MEDICAL SCIENCE

Role of dual plate fixation for the distal femur fracture to avoid varus collapse in a patient having multiple ipsilateral compound long bone fractures: A case report

Vivek Jadawala[1*], Aditya Kekatpure[2], Sanjay Deshpande[3], Shivshankar Jadhav[4], Parth Shah[1], Abhiram Awasthi[4]

To Cite:
Jadawala V, Kekatpure A, Deshpande S, Jadhav S, Shah P, Awasthi A. Role of dual plate fixation for the distal femur fracture to avoid varus collapse in a patient having multiple ipsilateral compound long bone fractures: A case report. *Medical Science* 2023; 27: e152ms2804.
doi: https://doi.org/10.54905/disssi/v27i133/e152ms2804

Authors' Affiliation:
[1]Post Graduate Resident, Department of Orthopaedics, Jawaharlal Nehru Medical College, Datta Meghe Institute of Higher Education and Research (Deemed to be University), Maharashtra, India
[2]Associate Professor, Department of Orthopaedics, Jawaharlal Nehru Medical College, Datta Meghe Institute of Higher Education and Research (Deemed to be University), Maharashtra, India
[3]Professor, Department of Orthopaedics, Jawaharlal Nehru Medical College, Datta Meghe Institute of Higher Education and Research (Deemed to be University), Maharashtra, India
[4]Senior Resident, Department of Orthopaedics, Jawaharlal Nehru College, Datta Meghe Institute of Higher Education and Research (Deemed to be University), Maharashtra, India

ORCID List

Vivek Jadawala	0000-0003-0163-9132
Aditya Kekatpure	0000-0002-8756-6415
Sanjay Deshpande	0000-0003-0064-1329
Shivshankar Jadhav	0000-0002-1933-2705
Parth Shah	0000-0003-4495-0916
Abhiram Awasthi	0000-0001-5677-9840

[*]Corresponding author
Post Graduate Resident, Department of Orthopaedics, Jawaharlal Nehru Medical College, Datta Meghe Institute of Higher Education and Research (Deemed to be University), Maharashtra, India
ORCID: 0000-0003-0163-9132
Email: vivekjadawala@gmail.com

Peer-Review History
Received: 03 January 2023
Reviewed & Revised: 07/January/2023 to 13/March/2023
Accepted: 16 March 2023
Published: 20 March 2023

Peer-review Method
External peer-review was done through double-blind method.

Medical Science
pISSN 2321–7359; eISSN 2321–7367

This open access article is distributed under Creative Commons Attribution License 4.0 (CC BY).

DISCOVERY SCIENTIFIC SOCIETY
Copyright © 2023 Discovery Scientific Society.

ABSTRACT

Open high velocity long bone fractures with bone loss and extensive soft tissue damage in poly-trauma patient presents unique challenges when the course of limb salvage procedure is recommended. The complexity of managing multiple fractures of ipsilateral long bones arises from the need to consider various management factors, such as the open fracture care, method of stabilization, soft tissue covers and bone-grafting technique, while also taking into account the possibility that the implant chosen for one fracture may not be optimal solution for another. In reality, unilateral fracture of the femur neck, femur shaft and floating knee injuries present numerous challenges and dilemma during fixation that surgeons need to take into consideration; yet, reports of patients presenting with such injuries are extremely rare. We present a case of 41-year-old male who sustained ipsilateral fracture of the femoral neck and shaft femur along with fractures of tibia and fibula (floating knee) following a high-velocity two-wheeler collision. He was managed with operative fixation but 3 months post-operatively, the patient developed varus collapse at distal femur fracture site. Patient was then operated again with medial buttressing along with bone-grafting for distal femur fracture. At his most recent 6 weeks follow-up, patient was walking without assistive devices in October 2022. The decision regarding the sequence in which to fix fractures should be based on judgement of the operating team and circumstances at hand. Although these cases are infrequent and challenging to manage, each case requires individualized, tailored approach since no standard protocol exists.

