



Indirect reduction and hybrid external fixation in management of comminuted tibial plateau fractures

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The aim of the present study is to assess the results of indirect reduction and hybrid external fixation in management of comminuted tibial plateau fractures. The study included 28 patients with high-energy tibial plateau fractures (Schatzker type V and VI). The ages ranged from 22 to 58 years with an average of 35 years. The trauma was a road traffic accident in 16 cases and a fall from a height in 12 cases. Concomitant soft tissue injuries were present in 18 cases such as skin wounds in 6 cases, excessive swelling with skin blisters in 9 cases, and compartment syndrome in 3 cases. After clinical and radiological evaluation all the patients were treated by indirect reduction using a traction table and a hybrid external fixator. The average time to healing was 3.2 months. At the final follow-up the range of knee movement ranged from 0°-140° with an average of 110°. The results were satisfactory in 23 cases and unsatisfactory in 5 cases according to the Rasmussen knee functional score. Complications included pin tract infection in 12 cases, an extension lag in 2 cases, varus deformity of about 15° in one case, deep infection in one case and early osteoarthritic changes in 2 cases. Hybrid external fixation is a good method for treatment of comminuted tibial plateau fractures. It allows for early joint movement and reduces the risk of serious complications.

Keywords: tibial plateau fractures ; hybrid external fixator ; indirect reduction.

INTRODUCTION

Tibial plateau fractures involve a wide spectrum of injuries that range from simple split to highly comminuted fractures with metadiaphyseal dissociation (12). High energy tibial plateau fractures are usually associated with significant soft tissue damage that limits the lines of management and adversely affects the final outcome. Open reduction and internal fixation of such fractures carries the risk of a high complication rate such as infection and skin breakdown. The rate of poor results increases with a growing complexity of the fracture and the worst prognosis is observed in Schatzker type VI lesions (18,3). Indirect reduction and external fixation has been advocated by many authors to improve the results and to minimise the risk of serious complications (10,4,8).

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The aim of the present study is to assess the results of indirect reduction and hybrid external fixator in the management of comminuted tibial plateau fractures.

PATIENTS AND METHODS

Between March 2005 and May 2009, 28 patients with comminuted tibial plateau fractures were treated in our institution by indirect reduction and hybrid external fixator. All the patients gave informed consent before being included into the study. Ages ranged from 22 to 58 years with an average of 35 years. Three were females and 25 were males. The mechanism of injury was a road traffic accident (RTA) in 16 cases and a fall from a height (FFH) in 12 cases. The fractures were closed in 22 cases and open in 6 cases. The open fractures were Gustilo-Anderson type II in 4 cases and type III in 2 cases (5). Ten fractures were Schatzker type V and 18 cases type VI. Concomitant soft tissue injuries were present in 18 cases such as wounds of open fractures in 6 cases, excessive swelling with skin blisters in 9 cases and compartment syndrome in 3 cases. Associated injuries were present in 6 cases which included an ipsilateral fracture of the femur in 3 cases, a stable pelvic fracture in one case and a fracture of the contralateral calcaneum in 2 cases. Computed tomogram (CT) was done in all cases to assess the degree of comminution, the amount of depression and to detect the main fragments through which the screws could be inserted. The time elapsed between trauma and surgery ranged from a few hours to 20 days with an average of 4 days. All cases were treated by indirect reduction, minimal internal fixation and hybrid external fixator. After induction of anaesthesia, the patient was placed on an orthopaedic table and traction was applied to help indirect reduction by ligamentotaxis. The reduction was assessed by fluoroscopy and if not conclusive by radiography. The depressed fragments were elevated through a limited incision and the resultant defects were filled with synthetic bone grafts in 5 cases and autogenous bone grafts in 4 cases. When the reduction was satisfactory (less than 5 mm depression with no varus or valgus angulation) two or three cannulated screws were inserted to restore the articular surface. The hybrid external fixator was then applied to fix the fracture. Three wires were inserted in the proximal fragments and fixed to a 2/3 ring: one transverse wire, one transfixing the head of the fibula and one from anterolateral to posteromedial to form a triangle of fixation in the proximal fragments (Fig. 1A). The wires were inserted

about 1.5 cm distal to the articular cartilage to avoid septic arthritis in case of pin tract infection. Three half pins were inserted in the tibial shaft and fixed to a tubular bar. Then alignment was adjusted and the bar fastened to the 2/3 ring. At this point the traction was released and the quality of reduction was re-assessed. If there was further depression or loss of reduction; additional wires or screws were added to support the flail fragments. Only image intensifier and radiography were used to control surface reconstruction; arthroscopy was never used.

