Chapter 3

Unicondylar Tibial Plateau Fractures

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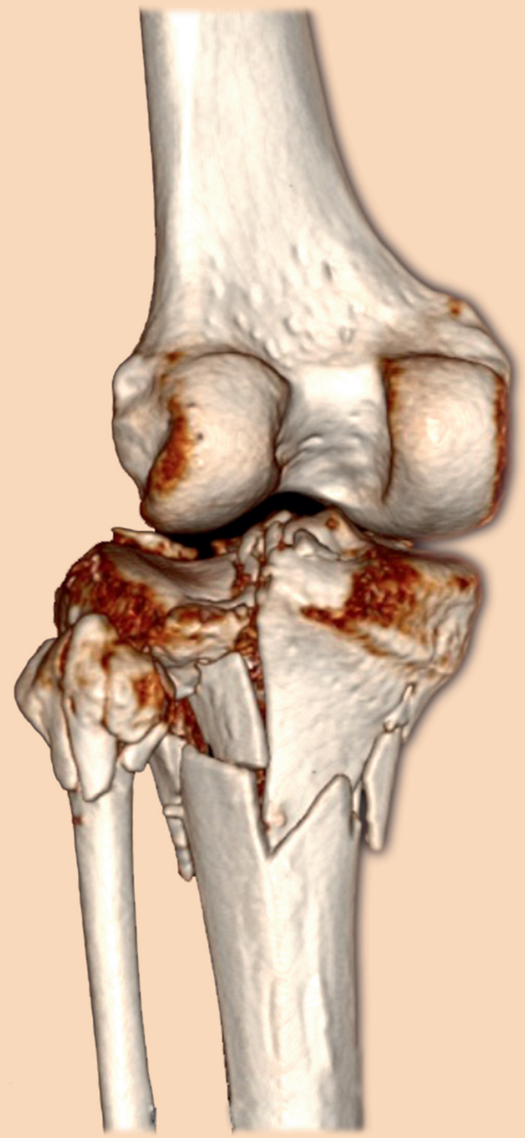


3 Unicondylar Tibial Plateau Fractures

Introduction

Tibial plateau fracture commonly occurs in road traffic accidents and sports injuries. These fractures are intra-articular and hence their fixation is an important issue. The spectrum of associated injuries, potential complications, and outcomes vary with fracture pattern. Various methods of fixation of tibial plateau fractures are presently in use, but proper analysis of fracture pattern is essential before selecting a particular method. Accurate determination of fracture pattern, as well as soft-tissue injury, is necessary when developing a treatment plan.

The classification of intra-articular proximal tibial fractures originally proposed by Hohl, and later modified by Moore and Hohl, was commonly used to describe tibial plateau fractures.[1,2] However, Schatzker classification continues to be mainstay to assess, plan the surgery, and decide about implant and their placement.[3] Anteroposterior (AP), lateral, and oblique X-rays and CT are necessary to evaluate these fractures. An assessment of the degree and the size of depressed articular fragments may be possible only with conventional or computed axial tomography. Often the classification of the fracture made from standard X-rays is changed to another type after the CT is evaluated. MRI is rarely indicated and should be done in cases where ligament injuries or other soft-tissue injuries are suspected along with fracture of the tibial plateau. Whatever the injury, the damage to the joint usually is more extensive than the X-rays indicate. Hence, routine CT scan should always be performed in tibial plateau fractures. The unicondylar tibial plateau fractures include Schatzker Types I, II, III of lateral tibial condyle and Type IV fracture of medial condyle of tibia (**Fig. 3.1**).

However, recent experiences have illustrated the importance of coronal plane fractures, which are only visible on the lateral X-ray or CT scans. If displaced fractures in the coronal plane are not addressed, they may lead to unstable fixation with poor results. The posterior shearing tibial plateau fracture has been underappreciated previously. It is an uncommon injury and

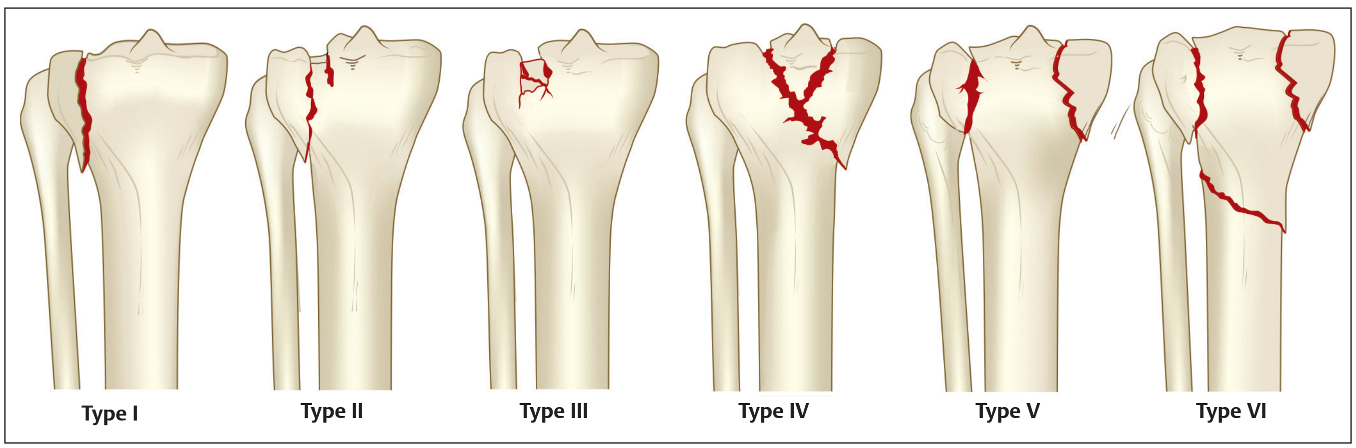


Fig. 3.1 Diagrammatic representation of Schatzker classification.

appears confusing on initial X-rays. For example, the AP X-ray shows little displacement. However, accurate analysis of the lateral film and the routine use of CT clarify the significance of the posterior fracture components, which might affect only one of the tibial condyle—either medial or lateral.

The soft-tissue injury and its meticulous assessment along with cruciate and collateral ligament injury and other comorbidities should be checked intraoperatively and during the planning of surgical treatment. In all tibial plateau fractures, displaced or undisplaced, one must suspect soft-tissue injury and hence pre- and postfixation stress testing is important.[4] This technique can aid in the diagnosis of collateral and cruciate injuries. Similarly, bony avulsions of anterior cruciate ligament (ACL) should be repaired at the time of surgery.

Mechanism of Production of Fracture

Commonly, lateral tibial condyle is fractured mainly because of valgus strain on the knee with intact soft tissues on the medial side of knee resisting separation of tibio-femoral condyles. The lateral femoral condyle depresses the weight-bearing lateral tibial condyle and central portion because of downward force, many times damaging the lateral margin of lateral tibial plateau with longitudinal extension of the fracture into the metaphysis. This fragment is large and looks triangular in shape with apex downwards with intact head of fibula. However, infrequently, lateral tibial plateau fracture is associated with fracture neck of the fibula, especially in Type III fractures with central depression.

Management

Goals of treatment of proximal tibial articular fractures include restoration of articular congruity, axial alignment, joint stability, and functional motion. If operative treatment is chosen, fixation must be stable enough to allow early mobilization, without any wound complications. Management of the unicondylar fractures of tibial plateau fractures includes Types I, II, III of lateral tibial condyle and Type IV of medial condyle of tibia. **Flowchart 3.1** shows the approach to management in case of proximal tibia fracture (unicondylar).