Keywords: Distal femur fracture, floating knee, neck femur fracture, open reduction and internal fixation, plate osteosynthesis, varus collapse, dual

plate fixation

1. INTRODUCTION

Open high velocity long bone fracture with bone loss and extensive soft tissue damage in the poly-trauma patient has unique therapeutic challenges when the course of limb salvage surgery is recommended. Using a planned out and staged approach to treatment, limb salvage should be taken into consideration even if amputation may be the patient's chosen reconstructive option if they have multiple injuries to the same extremity. Management factors that need to be considered are the extent of open fracture care, method of stabilisation, soft tissue cover and bone grafting technique (Sands et al., 2011; Shukla & Choudhari, 2023). Although, it might be argued that the timing of the reconstructive attempt to accomplish salvage of the limb is the most crucial aspect to take into account. Special attention should be paid to the physiology of the highly traumatised host and the surrounding musculoskeletal environment (Pape et al., 2009). It may be advantageous to postpone extensive reconstructive surgery until the host and local soft tissue conditions are optimised, even though early skeletal stabilisation and open fracture care stop the cycle of damage, eliminate infectious nidus and halt continuous haemorrhage (Pape et al., 2009). Ipsilateral fractures of proximal part of femur, distal femur and tibia and fibula shaft take place, in combination, very rarely. These types of injuries are commonly associated with very high velocity trauma. Delaney and Street, (1953) were the first to describe the combination of an ipsilateral femoral neck fracture and shaft fracture. This type of trauma was first described by Käch, (1993) and we came across only 13 such cases that has been reported in the literature ever since. According to the assumed mechanism of injury, the hip must be in flexion and abduction to the point where the head of femur is comfortably lying within the acetabular cavity. The force is delivered longitudinally along the femoral shaft, starting at the knee (Barei et al., 2003; Bartonicek et al., 2000; Douša et al., 1998; Lambiris et al., 2003).

As a result of the possibility that the chosen implant for one type of fracture might not be the preferred solution for the other, multiple fractures of the ipsilateral long bones present complex fracture management concerns. Although there is little evidence to make a decision, many surgical fixation systems have been documented to address this sort of injuries. One crucial (and still unresolved) issue is the order of fracture fixation. Each author emphasised the importance of treating these injuries on a case-by-case basis (Käch, 1993; Barei et al., 2003; Bartonicek et al., 2000; Douša et al., 1998).

Floating knee injuries i.e., same limb fractures of shaft femur and tibia are also challenging to manage. Blake and Mc-Bryde, (1975) first classified these fractures as Type I (extra articular) or Type II (articular). Floating knee type of injuries is commonly accompanied by open compound injuries with extensive soft-tissue destruction, occurring in 54% to 62% of patients (Fraser et al., 1978). Amputation might be needed in 1% to 3% of patients (Gregory et al., 1996; Adamson et al., 1992).

In reality, unilateral of the femoral neck, femur distal shaft and floating knee injuries present numerous challenges and dilemma during fixation that surgeons must keep into account; yet, reports of patients coming with such injuries are extremely rare. We report a case of 41-year-old male patient who sustained high velocity road traffic accident and was managed with surgical fixation for open ipsilateral fractures of femoral neck and distal fourth shaft as well as a floating knee injury who presented to emergency department within 6 hours following injury.

2. CASE PRESENTATION

A 41-year-old male was brought to Emergency department of Acharya Vinoba Bhave Rural hospital, Wardha after he sustained high velocity road traffic accident following motorcycle collision. Patient was transported within 6 hours following the injury. In the emergency room, he was administered Injection Ceftriaxone and Amikacin and Advanced Trauma Life Support protocol was started. On arrival the patients Glasgow-Coma-Scale (GCS) was 15. After primary and secondary assessment, radiographs were taken which showed displaced open fractures of trans-cervical neck femur (AO–31-B2) (Figure 1, 2, 3, 4) comminute fracture of distal fourth shaft femur with intra-articular, inter-condylar extension (AO–33-C2.3) (Figure 5A, 5B) and comminute fracture of midshaft tibia with comminuted segmental fracture shaft fibula (AO–42-C2) (Figure 5C, 5D). Fortunately, the patient had no head injury, blunt injury to chest or abdomen. 3-dimensional computed tomography scan of the lower-limb was carried out to identify the intra-articular fragments before fixation (Figure 6).

Figure 1 Clinical image of wound over lateral aspect of right hip

Figure 2 Clinical image of right lower-limb with wound over medial aspect of right distal thigh and leg

Figure 3 Clinical image of puncture wound over medial aspect of right mid leg

Figure 4 Pre-operative radiograph of pelvis including both hip joints (PBH) show trans-cervical fracture of neck femur right side (AO type–31–B2)

