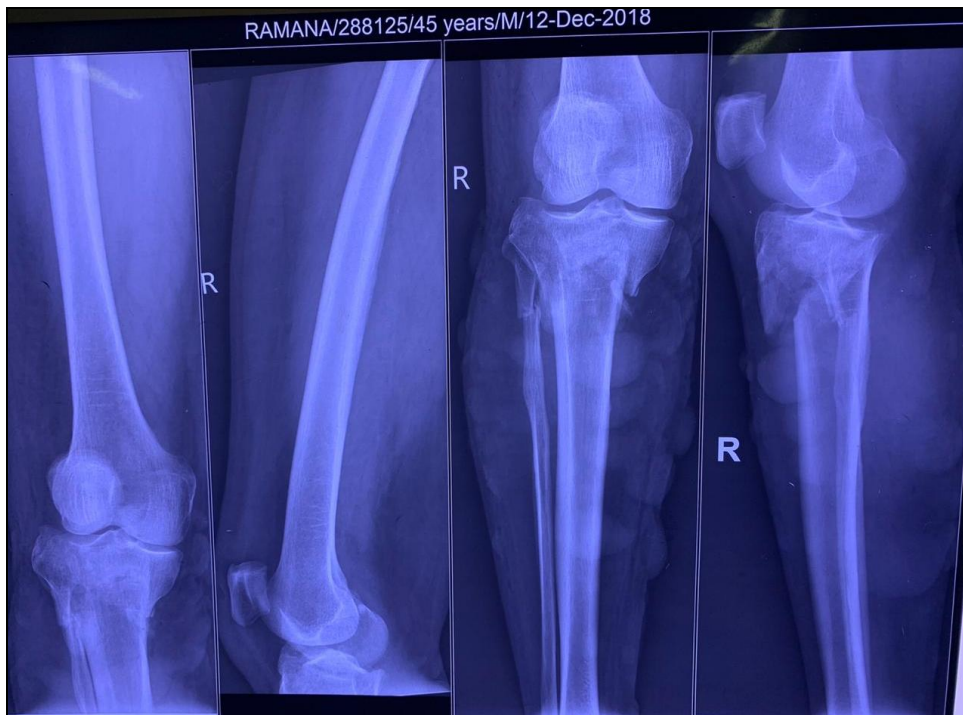


Fig 2.1 Showing pre-op x-ray



Fig 2.2

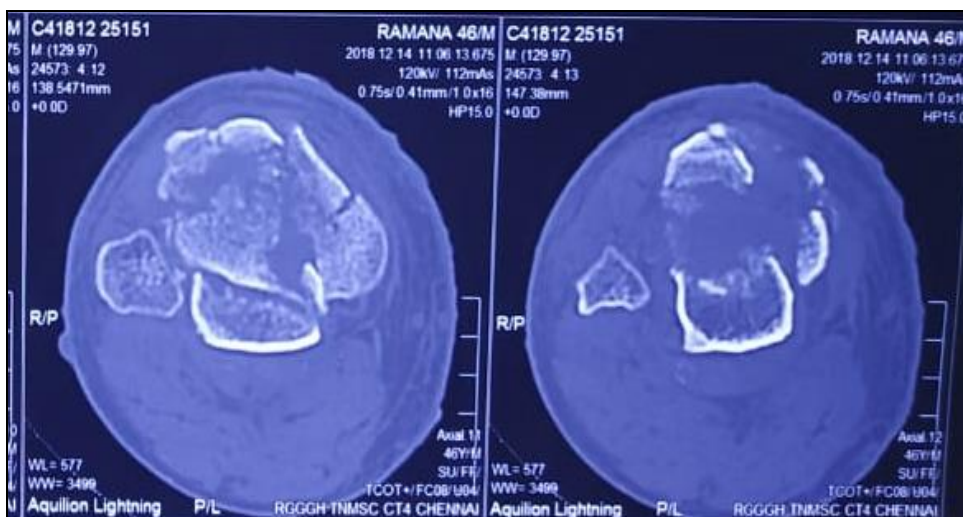


Fig 2.3



Fig 2.4

Fig 2.2, 2.3, 2.4: Showing pre-op CT images of the same patient with evident comminution of the tibial plateau and posterior displacement of the distal segment.