Flowchart 3.1

Proximal Tibia Fracture (Unicondylar)

↓

Evaluation by X-ray

↓

Schatzkar I | Schatzkar II | Schatzkar III | Schatzkar IV

Evaluation by 3D reconstruction CT for better delineation of fracture and associated injuries

Lateral meniscus tear	Lateral and medial meniscus tear MCL injury	Joint instability	Tibial spine, ACL, LCL, peroneal nerve, popliteal artery

- **Schatzkar I** → Lateral meniscus tear (91%)
  - No → Lateral fixation
  - Yes → Arthroscopy and lateral fixation
- **Schatzkar II** → Elevation of depressed fragment, lateral fixation +/- BG
- **Schatzkar III** → Elevation of depressed fragment, lateral fixation + BG
- **Schatzkar IV** → Tibial spine fixation if displaced > 5mm medial plating/dual plating address ACL injury

Types I, II, III Fractures of Lateral Tibial Condyle

Type I of lateral split fractures (pure cleavage) can be reduced percutaneously using traction and reduction forceps under arthroscopic or fluoroscopic control. If the displaced rim of the condyle cannot be reduced into a supporting position under the femoral condyle using closed manipulation, then open reduction is required. If the lateral condylar fracture is associated with a fibular head fracture, a lateral buttress plate provides additional stability. X-rays (**Figs. 3.2A–E; 3.3A, B; 3.4A, B; 3.5A, B; 3.6A–C; 3.7A–D; 3.8A, B**) show treatment of Types I, II fractures by different techniques.

In Type II fractures, cleavage is combined with depression fracture. A lateral wedge is split off and the articular surface is depressed down into the metaphysis. This tends to occur in older people. If the depression is more than 5 to 8 mm or instability is present, such fractures should be treated by open reduction, elevation of the depressed plateau "en mass," bone grafting of the metaphysis, fixation of the fracture with cancellous screws, and buttress plating of the lateral cortex.

All depressed tibial plateau fractures (II and III) require reduction by elevating the fragment usually through the cortical window created on the medial side at metaphyseo–diaphyseal region since it cannot be reduced simply by any traction. After elevation the void created should be supported by bone grafting and stabilized by cancellous and buttress plate. The reduction should be performed by arthrotomy and submeniscal approach. We have successfully achieved reduction under fluoroscopic control or arthroscopically assisted technique with support to the elevated lateral tibial plateau by bone graft/bone graft substitute and fixation by percutaneous cancellous screws in this depressed Type II/III Schatzker fracture.

Fig. 3.2 **(A–E)** Type I fracture treated by closed percutaneous fixation.

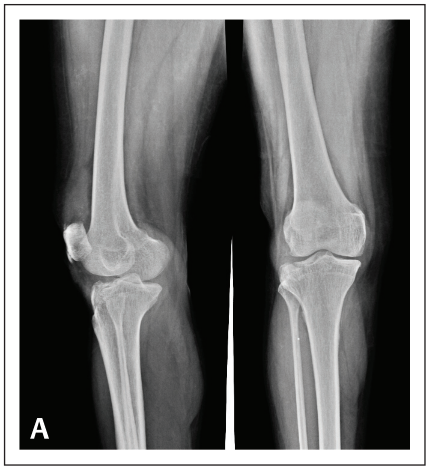


Fig. 3.2 **(A)** Anteroposterior and lateral showing minimum articular disruption, which is obvious only when one zooms under image intensifier control.

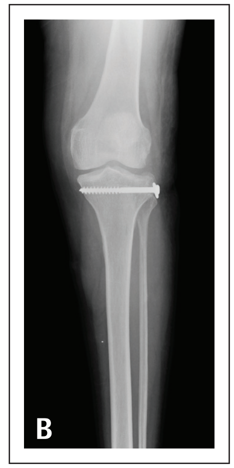


Fig. 3.2 **(B)** Screw with a washer, not only gives good bony surface, but also takes care of ligament disruption if any.

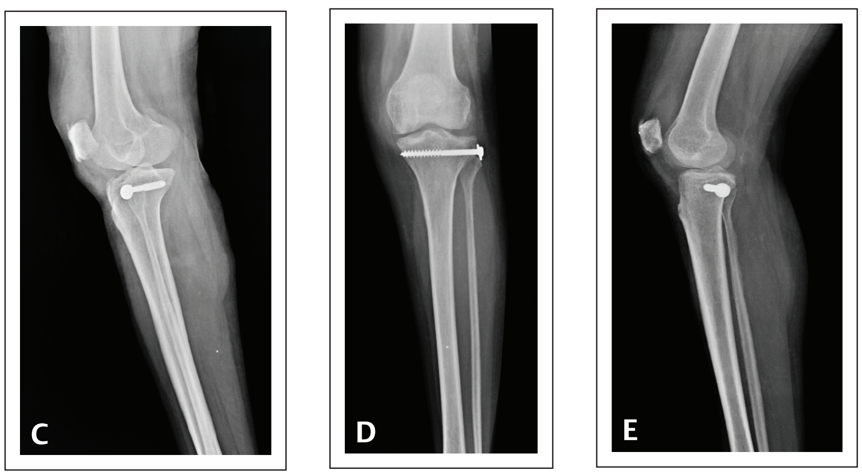
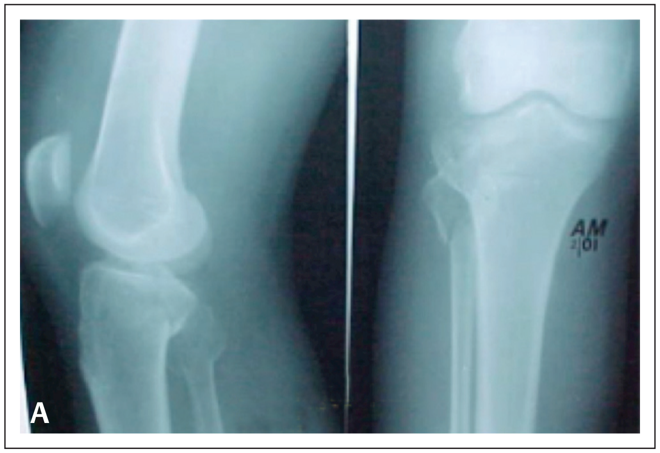


Fig. 3.2 **(C–E)** Position of screw is confirmed under image intensifier, take oblique views, subchondral position, fixing the depressed articular surface.

Fig. 3.3 **(A, B)** Two different examples of Type I fractures treated by closed percutaneous fixation.



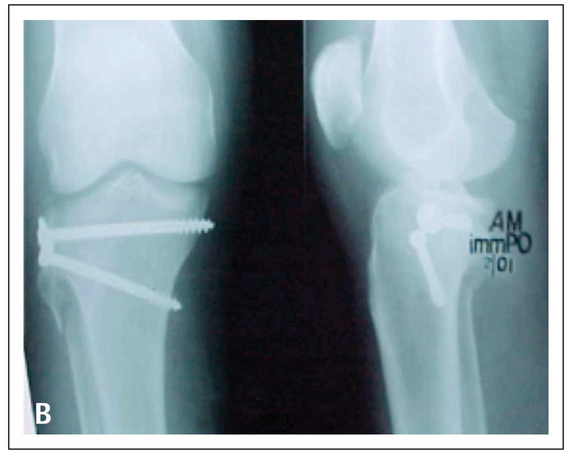


Fig. 3.3 **(A)** Anteroposterior and lateral showing split, depression of articular surface, posterior displacement, minimal comminution.

Fig. 3.3 **(B)** Reduction achieved by closed means using K-wire joystick maneuver and retained by two variable direction screws.

Fig. 3.4 **(A, B)** Two different examples of Type I fractures treated by closed percutaneous fixation.