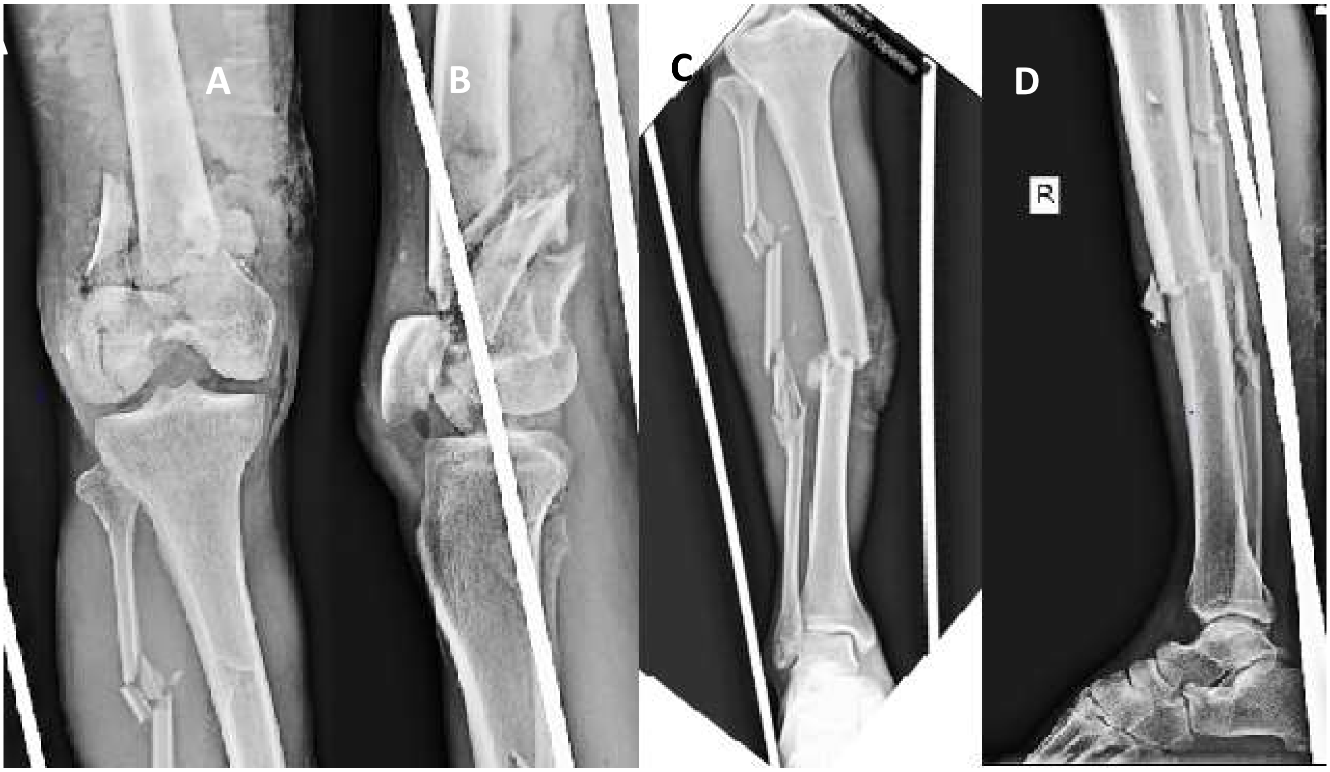

Figure 5 Pre-operative radiograph showing right knee with leg and ankle; A: Antero-posterior view showing comminuted displaced fracture of distal femur with intra-articular extension (AO type–33–C2.3); B: Lateral view showing comminuted displaced fracture of distal femur with patella subluxated posteriorly; C: Antero-posterior view showing mid-shaft tibia fracture with comminuted segmental shaft fibula fracture (AO type–42–C2); D: Lateral view showing mid-shaft tibia fracture with segmental shaft fibula fracture

After 2 hours from the arrival of the patient to emergency department, patient was cleared for pre-anaesthetic check-up and shifted for operative intervention by orthopaedic trauma team. As the patient was hemodynamically stable, the operating team opted for definitive fixation after thorough debridement for all long bone fractures. The patient was taken on radiolucent operating table and placed in supine position. Firstly, thorough irrigation and debridement of the wounds over medial aspect of distal femur, proximal leg and right hip were done (Figure 7). Distal femur fracture was addressed first as it was comminuted and there was risk of damage to popliteal vessels during manipulation of the limb. Distal femur fracture was managed with open reduction and internal fixation with lateral condyle buttressing locking plate. Intercondylar distal femur fracture was first converted into supracondylar femur fracture with the help of Kirschner wires (Figure 8). After fracture reduction was achieved and joint line was maintained, fracture was fixed with lateral condylar buttressing locking plate. After addressing distal femur, compound grade III B fracture of midshaft tibia was addressed using closed reduction and internal fixation with tibia interlocking nail. Polar screw was used while fixing tibia fracture to prevent the tibia nail from going posteriorly. Reduction was confirmed with the fluoroscopy guidance.

