

# Triplane Fracture of Distal Femur in an Adult Rare Case Study and Review

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## SUMMARY

A 30-year-old patient sustained the fracture in a motorcycle accident. A triplane-type of fracture of the distal femur was confirmed by CT scan. The trochlear fragment was reduced anatomically and was stabilized with 6.5mm cannulated screws. Once reconstruction of the coronal plane fracture was performed, the split lateral condylar fragment was fixed with a cannulated screw to the medial fragment converting three parts into one fragment. The mechanism of injury seems to be axial load to the distal femur with the knee in short of extension combined with the shearing force from the anteromedial aspect producing an anterior tangential fracture pattern. Triplane fractures are by definition fractures that have a component involving all 3 planes: sagittal, coronal and transverse, commonly seen before physcal fusion. Our case is the first reported case of triplane fracture in distal femur in an adult patient.

**Key words:** distal femur fracture, triplane fracture, lateral condyle fracture, trauma, triplane fracture mechanism

## INTRODUCTION

Triplane fractures are by definition fractures that have a component involving all 3 planes: sagittal, coronal and transverse. Such a fracture pattern is mostly seen before physal fusion, evident in the literature search. Triplane fractures of the distal tibia are the most common, all of them, except one, have been reported in the pediatric population [1,2]. But in sporadic reports, this pattern is now also recognised in the distal humerus, distal radius, the hand, and proximal tibia [8-11] (Tab 1 and 2) [2,11]. We found two cases of triplane fracture of distal femur (supracondylar-split lateral condyle distal femoral fracture

and coronal fracture of trochlea) [12,13]. All of the above cases were reported in children before physal fusion [except one case by Chin et al. of triplane fracture in hand] [2].

We consider our case to be different as the patient is a 30-year old adult with a triplane fracture of distal femur. Such fracture pattern has been reported only twice before in the femur, and that too in children. The aim of this case report is to document an unusual fracture pattern and to point out that such an injury can occur in the adult population also, needless to say that the mechanism and pathophysiology is different from the pediatric fractures. We have

Tab. 1. Triplane fracture cases reported at articular surfaces other than distal tibia – distal radius and proximal tibia

| AREA INVOLVED  | STUDY                 | YEAR | NO. OF CASES | AGE OF PATIENTS | TREATMENT     | OUTCOME                                              | FOLLOW-UP |
|----------------|-----------------------|------|--------------|-----------------|---------------|------------------------------------------------------|-----------|
| DISTAL RADIUS  | Mingo-Robinet et.al   | 2013 | 1            | 15 yr           | operative     | Full ROM                                             | 9 months  |
|                | Pearce et.al          | 2011 | 1            | 14 yr           | Non-operative | Full ROM                                             | 9 months  |
|                | Garcia- mata et.al    | 2006 | 1            | 13yr            | Non-operative | Physal arrest of distal radius, shortening, full ROM | 3 years   |
|                | Garcia mata et.al     | 1999 | 1            | 13yr            | Non-operative | Full ROM                                             | NA        |
|                | Peterson et.al        | 1996 | 1            | 14 yr           | Non-operative | Full ROM                                             | 4 months  |
| PROXIMAL TIBIA | Sinigaglia et.al      | 2007 | 1            | 15 yr           | Operative     | Full ROM                                             | 4 years   |
|                | Kanellopoulos et.al   | 2003 | 1            | adolescent      | Operative     | Full ROM                                             |           |
|                | Pietu et.al [French ] | 1991 | 2            | adolescent      | Operative     | Full ROM                                             |           |
|                | Conroy et.al          | 2000 | 1            | 11 yr           | operative     | Full ROM                                             | NA        |