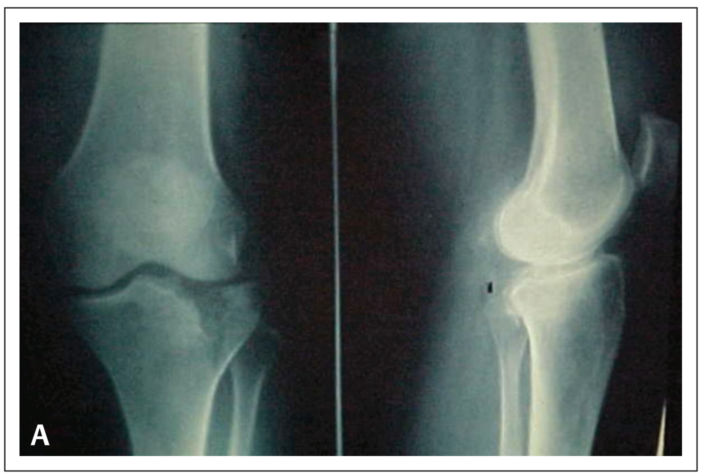


Fig. 3.4 **(A)** Anteroposterior and lateral showing split, depression.

Fig. 3.4 **(B)** Elevation technique of depression and parallel screw fixation.

Fig. 3.5 **(A, B)** X-rays showing Type II fracture treated by closed percutaneous fixation.

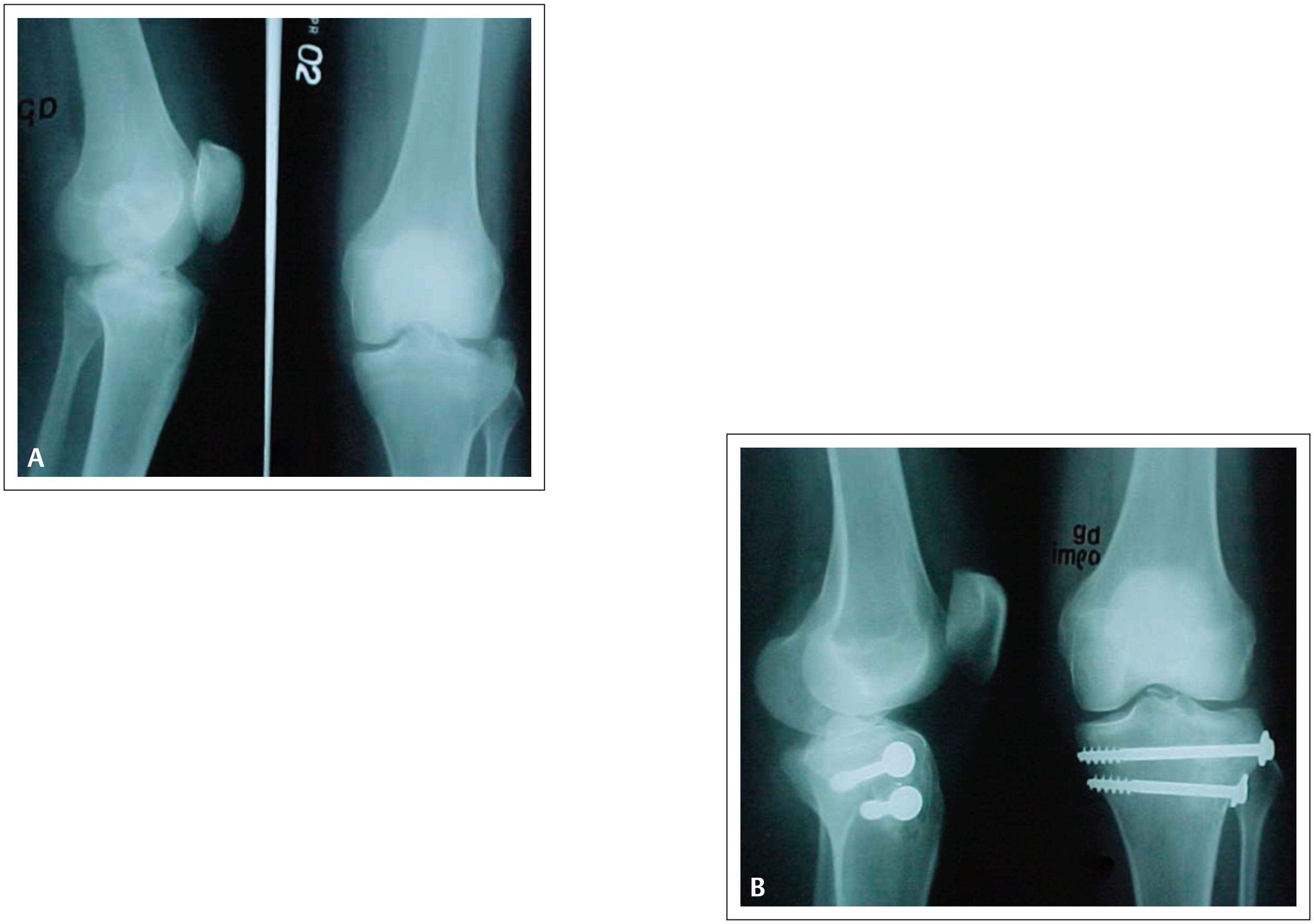


Fig. 3.6 **(A–C)** X-rays showing Type II fracture treated by closed percutaneous fixation.

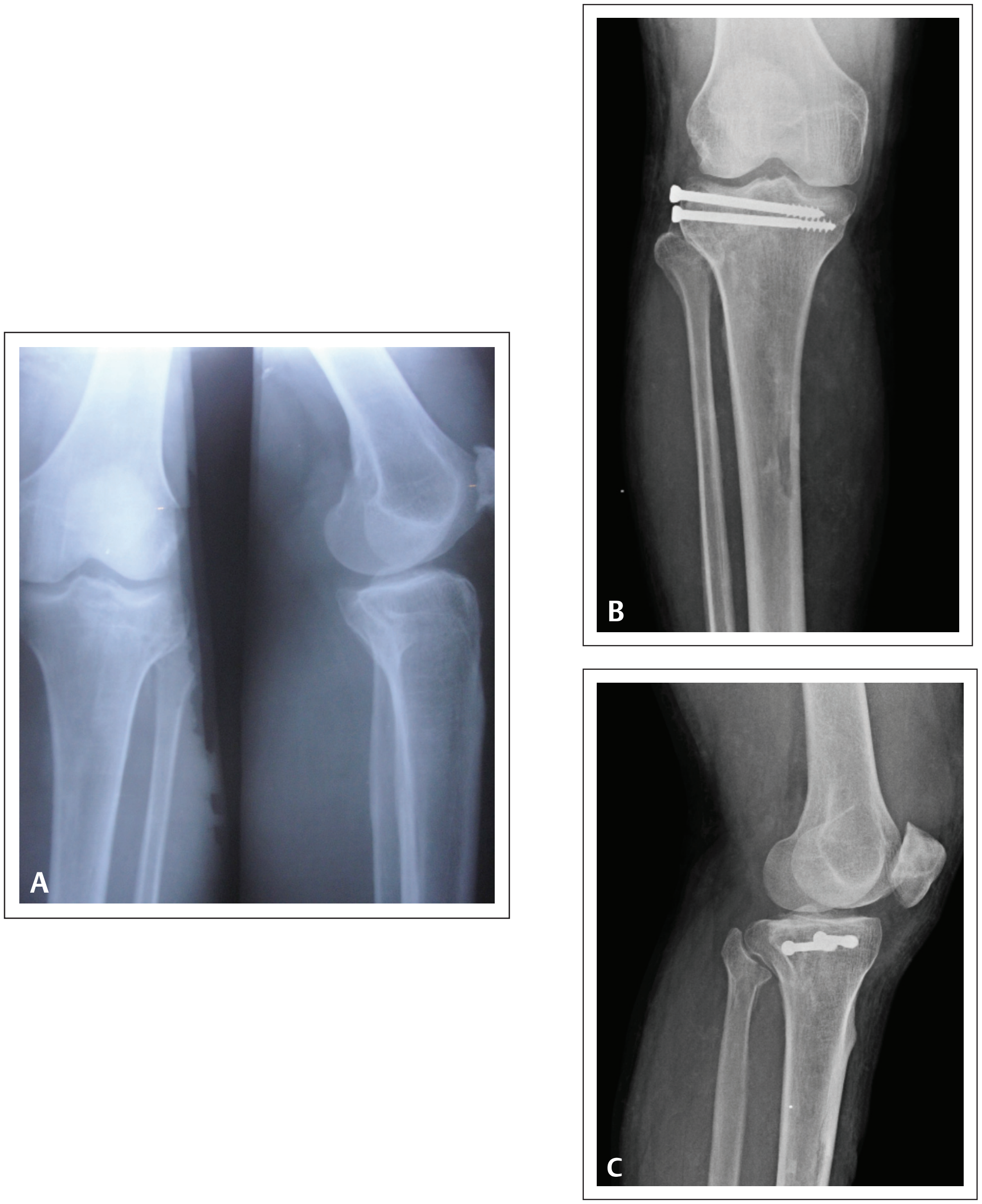


Fig. 3.7 **(A–D)** X-rays showing Type II fracture; CT scan showing depressed lateral tibial plateau, treated by open reduction, elevation, and buttress plate fixation; Final X-ray at 1 year and 3 months showing excellent articular restoration.