After treating the floating knee injury, next was addressing the fracture of right femoral neck. Patient was given left lateral position on radiolucent operating table and using lateral approach to the proximal femur, open reduction was done. A capsulotomy was carried out along the anterior neck and the fracture was reduced with manipulation and using Cobb and schanz pin. Reduction was confirmed under fluoroscopy guidance and fracture fixed with cannulated cancellous screws. At the conclusion of procedure, the wounds were addressed with stay suturing and vacuum assisted closure dressing. Patient was then shifted to recovery room for post-operative monitoring.

Figure 6 Three-dimensional Computed tomography scan of right knee with leg showing comminuted fracture of distal femur with mid-shaft tibia fracture with comminuted segmental shaft fibula fracture

Patient was subsequently shifted to the operating room on post-operative day 3 and day 7 for primary closure of his wounds. Post operatively patient was started on low-molecular weight heparin to prevent the chances of pulmonary embolism. Additionally, patient was advised to strictly avoid weight bearing over his right lower extremity. At 6 weeks post operatively, knee range of movement was initiated and patient was advised to bear weight over right lower-limb gradually up to pain tolerance with assistance. At the 8th week postoperatively, patient could bear weight over his right lower extremity with assistance but he had fixed flexion deformity of 10 degree and his knee range of movement was 10 to 50 degrees. Patient also had shortening of about 6 cm at 8th week post-operatively. The patient continuously underwent physical training to increase the hip and knee range of movements and strengthening of his quadriceps and knees. At this time, radiographs were taken which showed signs of callous formation at the femoral neck (Figure 11, 12) and shaft fractures as well as the tibia fracture (Figure 13A, 13B, 13C, 13D).

Figure 7 Intra-operative images following debridement of wound over medial aspect of right thigh and leg

