

Management of periarticular fractures of long bones of the lower extremity by hybrid external fixation

Mayil Vahanan Natarajan, Chethan Nagaraj, R Selvaraj, B Pasupathy, Antony Vimal Raj, P Sankarlingam

Department of Orthopaedic Surgery and Traumatology, Madras Medical College, Government General Hospital, Chennai

Background: Management of periarticular fractures is associated with many complications. Hybrid fixators allows for early partial weight bearing and range of motion exercises at adjoining joints. Furthermore, it promotes callous formation by continuous axial micro movements in the fixation frame.

Methods: We have prospectively analyzed the results of hybrid external fixation in the management of periarticular fractures of long bones of the lower extremity in 20 patients accounting for 22 limbs. We treated 19 fractures (18 compound and 1 closed) and three fracture nonunions with this method. The mean age of the patients was 36.5 years. In 12 patients hybrid fixation was the primary procedure while in 8 patients hybrid fixation was done following initial emergency AO Uniplanar external fixation. Fourteen patients required subsequent surgeries such as bone grafting and soft tissue cover.

Results: The mean follow up of our patients was 13.2 months (5 – 25 months). We achieved excellent results in 10 fractures, good in 4 fractures, fair in 3 fractures and poor results in 3 fractures. Two patients were lost to follow up. Bony union was achieved in 18 of the fractures. A short-term acceptable result was achieved in 17 cases.

Conclusion: Hybrid external fixation is a very effective and useful treatment modality in the management of fractures close to a joint providing excellent to good results. It combines the advantages of both Ilizarov and AO external fixators. It is minimally invasive, modular and yet efficient in promoting massive new proliferative callus formation at the fracture site.

Key-words: Periarticular fractures; Hybrid external fixation.

Introduction

Intraarticular and juxtaarticular fractures usually occur as a result of high-energy trauma in young patients, but in the elderly they can result from a simple fall. The main challenges in the management of such periarticular fractures are:

- i. Compromised skin and soft tissue envelope.
- ii. In the metaphysis, fixation is less satisfactory and early loosening is a frequent event ¹.
- iii. Comminuted fracture patterns, which create difficulty in achieving rigid fixation.
- iv. Associated with extremely damaged soft tissue envelope as well as comminuted metaphyseal region and articular surface, making anatomical reduction difficult ².
- v. Incongruity of articular surface leads on to early secondary osteoarthritis.

Hybrid fixation provides a ligamentotaxis reduction force and maintains this reduction as a neutralization device ^{3,4}. This study was conducted to analyze the results of hybrid external fixation in the management of periarticular fractures of long bones of the lower extremity.

Materials and methods

In a prospective study conducted from March 2002 to September 2004 on 20 patients accounting for 22 limbs for periarticular fractures of long bones of the lower limb, hybrid external fixation was used. Selection criteria included



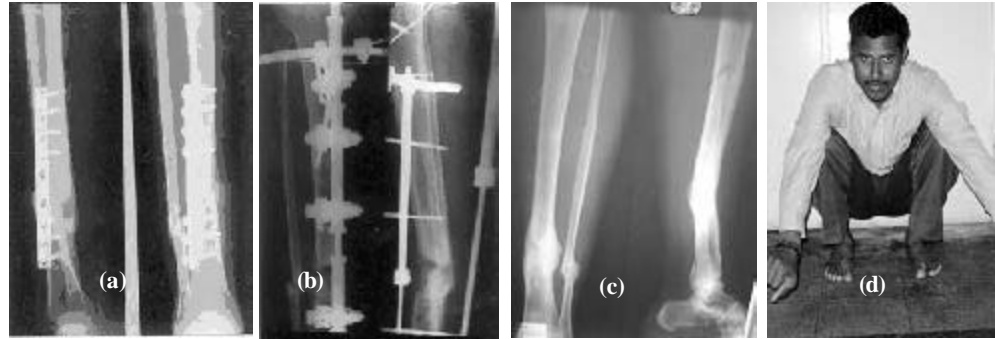
Fig. 1. Details of clamp to post-connection

Mayil Vahanan Natarajan, MS (Orth), D Orth, MCh Trauma (Liverpool), PhD (Orth Onc), DSc (Orth), Professor and Head
Chethan Nagaraj, PG

R Selvaraj, MS (Orth), D Orth, DNB Orth, Assistant Professor
B Pasupathy, MS (Orth), D Orth, DNB Orth, Assistant Professor
Antony Vimal Raj, MS (Orth), Assistant Professor
P Sankarlingam, MS (Orth), D Orth, DNB Orth, MNAMS, Assistant Professor

Mayil Vahanan Natarajan, Professor and Head, Department of Orthopaedic Surgery and Traumatology, Madras Medical College, Government General Hospital, Chennai; Email : drmayil@bonetumour.org

Fig. 2. (a) Non-union of Tibia with plate in situ, (b) Converted to hybrid external fixation, (c) after union, (d) functional status



- i. Compound fractures of distal femur, tibial plateau and plafond.
- ii. Compound segmental fractures of the tibia with either one fracture being juxta articular.
- iii. Closed juxta articular fractures with an acceptable alignment were excluded from our study.