Tab. 2. The Triplane fracture cases reported at articular surfaces other than distal tibia – hand , distal humerus and distal femur

|                |                          |      |   |             |                      |                                                                 |                  |
|----------------|--------------------------|------|---|-------------|----------------------|-----------------------------------------------------------------|------------------|
| DISTAL HUMERUS | Peterson et.al           | 1983 | 1 | 11 yr       | operative            | Full ROM                                                        | 5 months         |
| HAND           | Garcia mata et.al        | 1999 | 1 | 12 yr       | Non-operative        | Full ROM                                                        | NA               |
|                | Chin et.al               | 1999 | 2 | 30yr, 14 yr | Operative, operative | Some restriction in motion, Good function                       | 8 years, 3 years |
| DISTAL FEMUR   | Masquijo                 | 2011 | 1 | 13 yr       | operative            | Slight Knee stiffness, 0-100° ROM Tegner & lysholm scale 85/100 | 2 years          |
|                | Gosselin et.al           | 2005 | 1 | 9 yr        | Operative            | Restricted movements 10 – 90° ROM                               | NIL              |
|                | Gahlot et.al [our study] |      | 1 | 30 yr       | Operative            | Full ROM IKDC subjective score 83.2/100                         | 2 years          |

made an attempt to describe the injury mechanism and hence also the factors that should be kept in mind during reduction and rehabilitation.

### CASE REPORT

A 30-year-old male patient presented to our out-patient orthopaedic clinic after being transferred

[14]. But we could not find an accurate classification depicting such injury.

### OPERATIVE TECHNIQUE

The patient was positioned supine with a bump beneath the knee for a better sagittal plane reduction and a tourniquet was placed in proximal thigh. A mid-



Fig 1. Pre operative radiographs



Fig. 2. Pre operative radiographs

from an outside orthopaedic institution for evaluation of a complex distal femoral fracture. The patient sustained the fracture in a motorcycle accident. He was riding a two-wheeler and was hit by another two-wheeler coming from the opposite direction.

On examination, the patient was in good general condition, and the right knee area showed swelling and visible and palpable tender prominence antero-laterally with abrasion on the anteromedial aspect of the right knee. The distal neurovascular status was normal. AP and lateral X-ray views of distal femur with knee were obtained. A triplane-type of fracture of the distal femur was suspected, which was confirmed by computed tomographic (CT) scan of the knee (Fig. 1-3). The preoperative planning included reconstruction of the fracture pattern (Fig. 10, 11). This type of fracture pattern is not recognised separately anywhere; according to OTA classification it closest comes under 33-C1.1 (simple articular and simple metaphyseal, sub-group slight displacement)

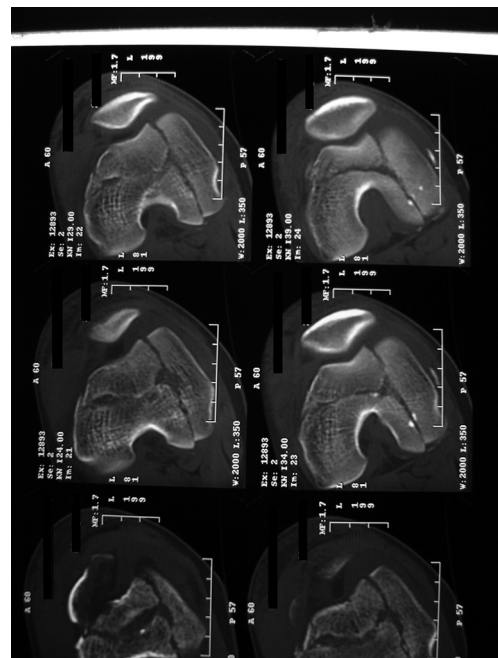


Fig. 3. Pre operative CT scan

line incision is made, and a medial parapatellar arthrotomy is performed preserving the fat pad. The intraoperative inspection showed that the trochlear fragment was displaced laterally with the patella and impacted in the sagittal fracture plane displacing the lateral condyle away (Fig. 4, 10, 11). After the fracture surfaces were freshened, the trochlear fragment was reduced anatomically and was stabilized with a 6.5 mm cannulated screw placed from anterior to posterior and countersunk, fixing it with medial condyle. Next, the split lateral condylar fragment was fixed with a cannulated screw to the medial fragment, converting three parts into one fragment. The unified whole distal fragment was then fixed to the

diaphysis with a distal femoral anatomical locking plate. Due to high energy trauma the articular cartilage was frayed along fracture margins, as seen in an intraoperative photograph (Fig. 4). The lateral collateral ligament was still attached on the lateral epicondyle and hence did not allow significant movements of the fragment for reduction. The tourniquet time was 75 minutes. Blood loss was less than 400 mL.