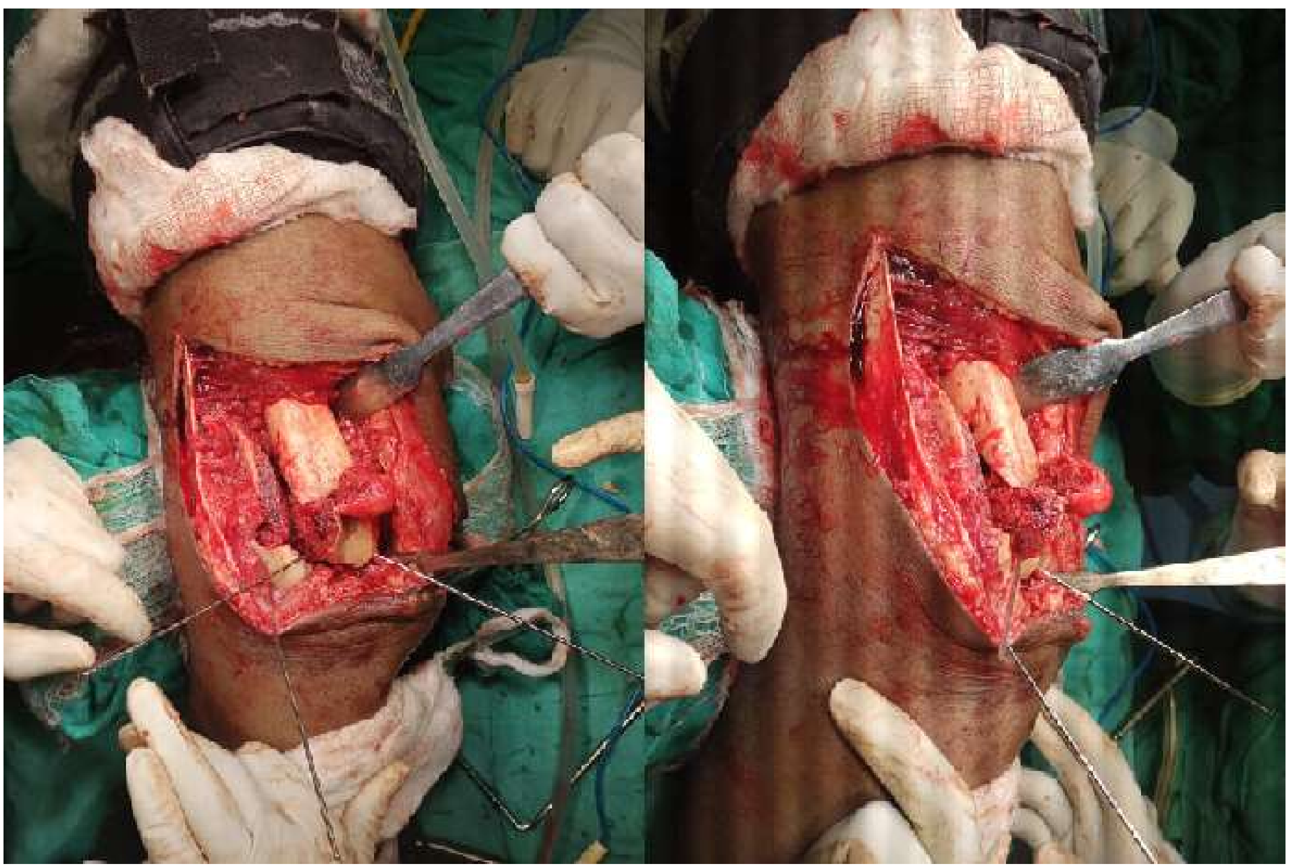

Figure 8 Intra-operative images showing fixation of distal femur fracture with Kirschner wires and lateral condylar buttressing plate

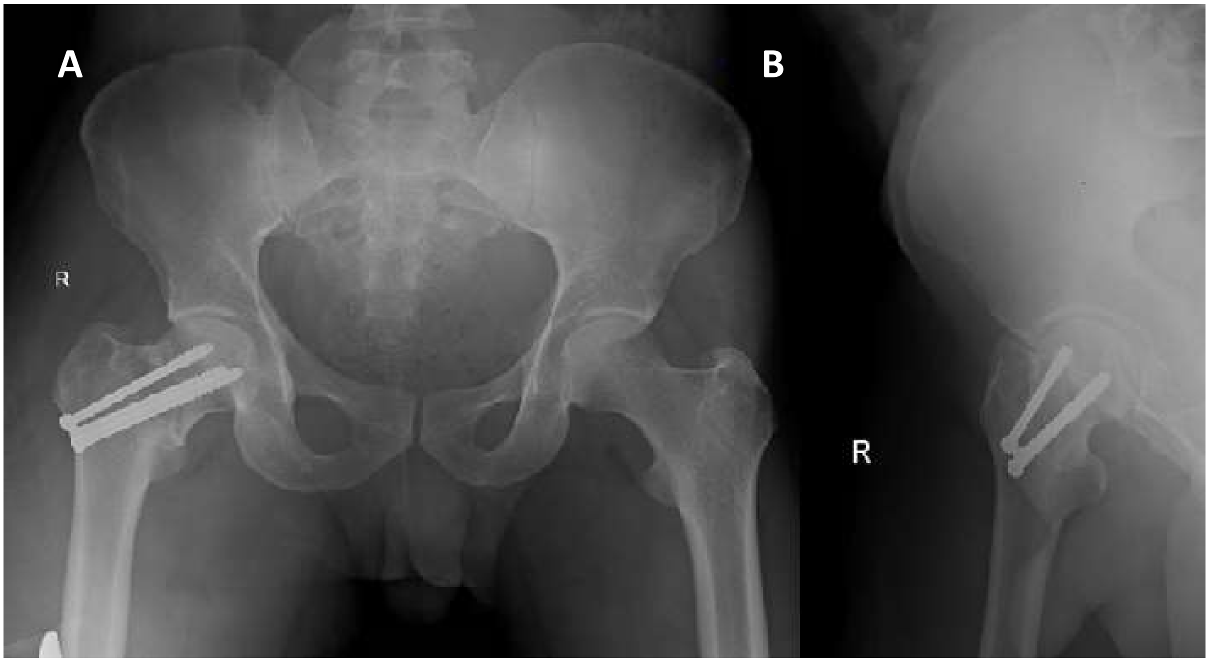

Figure 9 Post-operative radiograph of pelvis with both hips with neck femur fracture right side fixed with cannulated screws; A: Antero-posterior view; B: Lateral view