Our patients were in an age range of 15 years to 58 years with a mean of 36.5 years. There were 2 cases of distal femoral fractures, 10 cases of tibial plateau and proximal third fractures, 9 cases of tibial plafond and distal third fractures and one case of segmental fracture of both bones of the leg treated with hybrid external fixation.

There were 18 compound fractures, one closed fracture and 3 fracture nonunions. Out of the 18 compound fractures, 8 fractures were treated with an initial joint spanning AO uniplanar external fixator, one fracture treated with plaster of paris immobilization and 9 fractures treated with primary hybrid external fixation.

The closed injury of tibial plateau in our series was initially treated with calcaneal pin traction. The three cases of fracture nonunions were treated with open reduction and hybrid fixation. Patients with compound fractures treated with initial joint spanning AO external fixation and Plaster of Paris immobilization were subsequently taken up for hybrid external fixation after a period ranging from 10-46 days with a mean of 24 days.

Seven patients had other associated injuries such as an associated fracture shaft of femur fracture, fracture of both bones leg on opposite side, popliteal artery injury, fracture of mandible and distal radius fracture.

Surgical technique: After obtaining fracture site reduction, the metaphyseal fragment was fixed with an Ilizarov full ring of appropriate size (based on the maximum diameter of the limb) with either two or three K wires or olive wires. The K wires were passed keeping with the guidelines of

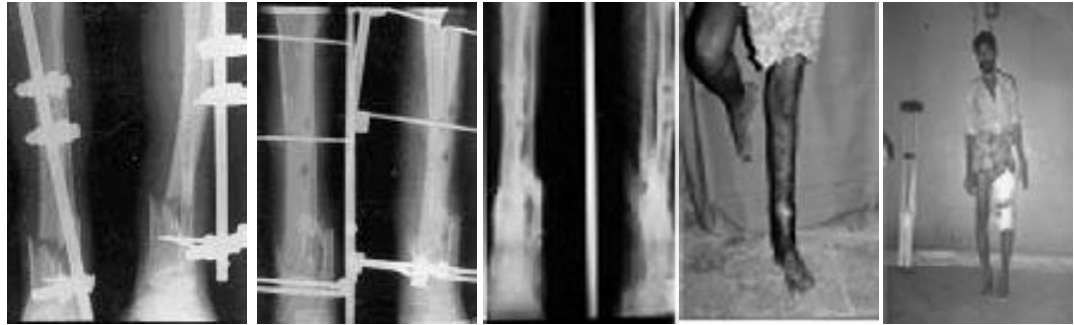
Ilizarov principle⁵. Additional half pins were applied in the metaphyseal fragment when adequate bone stock was available. The fracture site was then reduced and maintaining the reduction, half pins passed in the diaphyseal fragment either in a single plane or in two planes, depending on the stability provided. The half pins were connected to a side bar, which was then connected to the ring. The connection between the ring and the side bar was achieved by a unique technique. The pin holding slot of the adjustable clamp, known as the swivel, was removed and pin was connected to a male post, which was then connected to the full ring. We developed this technique of connecting the Ilizarov ring system and the AO external fixator system at our department. No special clamps have been used (Fig. 1).

Results

Average follow up was 13.2 months (range 5-25 months). Two patients were lost to follow up. The remaining 18 patients accounting for 20 injuries were followed up regularly and evaluated clinically and radiologically for bone union, deformity, infection, and range of motion of adjacent joints, the patient's functional status and other complications. Based on the Ovdia and Beals criteria⁶ we had excellent results in 10 patients, good in 4, fair in 3, and poor results in 3 patients (Fig. 2, 3).

Six patients had grade I pin tract infection (settled with pin site care without necessity for systemic antibiotics) and 4 patients had grade II pin tract infection (required systemic antibiotics in addition to pin site care⁷). All these patients were managed by pin site care and antibiotics and healed completely without any complications. Two patients had delayed bone union and had to be managed with subsequent bone grafting. Implant failure in the form of bent half pins was seen in one patient. We had 2 nonunions, one patient had shortening of the lower limb and stiffness of the adjoining joint, knee and ankle, was seen in 4 patients.