**Post-operative care**

Postoperatively, for a period of 3 to 5 days, the patients were administered with intravenous antibiotics. The patient was taught about pin site care [6]. Quadriceps strengthening exercise started on day 1. Knee and ankle ROM exercise started on day 2. Mobilization with non-weight bearing walking or toe-touch weight-bearing started depending upon fracture pattern, stability and if other associated injury permits. The patients were asked to come for follow up at 3<sup>rd</sup>, 6<sup>th</sup>, 9<sup>th</sup> and 10<sup>th</sup> months. The functional outcome and radiological outcome was evaluated at each visit.

**Results**

In our study road traffic accident was the most common mode of injury. Males(90%) are most commonly affected than females 10% in the ratio of 9:1. Clinically, the leg was examined for stability with a loosened fixator. Bridging callus was required to determine radiographic healing. The mean age was 40 years. Meantime for fracture union was 16 weeks which ranges from 13 weeks to 22 weeks.



Fig 3.2

Fig 3.1, 3.2: Post-op Xray and CT images showing construct in place after reduction of the fracture.

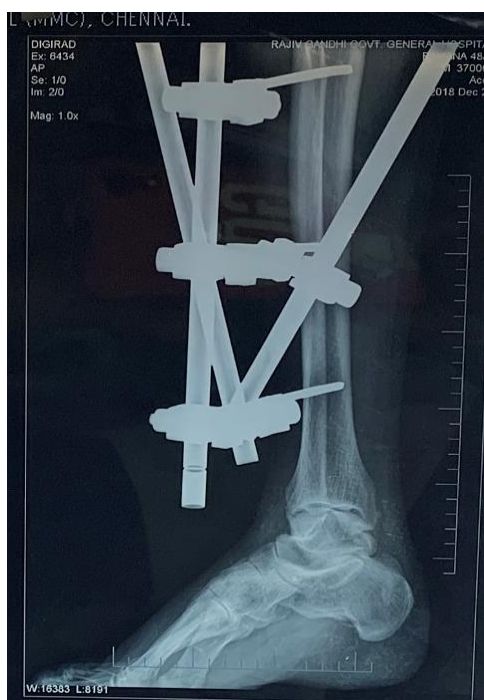


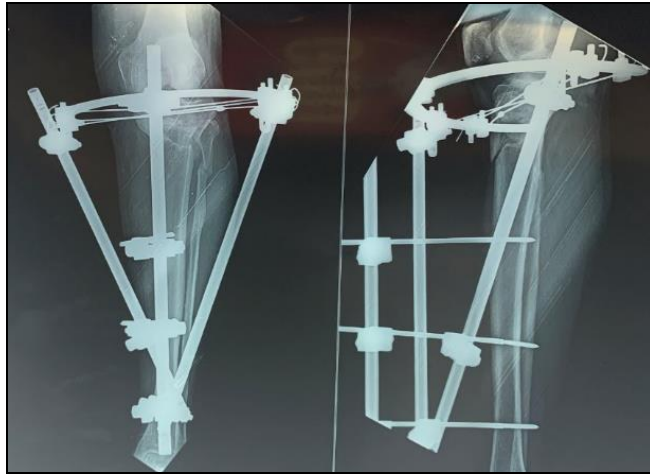
Fig 3.1



Fig 3.3: Patient on hybrid external fixator on the day of discharge. The patient was taught mobilization exercises and pin site care. The patient was also explained about the time of follow-ups.



**Fig 4.1**

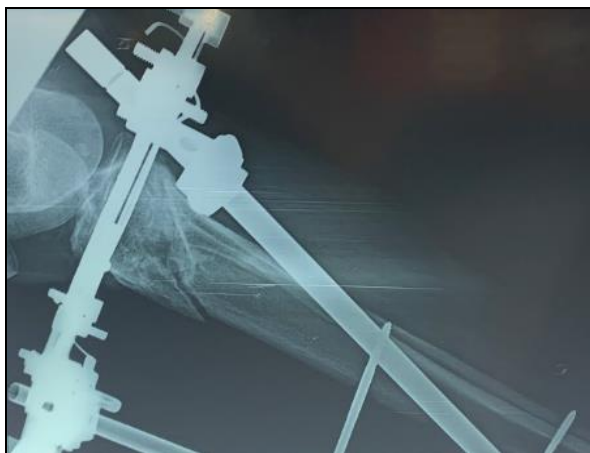


**Fig 4.2**

**Fig 4.1, 4.2:** Patient at the time of follow up after 3 months and Xray image showing callus formation with no displacement indicating high stability with the procedure.