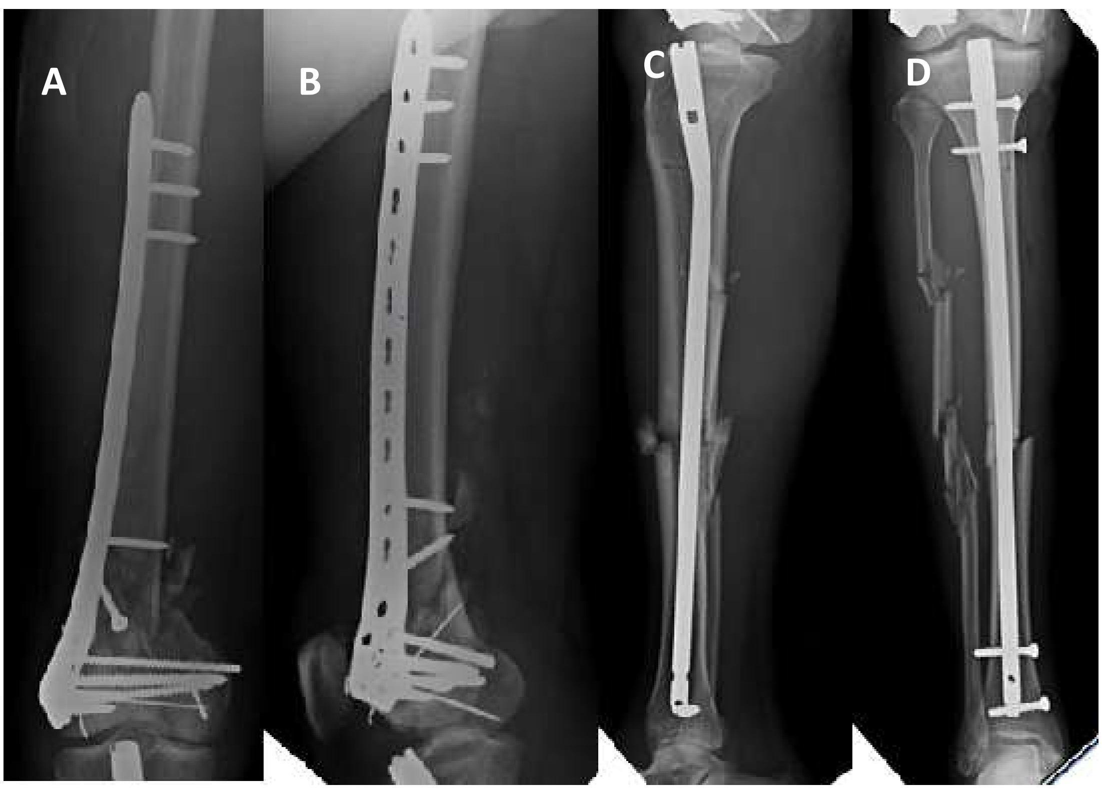

Figure 10 Post-operative radiograph showing; A: Antero-posterior view showing distal shaft femur fracture managed with lateral condylar buttressing plate and Kirschner wires; B: Lateral view showing distal shaft femur fracture; C: Lateral view showing mid-shaft tibia fracture managed with intra-medullary nail; D: Antero-posterior view showing mid-shaft tibia fracture managed with intra-medullary nail