Fig. 3. (a)
Comminuted distal
tibial fracture with
AO fixator,
(b) Converted to
hybrid frame,
(c) After union,
(d) With good
function



Discussion

Most treatment methods for periarticular fractures that are highly successful at obtaining union cannot address all the problems and not certainly at the same time⁸. Barberi et al in their series of 34 tibial plafond fractures treated with limited open reduction and hybrid external fixation had an acceptable result in 28 patients and poor results in 6. This is in concurrence with our series where we have achieved an acceptable result in 17 cases and poor results in 3.

We achieved bony union in 18 out of the 20 cases followed up and 2 cases of fracture nonunion. Rate of nonunion is less in other reported series^{4,9,10}. We had an average bone union time of 7 months, compared to 4.2 months in the series by Tornetta et al¹² and 4 months in the series by Barberi et al⁹. Our failure to perform bone grafting may have contributed to longer healing times. However keeping in mind that most of our cases are compound fractures, the delay in union time is acceptable in comparison to other studies, where closed fractures form the majority.

The nonunion in our study was due to persistent infection and failure to achieve accurate fracture site reduction and adequate compression. The increased incidence of pin tract infection in our series was probably due to inadequate pin site care by the patients once they were discharged. We have had 4 cases of stiffness in the adjoining joints. The probable causes of stiffness being failure to position the limb in correct position during insertion of the metaphyseal K wires, delay in taking up for hybrid fixation and poor compliance of the patients.

Shortening which resulted in functional difficulty was seen in one patient in our series. The cause of shortening was the initial comminution at the fracture site and bone loss, accentuated by compression at the fracture site.

Hybrid fixation is useful in management of intraarticular fractures as it is minimally invasive, provides greater preservation of soft tissues and there is better anchorage of thin wires than of half pins in cancellous bone¹. It can be

combined with lag screws. The construct is less heavier than Ilizarov ring fixators¹³. There is greater ease in spanning diaphyseal fracture lines than do plating devices¹. Early postoperative joint movement can be started.

References

1. Tencer AF, Johnson KD. *Biomechanics in Orthopaedic trauma*. 1st edition, Lippincott, 1994.
2. Lerner A, Stein H. Hybrid thin wire external fixation: an effective, minimally invasive, modular surgical tool for the stabilization of periarticular fractures. *Orthopaedics*. 2004, 27, 59 – 62.
3. Wood GW II. General principles of fracture treatment. In: *Campbell's Operative Orthopaedics*. Mosby. 10th edition, 2003; 2671 – 2723.
4. Watson JT, Ripple S, Hoshaw SJ, Fyhrie D. Hybrid external fixation for tibial plateau fractures. *Orthop Clin North Am*. 2002, 33, 199 – 209.
5. Catagni M, Benedetti GB, Argnani F. A.S.A.M.I Group, Fractures of the leg (tibia) and Fractures of the femur. In *Operative principles of Ilizarov*. Williams and Wilkins. 91 - 145.
6. Ovidia DN, Beals RK. Fractures of tibial plafond. *J Bone Joint Surg (Am)*. 1986; 68, 543 - 551.
7. McNally MA, Catagni MA. *Oxford's textbook of Orthopaedics*. 1735 – 1748.
8. Farrar M, Yang L, Saleh M. The Sheffield Hybrid fixator – a clinical and biomechanical review. *Injury*; 2001, 32, 8 – 13.
9. Barbieri R, Schenk R, Koval K, Aurori K, Aurori B. Hybrid external fixator in the treatment of tibial plafond fractures *Clin Orthop*. 1996; 332:16-22.
10. Marsh JL, Smith ST, Do TT. External fixation and limited internal fixation for condyle fractures of tibial plateau. *J Bone Joint Surg (Am)*. 1995; 77: 661-673.
11. Pugh KJ, Wolinsky PR, Dawson JM, Stahlman GC. The biomechanics of hybrid external fixation. *J Orthop Trauma*. 1999 Jan;13(1):20-6.
12. Tornetta P 3rd, Weiner L, Bergman M, Watnik N, Steuer J, Kelley M, Yang E. Pilon fracture: Treatment with combined internal and external fixation. *J Orthop Trauma*. 1993;7(6):489-96
13. Yilmaz E, Belhan O, Karakurt L, Arslan N, Serin E. Mechanical performance of hybrid external Ilizarov fixator in comparison with Ilizarov circular external Fixator. *Clin Biomech*. 2003; 18, 518–522.
14. Karunakar MA, Bosse MJ. Principles of external fixation. In *Rockwood and Green's Fractures in adults*. Lippincott Williams & Wilkins. 2001; 5th edition, Chapter 7, No 231 – 245.