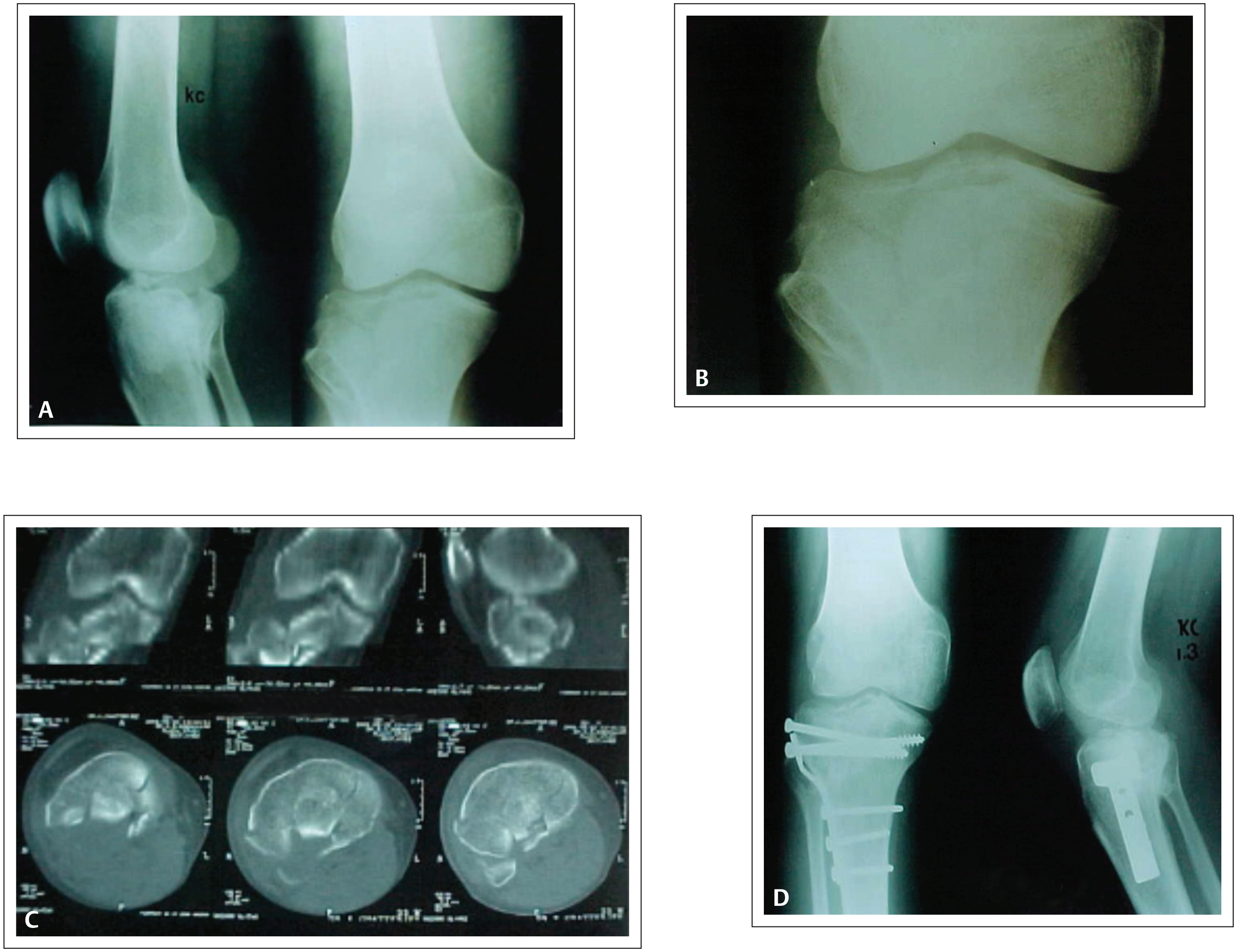
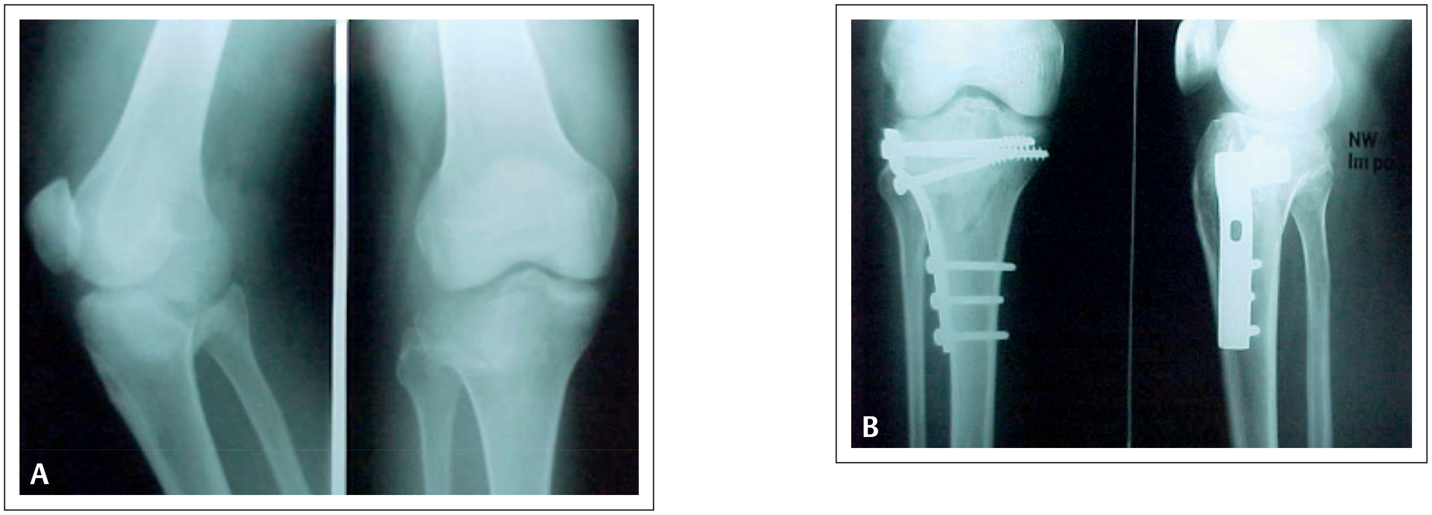
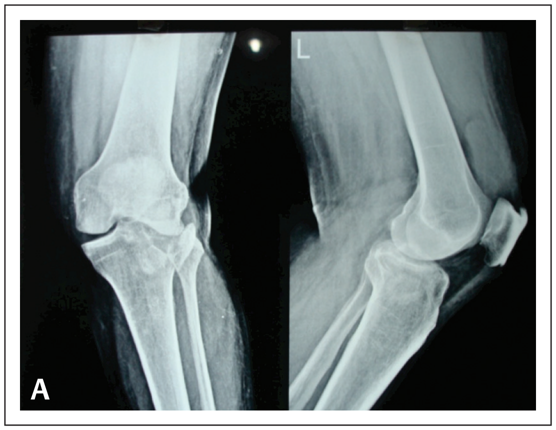