#### POSTOPERATIVE COURSE

The patient was placed in a long leg knee immobilizer for 4 weeks. Passive movements of the knee joint were started in a CPM (continuous passive motion) machine from day 3, when the pain decreased.



Fig 4. Intra-operative picture



Fig. 5. 1-month post-operative radiograph

By the end of 2 weeks we were able to achieve 90° arc of movements passively. Partial weight bearing was started after 4 weeks with crutches. At 4 weeks, range of motion was from 0 to 95 degrees. 6 weeks of further physical therapy and progressive weight bearing gave 0 to 120 degrees of flexion. The frac-

ture progressed to radiologic union by the 12 week mark, clinically and radiographically (Fig. 6, 7). There was no superficial or deep infection or hardware loosening. At most recent follow-up (2 years after the injury), knee range of motion was 0 to 120 degrees (Fig. 8, 9). Radiographs showed good alignment. The



Fig. 6. 3-month post-operative radiograph – AP VIEW

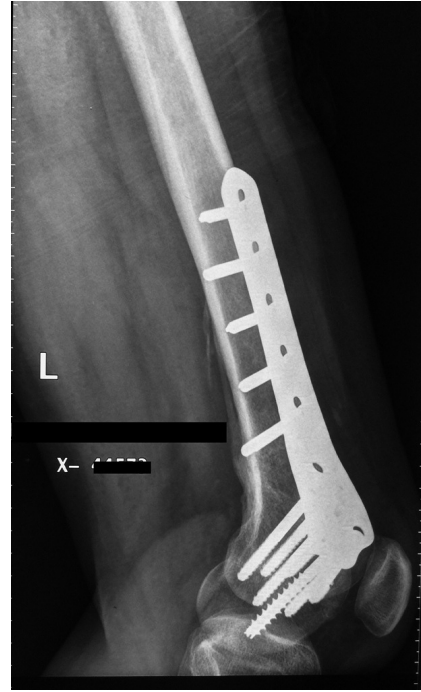


Fig. 7. 3-month post-operative radiograph showing union – lat view



Fig. 8. 2 year post-operative knee flexion ~120o – clinical photograph

IKDC subjective knee score after two year follow-up was 83.2 out of 100, with no difference in muscle power [15]. Patient is actively participating in routine activities and is able to resume the same pre-injury activity level, with no significant complaint of pain, swelling, limp or instability. Although he reported some discomfort on kneeling down or squatting and after prolonged sitting with knee flexed, most of the symptoms related to the patellofemoral joint.

## DISCUSSION

Searching PubMed database with search term “triplane fractures” gave 100 results, most of which were studies on distal tibia triplane fractures in children with the two largest series of 51 cases and 21 cases by Brown et al. and Karrholm et al., respectively [16,17]. But we also found sporadic case reports of triplane fracture in other articular surfaces also [distal humerus, distal radius, the hand, proximal tibia, distal femur, most of them reported in the last two



Fig. 9. 2 year post-operative knee flexion  $\sim 120^\circ$  – clinical photograph