Another bar was added antero-medially to increase the stability of fixation and to avoid varus collapse of the fracture. The 6 open fractures were treated by urgent wound debridement and fixation of the fracture. The 3 cases with compartment syndrome had an urgent fasciotomy and application of the frame. Continuous passive motion (CPM) was started the second post operative day for three days, and then active range of movement was encouraged. The patients were followed regularly in the outpatient clinic where they were checked for range of knee movement, signs of pin tract infection, quality of reduction and evidence of bone healing. Progressive weight bearing was allowed once healing was evident on radiography. Before removal of the frame, the clamps were loosened and bone union was checked clinically. The fixator was removed after an average of 12 weeks.

Fourteen patients had their frames removed under general anaesthesia while the others had their frames removed in the out patient clinic under local anaesthesia that was infiltrated around the half pins. Cast brace was applied in 3 cases in which the frame was removed prematurely due to noncompliance of the patients with the frame. Physiotherapy was continued after removal of the frame to improve range of knee movement.

RESULTS

Hospital stay ranged from 6 to 25 days with an average of 11 days. The fractures healed in all cases. The time to healing ranged from 2 months to 4.5 months with an average of 3.2 months. The follow-up period ranged from 16 months to 42 months with an average of 27 months. After removal of the frame an extension lag was a common finding. It was observed in 17 cases; most of them improved with physiotherapy and only 2 patients had persistent extension loss of about 10°. At the final follow-up, the patients were asked to answer a questionnaire regarding the level of pain and the walking

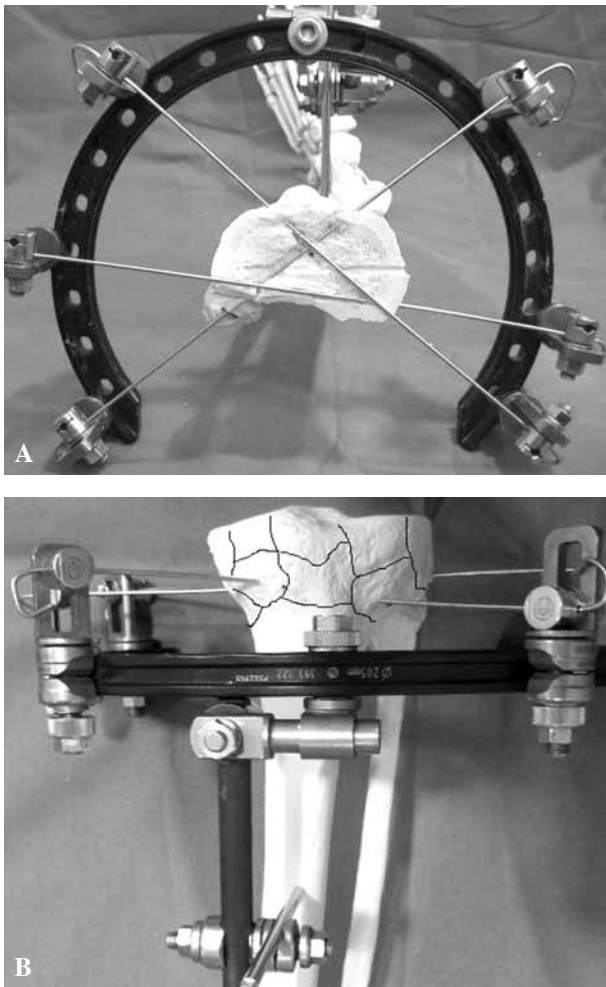


Fig. 1. — The three wires are inserted one transverse, one transfixing the fibular head and one from antero-lateral to postero-medial to form a triangle of fixation in the proximal tibial metaphysis (A) and to prevent collapse of the articular fragments (B).

capacity. Also stability of the knee and range of motion were noted and radiology checked overall alignment of the limb and signs of secondary osteoarthritis (OA). The range of knee movements ranged from 0°-140° with an average of 110° (Fig. 2). Two patients had a positive anterior drawer test but they did not show functional instability. No cases had medio-lateral instability.

The results were evaluated according to the Rasmussen (11) knee functional score. According to this scoring system the results were excellent in 5 cases, good in 18 cases, fair in 4 cases and poor in

one case. Complications included pin tract infection in 12 cases (three of them required removal of the infected pins and the others improved with local treatment and a short course of systemic antibiotics), varus deformity of about 15° in one case, deep infection over the synthetic bone graft in one case (treated by debridement and removal of the graft) and early secondary osteoarthritis in 2.