**Fig 5.1**



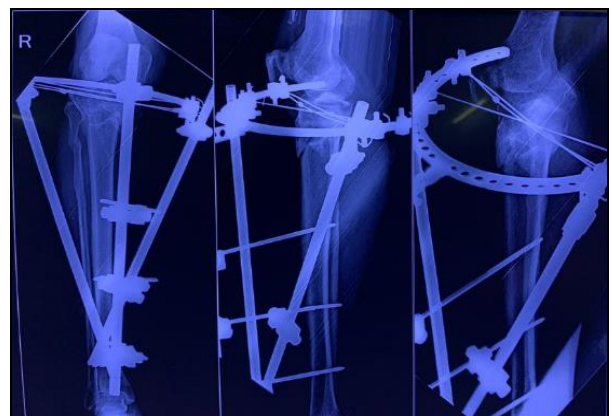
**Fig 5.2**

**Fig 5.1, 5.2:** X Rays took at 6<sup>th</sup> month follow up showing the gap at fracture site but with a moderate level of callus formation and a stable external fixator construct. No loosening at pin sites seen.



**Fig 5.3:** Patient during the 6<sup>th</sup> month follow up. No specific complaints. The construct was stable and no pin site loosening or pain.

Functional scoring of the knee by Rasmussen's criteria(Fig 8) showed excellent outcomes in 9 patients(45%), Good in 6 patients(30%), Fair in 3 patients( 15%) and poor in 2 patients(10%). Overall 75% of patients have an acceptable outcome. The most common complication encountered in our study was pin tract infection followed by 2 patients who went for Delayed union in proximal tibial fracture.



**Fig 6:** During the 9<sup>th</sup> month follow up, callus formation was found to be sufficient and hence the patient was put on patella tendon bearing cast and made to walk with full weight-bearing. No complaints of pain or instability.

The fractures of the proximal tibia united with an average of 16 weeks (14 - 22 weeks). The fractures of the Distal tibia united with an average of 15 weeks (14 - 22 weeks). There were two cases of delayed union in proximal tibial fractures.



Fig 7.1



Fig 7.2

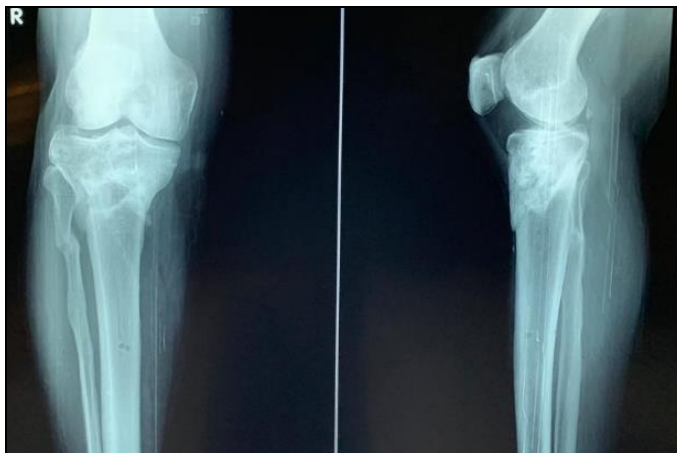


Fig 7.3: Xray image showing a united fracture site

Fig 7.1,7.2: Patient during the 10<sup>th</sup> month follow up. Knee flexion more than 90 degrees was possible and the patient was able to squat with little stretch pain at the ankle which later decreased with physiotherapy and exercises.