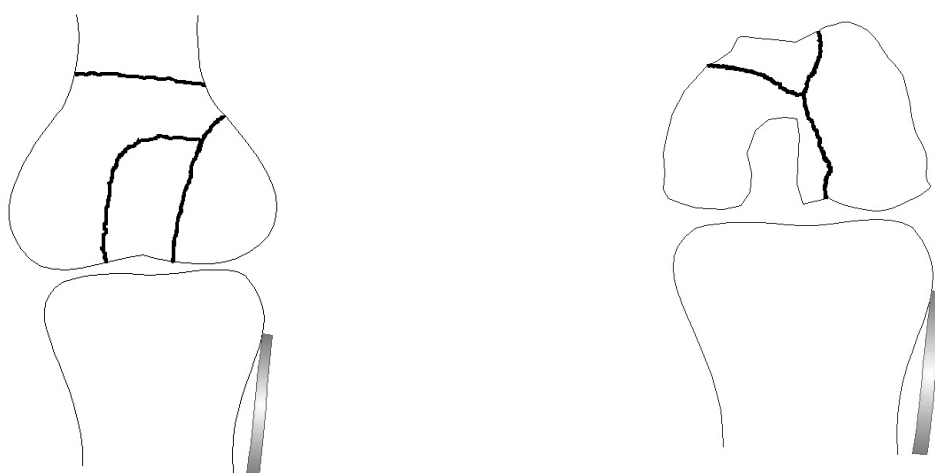


Fig. 10 and 11. Preoperative reconstruction of fracture pattern

decades (Tab. 1 & 2). One more case study of a distal femur triplane fracture was found outside PubMed database, by Gosselin et.al [2-13]. But all the above studies had cases in the pediatric age group; our case is the first case of triplane fracture being reported in an adult patient. Also only the third case of triplane fracture of the distal femur.

The mechanism of injury that produces this fracture pattern in the distal tibia is described as rotational stress causing fracture along the physis and another line producing a metaphyseal fragment [1]. In our case, based on the displacement of fracture fragments, the mechanism might have been shearing

force from the anteromedial aspect producing an anterior tangential fracture pattern with energy dissipation to the lateral femur causing a split lateral condyle fracture with structural failure of the supracondylar femur. This along with axial load to the distal femur with the knee in short of extension caused a supracondylar fracture at the junction of the metaphysis and diaphysis, a weak point; thus completing three planes of fracture lines. Due to the knee being in flexion (around  $30^\circ$ ) and patella in contact with the trochlea, shearing force was dissipated through the distal femur causing its fracture.

Recognition of these injuries (especially nondisplaced fractures) on the basis of just anteroposterior and lateral plain radiographs is often difficult. Oblique radiographs and computerized tomographic scans have been recommended. In our case, a combination supracondylar fracture in axial plane, trochlear fracture in the coronal plane and split lateral condyle fracture in sagittal plane without evidence of ligament injuries were observed intraoperatively [18-20].

Intraoperative evaluation of ligament injuries is important as this will have effect on post-operative rehabilitation and the overall functional outcome of the knee. Our case had no collateral or cruciate ligament injury, which enabled us to put patient on a rapid physiotherapy protocol and was later reflected in a good functional outcome [IKDC subjective knee score after two years – 83.2/100] [15]. But due to high energy trauma there was some damage to the articular cartilage, which was the reason why the patient had patellofemoral symptoms of pain while kneeling or getting up from chair. Accurate reduction of the articular surface is the key to good functional outcome.

The main complications which could be expected out of such an injury are knee stiffness, reduced range of movements or persistent laxity of collateral ligaments. Early start of passive physiotherapy is the solution to the above problems. Although we did not find any obvious collateral ligament injury, still we

recommend placing the knee in a ROM-brace [range of motion brace], which protects from any varus-valgus stress on the knee. Partial tear or lengthening of ligaments can occur which cannot be seen intraoperatively; a knee brace will give those injuries time to heal in proper position.

## CONCLUSION

The case presented in this study is only the third case reported with a documented triplane fracture of the distal femur, and first case to be reported in an adult patient. We believe that a high suspicion index should be maintained in high energy trauma to the knee and CT scan evaluation should be done to recognise any hidden fracture lines. Anatomic reduction is especially important to minimize the risk of development of degenerative arthritis and proper reduction of each fragment is essential under direct vision. Notification of collateral or cruciate ligament integrity is essential in every case, as presence of ligament tear changes the physiotherapy protocol immensely and affects the functional outcome. Close follow-up with good and early physiotherapy is critical to prevent knee stiffness and achieve long term good function.

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