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ORIGINAL STUDY

Hybrid external fixation in periarticular tibial fractures Good final outcome in 56 patients

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Out of 65 patients with periarticular fractures of the tibia treated by use of hybrid external fixation (a combination of indigenously manufactured version of ring and AO tubular fixator) from February 1997 to October 2003, 56 cases were taken up for this study with a minimum follow-up of 12 months. The injury was due to a high-velocity motor vehicle accident in 49 and a fall in 7 patients. Thirty five were tibial plateau fractures and 21 were distal tibial plafond fractures. Forty eight were compound fractures and eight were closed. They were treated by debridement (48 compound) and hybrid external fixator (n = 56). All the patients were assessed clinically and radiographically for an average follow-up of 42.5 months (range : 12 to 67). In tibial plateau fractures (n = 35), the final outcome was good to excellent in 30, fair in 2 and poor in 3. In tibial plafond fractures (n = 21), results were good to excellent in 16, fair in 3 and poor in 2. We recommend the use of hybrid external fixator for periarticular tibial fractures occurring due to high-energy trauma. In addition, rates of complications as seen with other modalities of fixation are greatly reduced. It facilitates adequate care of associated soft tissue injuries.

Keywords : tibia ; periarticular fractures ; tibial plateau ; tibial plafond ; hybrid external fixation.

INTRODUCTION

Intraarticular fractures of the tibial plateau and tibial plafond, especially caused by high-energy trauma, pose a therapeutic dilemma. Such fractures are usually associated with extensive soft tissue damage with or without compounding. The management of such high-velocity injuries becomes a challenge to the trauma surgeons. The goals of management of these periarticular fractures are : restoration of joint congruity by anatomic reduction of the articular fragments, stable fixation of fragments thus allowing early joint movements, and proper care of injured soft tissues. Various authors have reported their results following open reduction and extensive internal fixation with high rates of wound problems, infection and other major complications (*2, 3, 14, 17*). In earlier days, uniplanar external fixations were used with very high rates of pin-tract complications (*4*). These fixators require placement of pins across the adjacent joints, thus causing joint stiffness. Recently, great emphasis has been laid on limited internal fixation supplemented with external fixation of the periarticular fractures (*5*).

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We present the use of a ring external fixator using small diameter tensioned transfixion wires, combined with a tubular external fixator in a hybrid mode in high-energy periarticular fractures of the tibia. The purpose of this study was to assess the utility of this hybrid arrangement and to analyse the results vis-à-vis functional outcome, soft tissue healing and fracture union.

PATIENTS AND METHODS

From February 1997 to October 2003, 65 cases of periarticular fractures of the tibia were treated by use of a combination of an indigenously manufactured version of ring external fixation and AO tubular fixator (Hybrid fixator) in a prospective study. A total of 56 cases were available for study with minimum follow-up of 12 months ; 4 cases were lost to follow-up. Thirty five were tibial plateau fractures, 21 involved the distal tibial plafond, 48 were compound fractures and 8 were closed.

There were 6 Type-I, 12 Type-II, 27 Type-IIIA and 3 Type-IIIB open fractures according to the Gustilo-Anderson Classification (*7*). Fibula fracture was seen in 38 patients (67.9%). Proximal tibial plateau fractures were classified according to the Schatzker classification (*16*) and distal tibial plafond fractures according to the Ruedi and Allgöwer classification (*13*).

The majority of the cases (n = 49) had sustained injuries in road traffic accidents (high velocity) whereas 7 were due to falls.

Proximal Tibial fractures

Compound fractures were treated with immediate debridement and hybrid external fixator. Closed fractures were initially treated with elevation and splintage to allow for subsidence of soft tissue swelling for 5-7 days ; subsequently fractures were treated by application of hybrid external fixation. Articular congruity was achieved by elevating the depressed fracture fragments percutaneously under fluoroscopic control. Proximal small periarticular fragments were fixed with two to three 1.8 mm transfixion wires, duly tensioned and fixed with 2/3^{rds} ring. The first K-wire was passed, transfixing fibula with tibia. Olive wires were used to reduce and compress the fragments together. The distal fragment was fixed with three 5.0 mm Shanz pins. These pins were connected with 2-3 tubular rods which were ultimately connected to the ring frame. Reduction of the metaphysis to the diaphysis was achieved by indirect reduction technique, using the fixator. The whole frame was finally tightened (figs 1 to 5).

Tibial Plafond Fractures

All the 21 distal tibial plafond fractures were compound. After thorough wound debridement, the different fracture fragments were reduced and articular congruity at the distal articular surface was achieved. In those intraarticular fractures (n = 5) where the overlying skin was healthy, the fibular fracture was internally fixed with a one-third tubular plate. The distal tibial fragment was fixed first with 1.8 mm K-wires. The first K-wire was passed posterolaterally through the distal fibula and

Fig. 1. — Preoperative radiograph showing a complex intra-articular fracture of the proximal tibia.