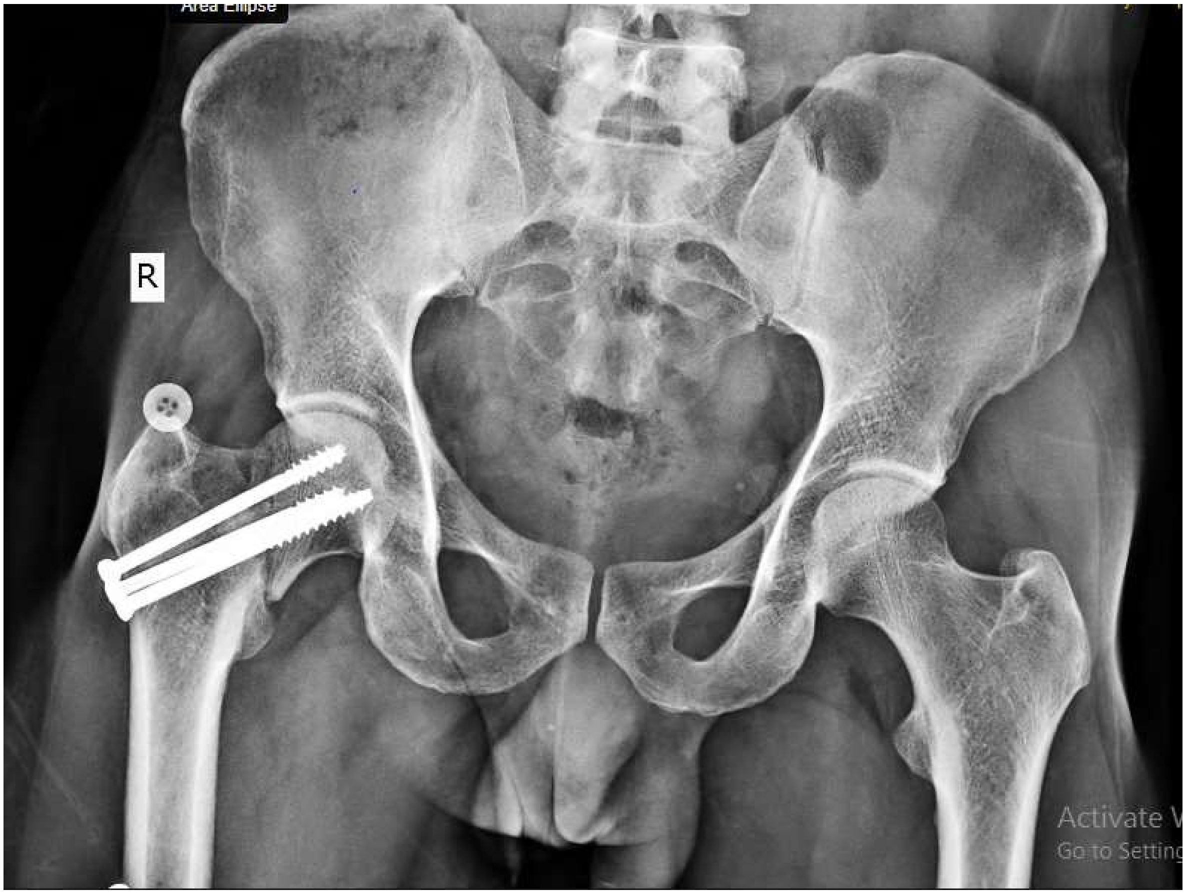

Figure 11 3 months post-operative radiograph of pelvis with both hips antero-posterior view showing signs of union at neck femur fracture site right side

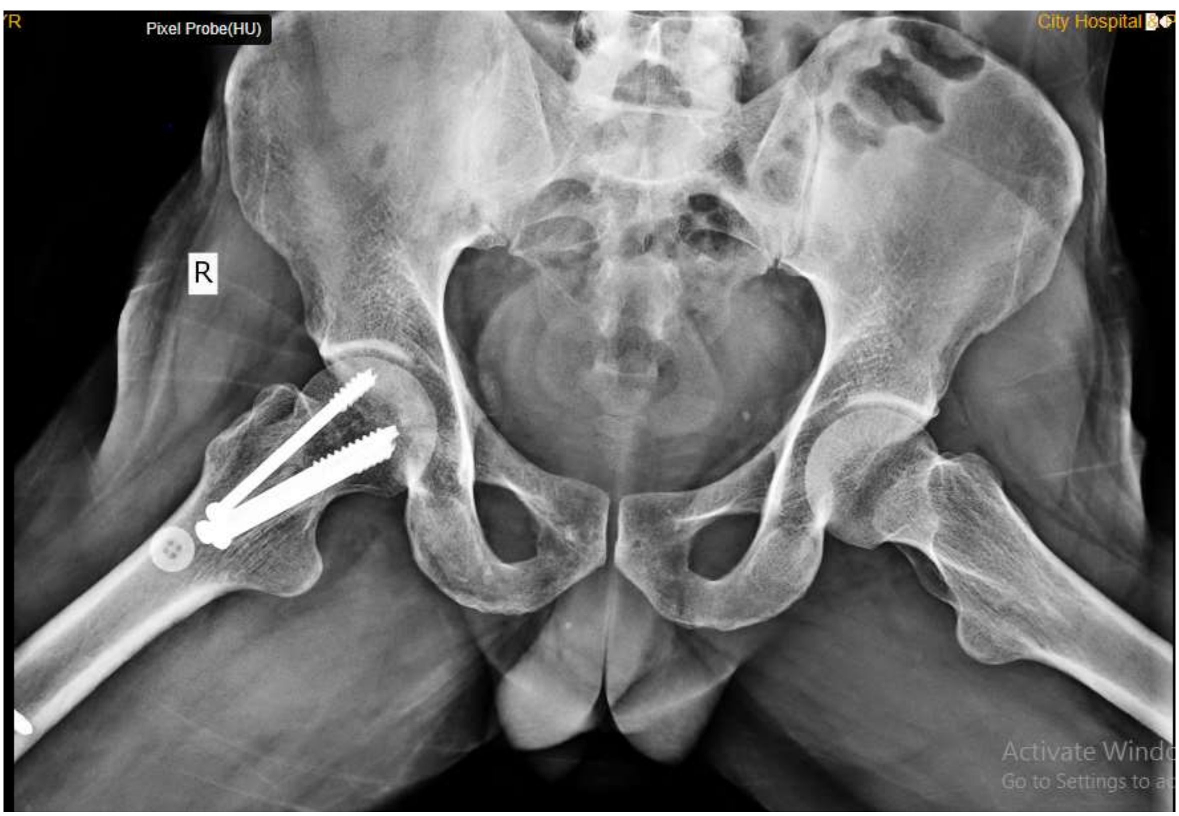

Figure 12 3 months post-operative radiograph of pelvis with both hips frog leg view showing signs of union at neck femur fracture site right side