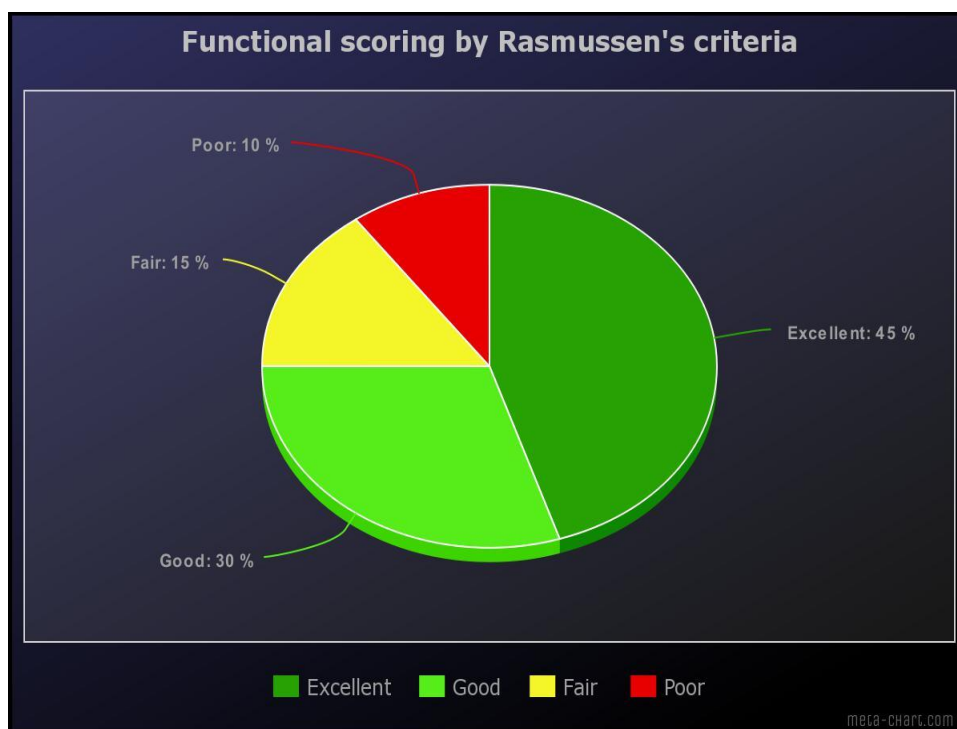


Fig 8: Chart showing the functional outcome of the cases as per Rasmussen's criteria

**Discussion**

This method provides adequate stability and allows an early motion for both proximal and distal tibial fractures. The closed reduction not only helps achieve reduction in difficult situations but also in the rapid union, as it preserves blood supply to the fragment. It is also effective in extra-articular fractures occurring within 5 cms of the knee joint proximally and 3 - 4 cms from the ankle joint distally, wherein the IM nails often do not provide enough stability and plating requires extensive soft tissue dissection. The major advantages of this technique are being a minimally invasive procedure, very good preservation of soft tissues, better anchorage of in cancellous bone area giving better stability, easy application of half pins in diaphysis without neurovascular injury, early mobilization of the knee joint, good skincare and easy application of flap cover. But the risk of articular infection if pins are applied very close to joint, difficulty in obtaining articular reduction, radio-opaque ring obstructing radiological image are the major disadvantages. Though there was an initial poor cosmetic acceptance of the

external fixator in some patients, this was temporary since external fixators were removed once bony union and skin wound healing was complete. Regarding the increased weight of the construct which caused hip pain in few patients, pain alleviation can be done with analgesics and the use of low weight carbon fiber constructs. We recommend that hybrid external fixators for both proximal and distal tibial metaphyseal fracture fixation wherein soft tissue injury and compound wound are the major constraints for internal fixation.

**Conclusion**

In summary, the surgical management of juxta-articular fractures is an orthopedic challenge and needs a comprehensive understanding of fracture, soft tissue, the time interval from injury to surgery and post-operative rehabilitation. Anatomical reduction and stable fixation are very important. Knee and ankle stability are the most important factors for good prognosis including factors like avoidance of soft tissue necrosis, direct and accurate fracture

reduction. The advantages of hybrid external fixators are as mentioned above. It is noteworthy to mention that better functional outcome is achieved earlier in patients treated with hybrid external fixators than in those treated with plating.

**Conflict of interest:** The authors declare no conflict of interest regarding this paper. No funding was received for this study.

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