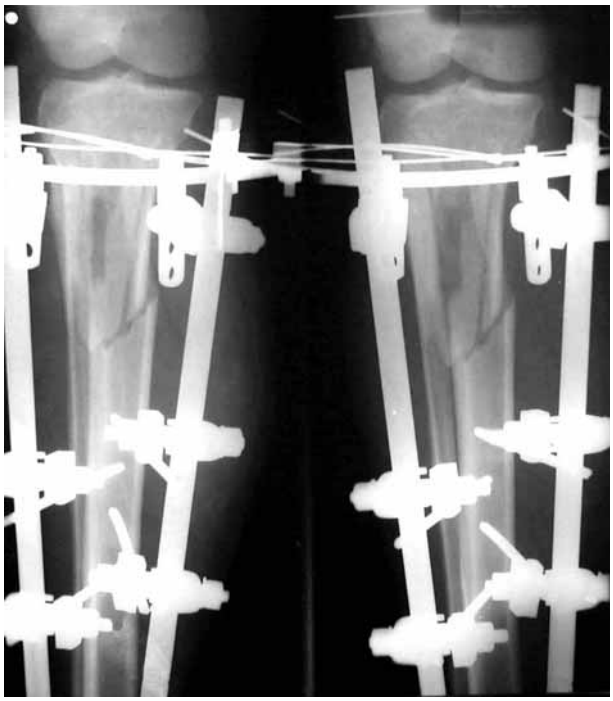

Fig. 2. — Immediate post-operative radiograph of the same case showing the hybrid fixator *in situ*.

Fig. 3. — Follow-up radiographs of the same case after 46 months, depicting consolidation of the fracture.

exiting anteromedially through the tibia. Two more K-wires were passed through the distal fragment. All the K-wires were tensioned and fixed with a 2/3^{rds} circular ring frame. The proximal fragment was fixed with three 5.0 mm Shanz pins and attached with a tubular rod through clamps. The two frames were interconnected in a hybrid configuration with an indigenously manufactured AO type single universal adjustable clamp through 2-3 tubular rods. Reduction of the metaphyseal fracture was achieved by using the fixator as an indirect reduction device and the whole frame was finally tightened.

The wound was sutured primarily in 18 compound cases. In 27 cases, delayed primary closure was done. In three IIIB fractures, a skin graft (n = 1) or a myocutaneous flap (n = 2) were used. Passive and active range of motion exercises in the ankle were started early after 2-3 days post-operatively, whereas in the knee joint, range of motion (ROM) exercises were started after 1-2 weeks post-operatively. In grossly comminuted tibial plateau fractures, movements were started after three weeks post-operatively.

Non-weight bearing crutch walking was continued up to 10-16 weeks. Partial weight bearing was started 10-12 weeks postoperatively (average : 10.8 weeks) in distal tibial fractures and 11-16 weeks postoperatively (average : 12.5 weeks) in proximal tibial fractures. Full weight bearing was advocated 14-24 weeks postoperatively. All the patients were followed-up and evaluated both clinically and radiographically. Clinically in proximal tibial fractures, the final outcome was evaluated using the Knee Society clinical rating system (*8*). In tibial plafond fractures, results were evaluated by functional criteria which included assessment of pain, range of motion and swelling (*17*) (table I).

Follow-up ranged from 12 months to 67 months (mean : 42.5 months).

Fig. 4. — Post-operative radiograph of another case demonstrating a hybrid fixator in a case of intra-articular fracture of the proximal tibia.

Fig. 5. — Follow-up radiographs of the same case after 36 months showing complete union of fracture.

RESULTS

The characteristics of the study group are given in table II. The majority (n = 38) were males with an average age of 39.4 (18-66) years.

Tibial plateau fractures

The fracture healed in all cases except two in which non-union occurred. These were treated by freshening of the bone ends, open reduction and internal fixation with a buttress plate and bone grafting, resulting in union. Healing of the fracture was assessed clinically by stability without pain and roentgenographically, by the evidence of bridging callus. The average time to healing was 20.5 weeks post-operatively (range : 13 to 48).

The fixator was removed after wound healing and radiographic evidence of bridging callus i.e. 7-19 weeks (average : 10.6 weeks). A patellar tendon bearing cast was applied for 4-6 weeks in tibial plafond fractures. In tibial plateau fractures, an above-knee POP cast was applied for 4-6 weeks and partial weight bearing crutch walking was advocated.

Pin tract infection occurred in 8 patients. In 5 patients, superficial infection resolved with pin tract care and oral antibiotics. In 3 cases osteomyelitis developed, which was treated by debridement, sequestrectomy and antibiotic-impregnated polymethylmethacrylate.