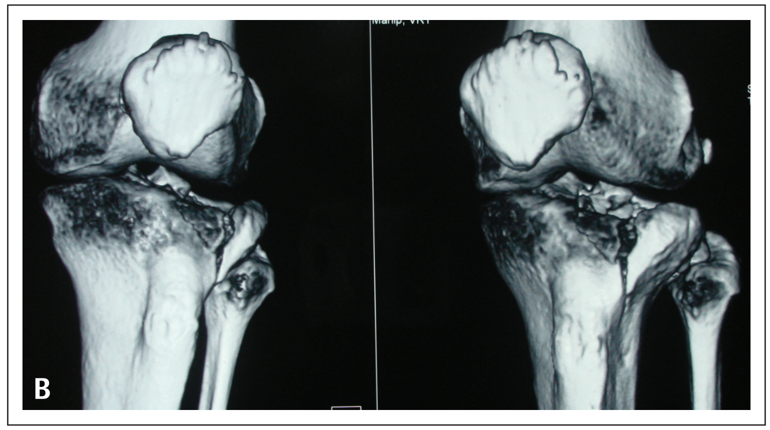
Fig. 3.8 **(A, B)** X-rays showing Type II fracture, treated by open reduction, elevation, and buttress plate fixation. Postoperative X-rays showing excellent articular restoration.



Types II and III fractures require proper elevation of the depressed fragment. Routinely an anterolateral submeniscal approach is taken to expose the depressed fragment. A separate incision is made medially at the metaphyseo–diaphyseal region where a small window is made. The operative technique involves insertion of impactor through this window well beneath the depressed articular fragments, and by slow and meticulous pressure elevation of the articular fragments and compressed cancellous bone as one large mass. The impactor is passed to elevate the depressed fragment under fluoroscopic control and direct visualization of articular fragment through submeniscal view. Once the elevation of the fragment is satisfactorily achieved, temporary stabilization by two Kirschner wires (K-wires) is done. This elevation creates a big void and cavity in the metaphyseal region, which should be filled with either autogenous bone graft procured from the iliac crest or with bone graft substitute. Unless this is done, redisplacement and settling cannot occur. Finally, an anatomically contoured lateral tibial plate is fixed to the proximal tibia with three to four raft screws passed subchondrally to prevent the collapse. Another oblique screw is passed from the plate directed medially, which protects the bone graft or substitutes while the fracture is healing (**Fig. 3.9A–F**).

Fig. 3.9 **(A–F)** X-rays showing Type III fracture, confirmed by CT scan, treated by open reduction, elevation and confirmation by sub-meniscal lateral approach, bone grafting inserted after elevation by impactor from medial side, and buttress plate fixation with raft screws from lateral side. 3D CT scan reconstruction aids a surgeon in locating the fracture planes, amount of displacement, and degree of comminution.





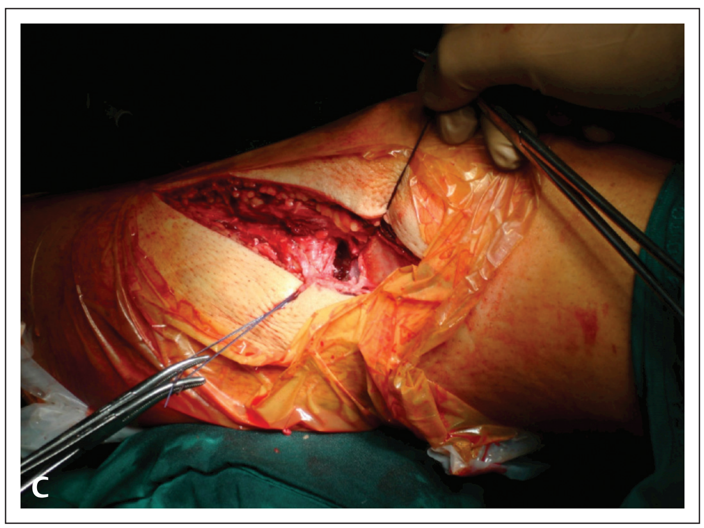


Fig. 3.9 **(D–F)** *Continued.*

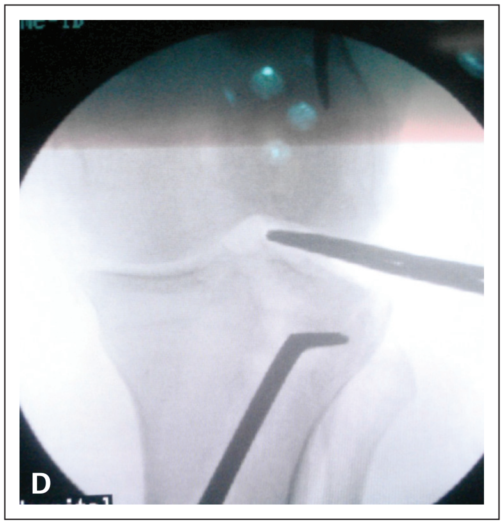


Fig. 3.9 **(D)** Medial cortical window is created to punch out obliquely the depressed articular surface. Amount of elevation and reconstruction should be checked by submeniscal approach, direct vision, and image intensifier confirmation.

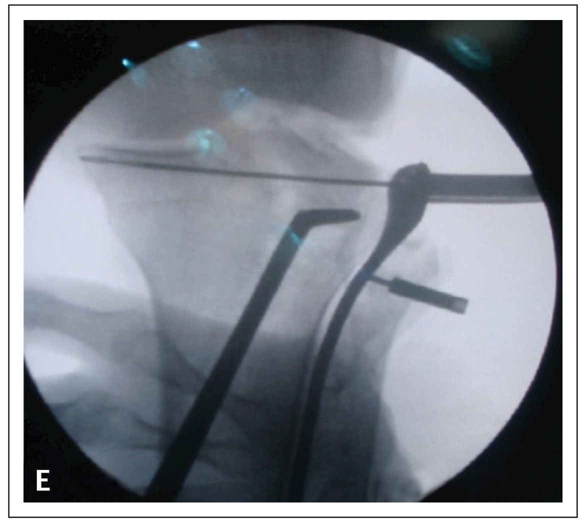


Fig. 3.9 **(E)** Temporary plate position should be confirmed under image intensifier, articular fragment graft should be elevated with K-wires and assessment of void should be undertaken.

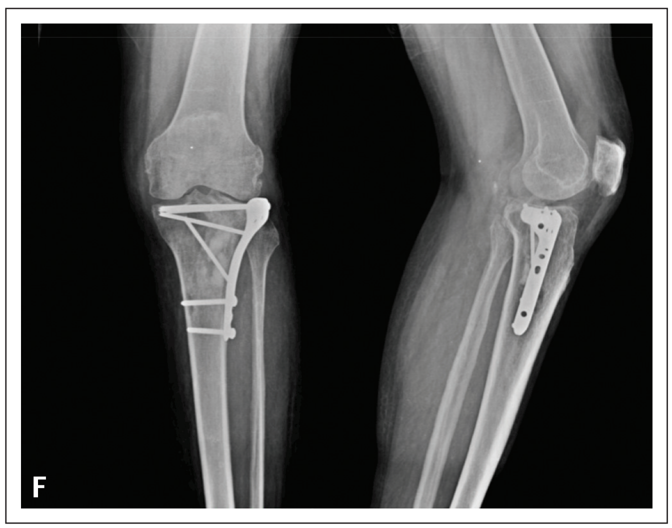


Fig. 3.9 **(F)** Use of plate with raft screws mostly obviates the need for bone grafting. If void is huge, choice of bone graft could be illiac crest, allograft or commercially available synthetic grafts.