No cases were complicated by deep venous thrombosis, skin breakdown or nonunion.

DISCUSSION

Comminuted tibial plateau fractures are difficult to treat. Residual morbidity is common after these injuries. The final outcome depends on many factors which include: the amount of damage to soft tissues and articular cartilage, the accuracy of reduction, the stability of the knee joint, the stability of fixation and the overall alignment of the limb (2,11,14,16,17). The first variable is not under control while the others can be controlled. Many options are available for the management of such fractures. Open reduction and internal fixation has the advantage of an accurate reduction and stable fixation but it carries the risk of further soft tissue damage and infection. A single, midline incision provides a convenient approach to dual plating of these fractures. However, the amount of soft tissue dissection needed to adequately expose the fracture through this approach devitalises comminuted bone fragments and produces what is known as the dead bone sandwich with a high complication rate. Deep infection rate has been reported to be as high as 73% to 80% (18,19). The use of dual incision led to a significant reduction of soft tissue complications but deep infection was still reported in 13.8% of the cases (15). The less invasive stabilisation system (LISS) is recently used for the management of comminuted tibial plateau fractures. Although less invasive, the risk of deep infection and soft tissue complications is still present. Lee *et al* (9) reported on 36 tibial plateau fractures treated with the LISS system. Two of them had deep infection and one had extended skin necrosis and required plastic surgery. A locked plate at the lateral side does not prevent the development of a varus collapse of the