Knee range of motion ranged from 0°-130° to 15°-90° (average : 5°-103°). In 6 cases, varus malunion of 5°-15° (mean : 7.4°) occurred. However, functionally the knee range of motion was unaffected. Early weight bearing by the patient

Table I. — Functional evaluation criteria for tibial plafond fractures

Rating	Clinical features			
	Pain	ROM	Gait	Swelling
Excellent	No	Normal	Normal	No
Good	Minimal	75% of normal	Normal	Trivial
Fair	Aching with use (NSAID use required)	50% of normal	Normal	Mild
Poor	Pain with walking or rest	50% of normal or less	Limp	Gross

Abbreviations : ROM – Range of Motion
NSAID – Non Steroidal Anti-Inflammatory Drugs.

Table II. — Population Study demographics

Age		
	Years	No.
	18-35	25
	36-45	17
	46-55	10
	> 55	4
Sex		
	Males	45
	Females	11
Fracture categorisation		
	Compound	48
	Type I	6
	Type II	12
	Type IIIA	27
	Type IIIB	3
	Closed	8
	Proximal tibial plateau	35 (Cl.-8, Com.-27)
	Distal tibial plafond	21 (Cl.-0, Com.-21)

Abbreviations : Cl. – Closed
Com. – Compound.

was the main reason for varus malunion. The final outcome was good to excellent in 30 (85.7%) patients, fair in 2 (5.7%) and poor in 3 (8.6%).

Tibial Plafond fractures

Fracture healing occurred in 11-27 weeks (average : 18.7 weeks). The fixator was removed after 10-30 weeks (average : 16.4 weeks). A patellar tendon bearing POP cast was applied for 4-6 weeks after fixator removal.

Fracture union occurred in all cases. Delayed union was seen in 3 cases, which ultimately healed on protected full weight bearing for a prolonged period of 6-8 weeks.

Superficial pin tract infection was found in 5 cases ; it was managed with pin tract care and oral antibiotics for a short period. Two cases had deep infection managed by debridement, sequestrectomy and antibiotics. Early removal of the fixator because of infection was not required.

The ankle range of motion was found to be dorsiflexion 0°-20° (average : 7.4°) and plantar flexion 20°-40° (average : 25.4°). Varus malunion of 5°-10° (mean : 6.5°) was seen in 5 cases.

On final outcome assessment, 16 (76.2%) had good to excellent, 3 (14.3%) fair and 2 (9.5%) poor results.

DISCUSSION

Periarticular fractures of tibia, especially compound injuries, are complex problems. Management of these fractures is difficult and varies from surgeon to surgeon. Such injuries are usually associated with soft tissue injury and marked comminution of articular surfaces.

Use of transarticular fixators in periarticular fractures may lead to joint stiffness, thus affecting the ultimate functional outcome. Uniplanar external fixators do not provide stability to the comminuted fractures.

The goal of surgical treatment of these periarticular fractures is to provide stable fixation, thus allowing early joint motion, and to obtain articular congruity. Early joint motion is probably the single most important factor in promoting cartilage nutrition and healing (*15*). Ruedi and Allgower in 1973 (*13*) and Schatzker in 1988 (*16*) advocated open reduction and internal fixation for high-grade tibial plateau and plafond fractures respectively, which necessitated extensive soft tissue stripping for adequate exposure. However, such procedures were associated with a high incidence of complications such as non-union, wound dehiscence and infection (*9, 10, 19*).

In our study, 35 cases of tibial plateau and 21 cases of tibial plafond fractures were treated by hybrid external fixation. The use of olive wires from opposite directions helped in achieving interfragmentary compression and articular congruity. In addition, use of a ring in the periarticular area helped in achieving stable fixation, thus allowing early joint motion. This helped in achieving good to excellent clinical outcome. In the present study, good to excellent results were seen in 86% of tibial plateau fractures and 76% of tibial plafond fractures. These results are comparable to those in the scarce studies on the hybrid fixator reported in the literature (*1, 6, 12, 18*). The use of small diameter K-wires with the circular frame near the joint reduces the complication rate, especially pin tract infection. Loosening of the wire resulting in loss of stability was not seen in our study. The combination of a ring frame with a tubular frame does not affect the stability of the construct (*11*). Such hybrid combination helps in achieving articular congruity besides providing stable fixation, which allows for early movements of joints.

Few hybrid external fixation systems are commercially available ; they are very expensive and are not easily available. Thus in a Third World country like India, such a system is beyond the reach of the poor patients. In this study, we have used a combination of indigenously manufactured Ilizarov type ring fixator with an AO type tubular fixator using a universal single adjustable clamp of AO type. Such frame is versatile, easy to use and economically within the reach of poor patients.

Hence we suggest use of a hybrid configuration of the external fixator for periarticular tibial fractures, especially resulting from high-energy trauma.

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