Open treatment of tibial plateau fractures is made easier by the use of the AO-femoral distractor. For lateral plateau fractures, one bicortical pin is inserted just anterior to the lateral femoral epicondyle, parallel to the joint. The second pin is inserted into the lateral tibial cortex, distal to the site of proposed fixation, in the midcoronal plane, perpendicular to the tibia. As the distractor is lengthened, much of the reduction is attained by ligamentotaxis. Because the femoral pin is located near the center of rotation of the femoral condyle, the fracture is minimally disturbed by flexion and extension of the knee in attempts to locate the fracture lines and fix the plateau (**Fig. 3.10A–L**).

Brown et al showed that an articular step-off of 3 mm caused a significant increase in articular cartilage contact pressures in an experimental model of split fractures.[5] Bennett and Browner[4] and Honkonen[6] listed more than 5 mm of joint depression or displacement of more than 5 degrees of axial malalignment (valgus–varus) and condylar widening of more than 5 mm as their indications for operative treatment. Most authors agree that if depression or displacement exceeds 10 mm, surgery to elevate and restore the joint surface is indicated. If the depression is less than 5 mm in stable fractures, nonoperative treatment consisting of early motion in a hinged knee brace and delayed weight bearing usually is satisfactory. If the depression is 5 to 8 mm, the decision for nonoperative or operative treatment depends to a great degree on the patient's age and the demands of activity on the knee.

Routine anterolateral approach does not provide proper visualization of posterolateral plateau fragment and a better access for stabilization; hence in few instances extensile approach is necessary, especially for posterior shearing tibial plateau fracture. In this situation, the fascial incision follows the insertion of the extensor muscles and continues over the subcapital fibula. The entire layer is stripped distally as required. The peroneal nerve is exposed, and the osteotomy of fibular neck is performed. This allows exposure of the posterolateral plateau as well as the lateral and posterior flare of the proximal tibia. As the fragments are elevated and reduced, they are temporarily fixed with multiple small K-wires. Usually a contoured T or L buttress plate or "hockey-stick"–shaped AO lateral tibial buttress plate is applied for definitive fixation. This plate is applied to the anterolateral tibial condyle and contoured precisely to conform to the condyle and proximal metaphysis. If the fracture consists of only one or two large fragments with little or no comminution and little central depression, replacement and internal fixation with cancellous screws have been used. If the meniscus has been detached peripherally, carefully suture it back to its coronary ligament attachment. If the iliotibial band has been reflected from its insertion at the Gerdy tubercle, reattach it.

After the treatment, the knee is placed in a posterior plaster splint. After 3 to 4 days, if the wound is healing satisfactorily, the splint is removed and physiotherapy with quadriceps exercises and gentle active-assisted exercises are begun. Crutch walking is begun, but no weight bearing is permitted for 12 to 16 weeks. If extensive suturing of the periphery of the meniscus was required, immobilization for approximately 3 weeks is required before motion exercises are permitted.

Fig. 3.10 **(A–L)** X-rays showing Type III fracture, confirmed by CT scan, treated by open reduction, elevation and confirmation by sub-meniscal lateral approach, bone grafting inserted after elevation by impactor from medial side, and buttress plate fixation with raft screws from lateral side.