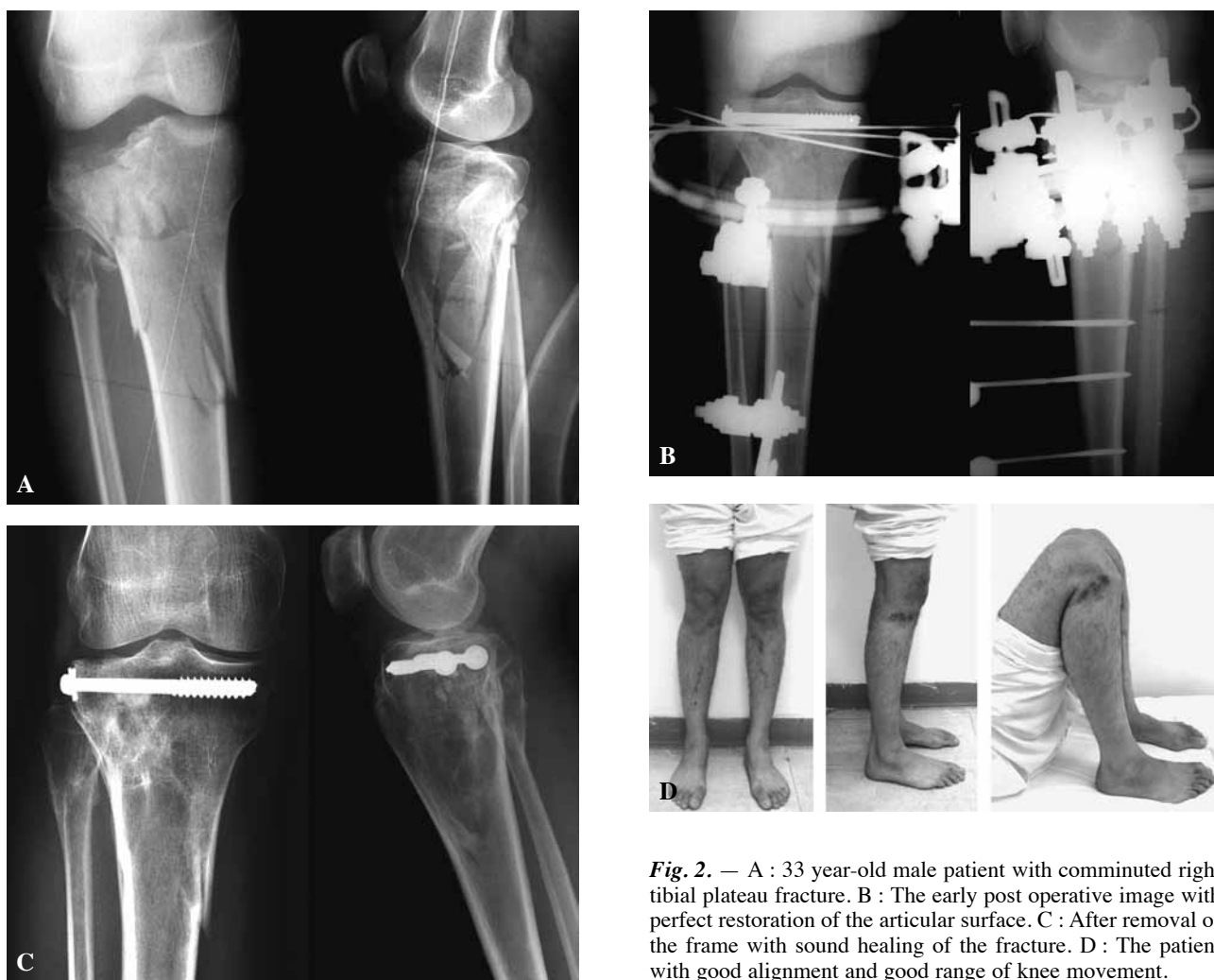


Fig. 2. — A : 33 year-old male patient with comminuted right tibial plateau fracture. B : The early post operative image with perfect restoration of the articular surface. C : After removal of the frame with sound healing of the fracture. D : The patient with good alignment and good range of knee movement.

fracture over time (6,13). Furthermore, the cost of the locked plates is a concern and their removal after fracture healing is a significant problem (7).

In this prospective study 28 patients with comminuted tibial plateau fractures were treated by indirect reduction, minimal internal fixation and hybrid external fixator. We used a traction table with support under the thigh to achieve indirect reduction by ligamentotaxis. It is a simple method and it allows for easy application of the frame and easy fluoroscopic monitoring during surgery (Fig. 3). The thin tensioned wires produce good grip in the small proximal bone fragments and achieve relative stability that allows for early joint movement. The triangle of fixation formed by the

three tensioned wires in the proximal tibial metaphysis supports the articular surface and prevents further collapse (Fig. 1B). We recommend the triple mode of fixation ; three wires for the proximal fragment and three half pins for the distal fragment. This produces good stability and if one pin or wire got infected, it could be removed and the remaining wires would provide sufficient fixation.

The soft-tissue envelope is important in fracture surgery to the extent that the injury should be thought of as a soft-tissue injury with a bony disruption. The tactic of management should always take into consideration the soft-tissue envelope, from skin to capsule to ligaments, and finally bone (11). External fixation is a good method for the early



Fig. 3. — The traction table with support under the thigh allows for indirect reduction by ligamentotaxis, easy fluoroscopic monitoring and easy application of the frame.

management of such fractures with compromised soft tissue condition. Most of our cases (64%) had a poor soft tissue condition and they were operated without waiting to allow for early soft tissue recovery. Once the fracture was reduced and the fixator applied the skin and soft tissue condition started to improve. Most of the authors who had good results with internal fixation of such fractures have used the external fixator as a preliminary step to help soft tissue healing before internal fixation (1,15). We prefer to use the external fixator as a definitive line of treatment and to avoid exposure to another surgery. We found that the age of the patient, the timing of surgery and the accuracy of reduction directly affected the final outcome. Of the five cases with unsatisfactory results in our study, three were older than 50 years and two had residual depression of more than 5 mm (they were operated more than 14 days after the trauma). Late interference makes the reduction more difficult. Pre-existing arthritic changes with old age may be responsible for poor results. We have only one case of deep infection (3%). It was related to the use of synthetic bone graft and was treated by debridement and removal of the graft. The varus deformity that occurred in one of our cases was due to a premature removal of the frame and the patient refused surgery to correct the deformity. One of the advantages of the hybrid external fixator is that it is less bulky than the Ilizarov external fixator. The main disadvantage of the frame is that it does not easily allow for bridging of the knee joint and it does not allow for

precise radiological evaluation of the reduction and bone healing, as the radio-opaque wire-clamps hide the bone especially in the lateral view. Different oblique views must be taken to overcome this problem.

CONCLUSION

Indirect reduction and hybrid external fixation is a good method for the management of complex high-energy tibial plateau fractures. It minimises the risk of soft tissue damage and reduces the incidence of serious complications. In this study we stressed some technical points which include : the ability to use a traction table to achieve indirect reduction and to facilitate application of the frame, the triple fixation for each fragment to improve stability and the arrangement of the wires in the proximal fragment to support the articular fragments.

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