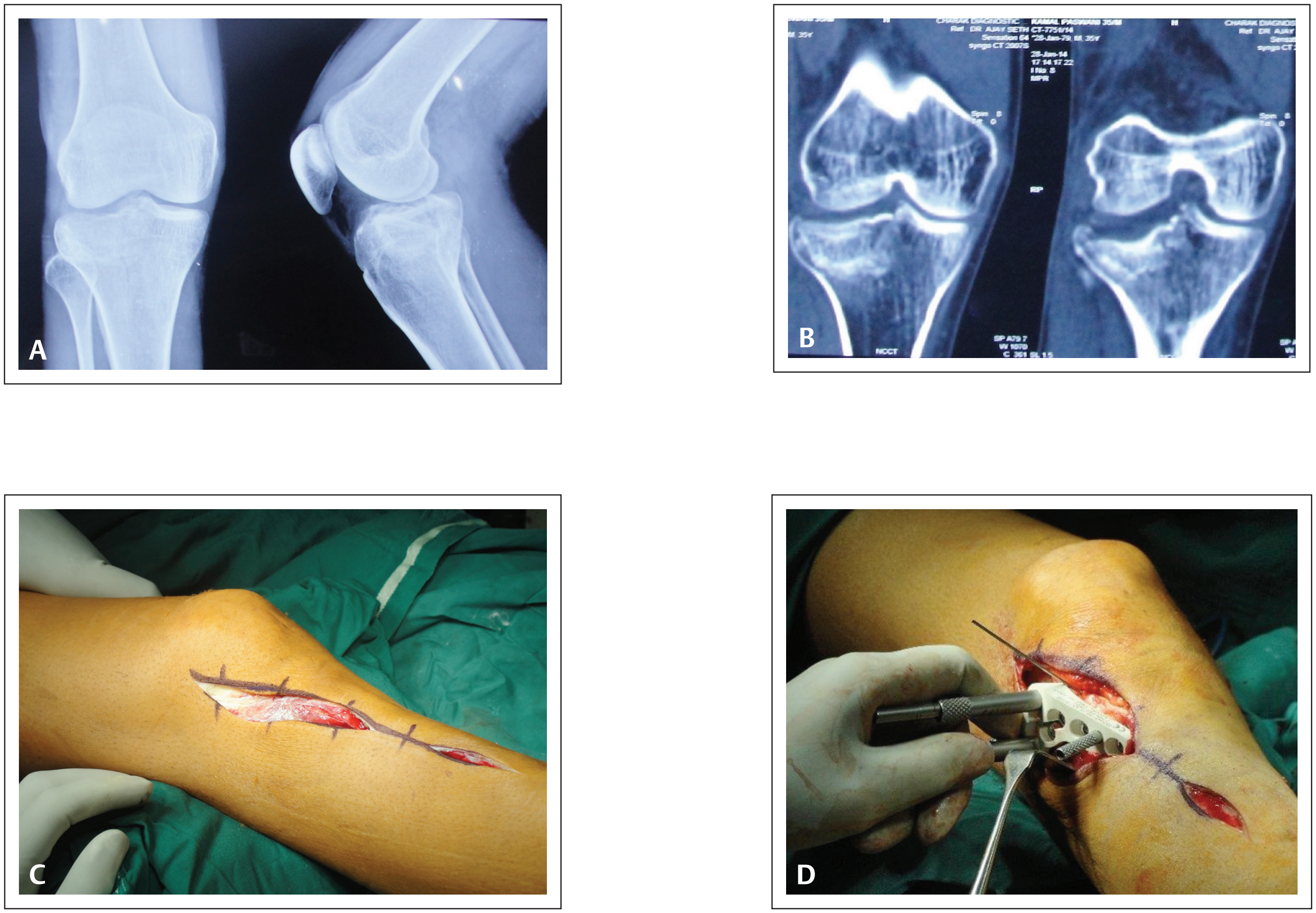


Fig. 3.10 (E–H) *Continued.*

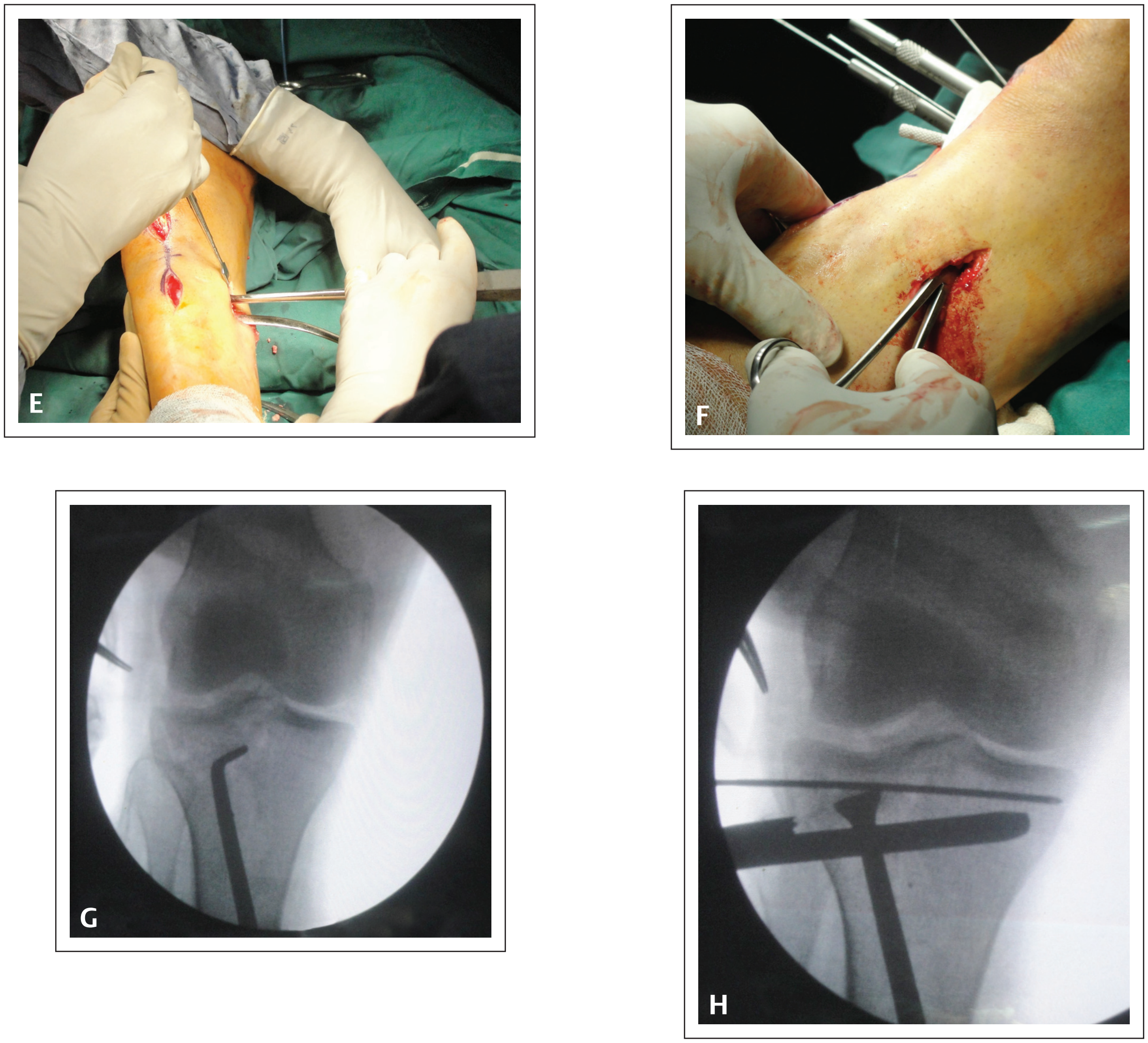
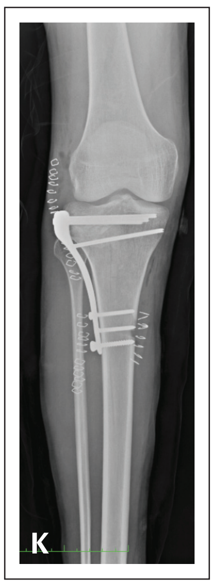
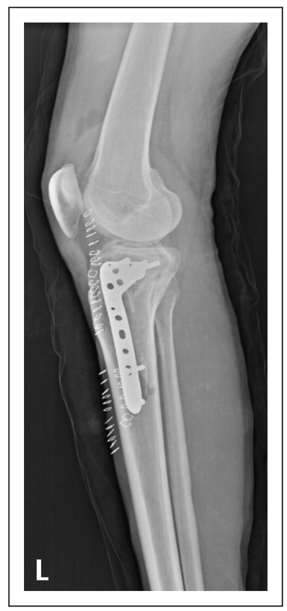


Fig. 3.10 **(I–L)** *Continued.*





Type IV Fracture of Medial Tibial Condyle

Type IV depressed medial tibial condyle fractures (Schatzker Type IV) are often quite unstable and generally best treated with open reduction and fixation with a medial buttress plate. Medial condyle fracture may involve total condyle or partial, anteromedial, or posteromedial fragment, best delineated by lateral view and CT.

Mostly open reduction, elevation, and internal fixation of the medial tibial condyle is required, and a technique similar to that previously described for the lateral tibial condyle is performed. This is called "medial extensile exposure" technique as described by Tscherne and Lobenhoffer.[7] The fracture can be approached through a straight anterior or anteromedial incision. If fracture medial condyle consists of posteromedial fragment a posteromedial approach, exposing the pes anserinus is desirable. For split compression and total depression fractures of the medial tibial condyle, in addition to elevating the depressed fragment and packing bone beneath it, an AO plate can be used as a medial buttressing plate. This can be bent to an accurate contour to fit the tibial metaphysis and the tibial condyle, and the fracture can be fixed with cancellous screws in the proximal portion of the plate and regular cortical screws in the distal portion.

Posterior Shearing Tibial Plateau Fracture

The posterior shearing tibial plateau fracture has been previously underappreciated. It is an uncommon injury and appears confusing on initial X-rays. For example, the AP X-ray shows little displacement. However, accurate analysis of the lateral film and the routine use of CT clarify the significance of the posterior fracture components. These injuries form a consistent pattern of primarily posterior displacement, which may be unicondylar or bicondylar. Proper analysis of the lateral X-ray and CT scans clarifies the fracture pattern and allows planning of appropriate treatment (**Fig. 3.11A–D**).

It is advisable that for shearing B-type injuries, a direct approach allowing traditional buttress plating is the appropriate form of surgical management.

The posterior approach, posterolateral or posteromedial, is well described and it allows direct exposure of the major fracture fragments (depending upon posteromedial/posterolateral fragment) and direct plating. Other authors have described fixation through a posteromedial approach with the patient lying in supine position. The posteromedial approach is often adequate for the posteromedial condyle, but it does not allow access to the lateral condyle if required[8] (**Fig. 3.12A–C**).

Fig. 3.11 **(A–D)** X-rays of posterior shearing medial tibial plateau treated by open reduction, elevation, and screw fixation.

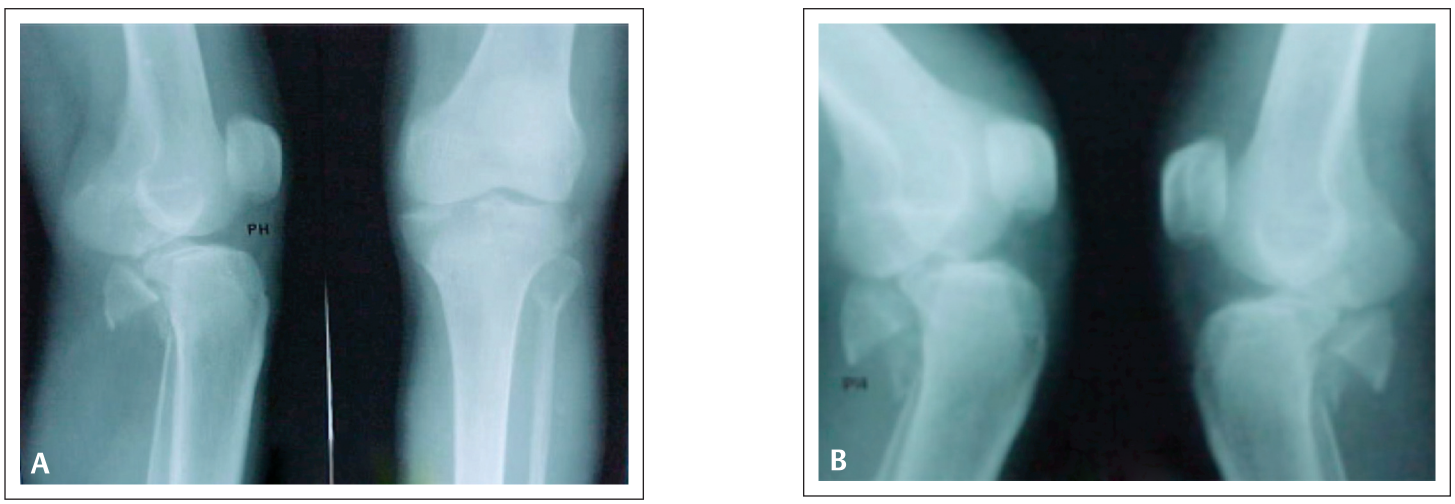


Fig. 3.11 (C, D) *Continued.*

Fig. 3.12 **(A–C)** X-rays of posteromedial shearing medial tibial plateau treated by open reduction, elevation, lag screw fixation, and posterior buttress plating.

Arthroscopy-Assisted Reduction and Fixation of Tibial Plateau Fractures

Presently many patients with Types I, II, and infrequently Type III lateral tibial plateau fractures are being treated by arthroscopic assistance. This technique gives excellent exposure of articular surface and can tackle concomitant lateral meniscus injury.

Arthroscopy-assisted percutaneous fixation was first described in the 1980s by Caspari and Jennings, and was subsequently proven effective in Schatzker Types I, II, and III fractures.[9–12] Compared with open reduction and internal fixation, the decreased invasiveness of arthroscopy-assisted percutaneous fixation translates into decreased morbidity rates. Combining arthroscopy and percutaneous fixation improves the diagnosis, evaluation of the reduction, and management of accompanying lesions. Buchko and Johnson described the technique for arthroscopic reduction and stabilization.[13]

Arthroscopic reduction and internal fixation offer the advantage of direct visualization of the fracture and its subsequent reduction without a formal arthrotomy or detachment of the anterior horn of the lateral meniscus. A low-pressure arthroscopic pump can be used to improve exposure and facilitates joint lavage. If the pump is used for extracapsular fractures (Schatzker Types I, III, and IV) the metaphyseal portion of the fracture site should be exposed to prevent extravasation of irrigation fluid into the soft tissues. This incision can be used later to create a bony window for reduction and bone grafting. The joint should be thoroughly lavaged to evacuate the hemarthrosis and remove loose bony and chondral fragments. Once the diagnostic evaluation has been completed, reduction can be performed with the pump off or as a dry arthroscopic technique.

By arthroscopic approach, entrapped lateral meniscus at the fracture site can be easily lifted with hook and repaired. The restoration of depressed fragment, which is elevated by medial cortical window, can be confirmed by arthroscopic assistance and subsequently stabilized by bone grafting and cancellous screw and buttress plate if required, especially in Type III fracture. This technique is less suitable in severely osteoporotic depressed comminuted lateral tibial condyle fracture.

Small clinical studies by many arthroscopists using arthroscopically assisted reduction and fixation techniques in predominantly Schatzker Types I, II, and III tibial plateau fractures have demonstrated good or excellent results in 80 to 100% of patients.[10–16]

Ligament Repair with Condylar Fracture

Collateral and cruciate ligament injuries occurring with tibial condylar fractures are much more common than once realized and, if untreated, may be responsible for instability and a poor delayed result, despite a well-healed condylar fracture. Honkonen found an increased incidence of posttraumatic arthritis after tibial plateau fractures with concomitant ligamentous injury.[6] Ligamentous injuries have been reported in 4 to 33% of tibial plateau fractures and 60% of fracture dislocations. The medial collateral ligament (MCL) is most commonly injured, usually with undisplaced or local depression fractures of the lateral tibial condyle. Stress X-rays are helpful in making this diagnosis. MCL injury occurred most often with Schatzker Type II fractures, whereas meniscal injury occurred most often with Schatzker Type IV fractures.

Bennett and Browner recommended preoperative and postoperative stress examination of the knee to detect ligamentous injury.[6] Residual laxity after anatomical reduction of the tibial plateau indicates ligamentous injury. Delamarter, Hohl, and Hopp pointed out the poor prognosis of cruciate injury occurring with tibial plateau fractures and the frequency of significant residual laxity.[17] If the intercondylar eminences of the tibia are fractured and displaced, these should be replaced and secured at the time of open reduction of the condyle. Midsubstance tears of the anterior cruciate ligament should be reconstructed later if significant laxity remains after fracture healing. Acute midsubstance tears of the MCL usually heal satisfactorily with nonoperative treatment. Because the increased surgical exposure necessary to repair the ligament and postoperative immobilization required can lead to increased knee stiffness, acute repair of the MCL is infrequently indicated. Collateral ligament injuries should be protected with a hinged knee brace. If the MCL is repaired, a separate medial incision is required. When the ligament has been repaired and the condylar fracture fixed, the knee is immobilized in a long leg plaster cast with the knee flexed at 45 degrees. Although early motion after fixation of tibial condylar fractures is desirable, motion must be delayed if repair of an acute collateral ligament injury is also involved.

Summary

Unicondylar tibial plateau fracture needs careful evaluation clinically, radiologically along with assessment of soft-tissues injuries. For this intra-articular injury, CT scan should always be done, since damage to the articular surface is more extensive than the X-rays indicate. Preoperative and during surgery after fixation ligamentous injury should be ruled out by stress test. Open reduction and internal fixation of tibial plateau fractures always require careful preoperative planning.

Lateral split fractures (Type I—pure cleavage) can be reduced percutaneously using traction and reduction forceps under arthroscopic or fluoroscopic control and stabilized by one to two screws.

In Type II—cleavage combined with depression—a lateral wedge is split off and in addition the articular surface is depressed down into the metaphysis. If the depression is more than 5 to 8 mm or instability is present, most should be treated by open reduction, elevation of the depressed plateau “en mass,” bone grafting of the metaphysis, fixation of the fracture with cancellous screws, with or without buttress plating of the lateral cortex.

Arthroscopy-assisted percutaneous fixation along with fluoroscopic control is an excellent method for fixation of Types I and II tibial plateau fracture, as compared with open reduction and internal fixation. Arthroscopically assisted elevation of depressed fragment and percutaneous fixation decreases the invasiveness and reduces the morbidity rates.

Type III can also be treated by arthroscopy-assisted surgery, though open reduction, elevation, of depressed fragment, bone grafting and stabilization by precontoured lateral tibial plate with raft screws is preferred technique.

Type IV where medial tibial condyle is fractured needs open reduction, elevation, and stabilization of fracture. Depending upon the fracture pattern, which may include total medial condyle fragment, a large posteromedial split fragment, or anteromedial fragment, consideration should be given whether to approach by anteromedial or posteromedial approach. If it is a posteromedial fragment or there is a coronal split in the posteromedial tibial plateau, look for a depression or split which needs elevation and stabilization by buttress plating or by screws. Direct exposure of the fracture fragments through the posterior approach, though unfamiliar, makes for an efficient reduction and fixation.

Tips and Pearls

- Moore and Hohl classification is used to describe tibial plateau fractures, whereas Schatzker's classification is widely used for management.
- CT scan plays an important role in tibial plateau fractures.
- All depressed tibial plateau fractures (II and III) require reduction by elevating the fragment usually through the cortical window created on the medial side at metaphyseo–diaphyseal region.
- If the depression is less than 5 mm in stable fractures, nonoperative treatment consisting of early motion in a hinged knee brace and delayed weight bearing usually is done.
- If the depression is 5 to 8 mm, the decision for nonoperative or operative treatment depends to a great degree on the patient's age and the demands of activity on the knee.
- If depression or displacement exceeds 10 mm, surgery to elevate and restore the joint surface is indicated.
- Type IV—depressed medial tibial condyle—fractures (Schatzker Type IV) are often quite unstable and generally are best treated with open reduction and fixation with a medial buttress plate.
- Ligamentous injuries have been reported in 4 to 33% of tibial plateau fractures and 60% of fracture dislocations.
- Medial collateral ligament injury occurs most often with Schatzker Type II fractures, whereas meniscal injury happens most often with Schatzker Type IV fractures.

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