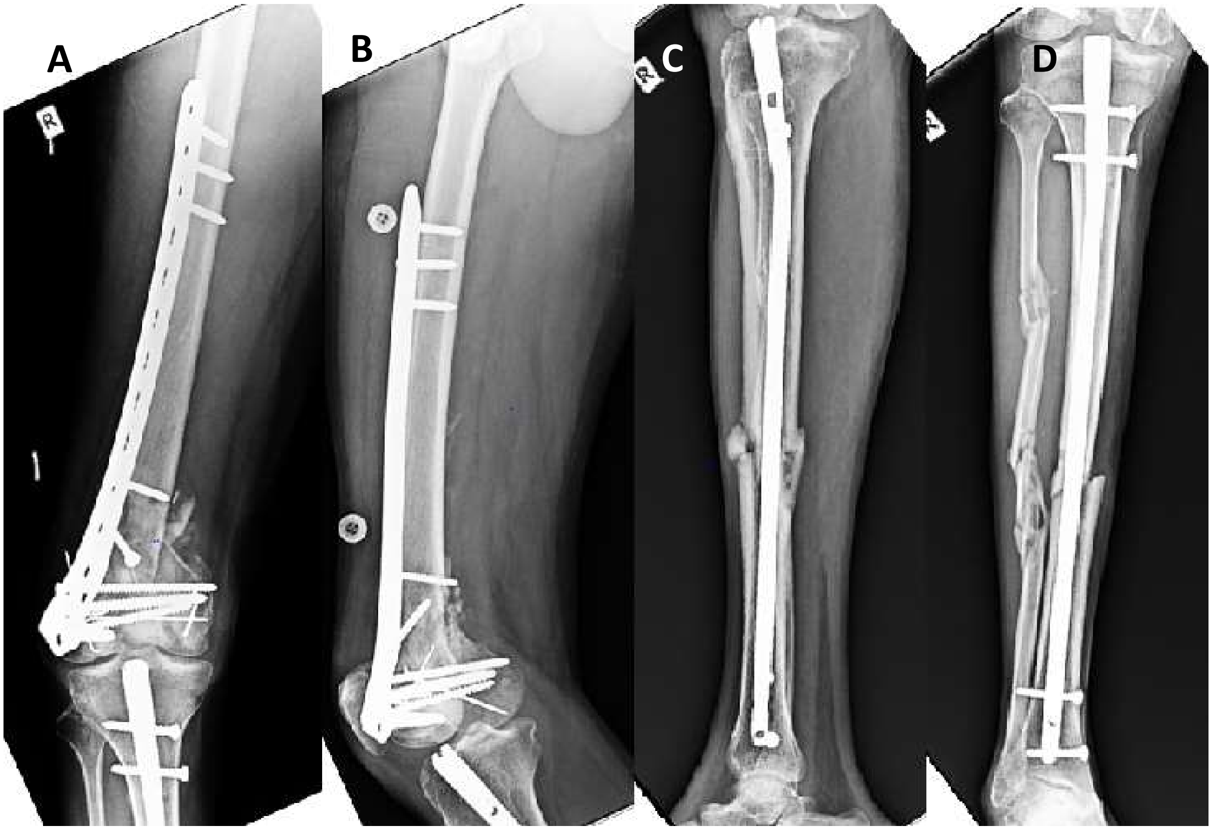

Figure 13 3 months post-operative radiographs showing; A and B: Antero-posterior and lateral views of distal shaft femur fracture managed with lateral condylar buttressing plate with varus collapse at the fracture site; C and D: Lateral and antero-posterior views of leg with midshaft tibia fracture managed with intra-medullary nail with signs of union

At the 3rd month follow-up, patient presented with loss of reduction and varus collapse at the distal femur fracture site. Patient was then advised to undergo another operative procedure to address the varus collapse of distal femur fracture and provide additional medial column buttressing plate to correct the varus collapse. Patient was then re-admitted and managed with open reduction using antero-medial distal femur approach and internal fixation with medial column locking buttressing plate along with bone grafting. Cortico-cancellous bone graft was harvested from iliac crest and utilized for fixation. Post-operatively, patient had no residual fixed flexion deformity and knee range of motion was started from day 3 onwards as tolerated (Figure 14A, 14B, 14C, 14D, 15). Patient was advised non-weight bearing mobilization for 2 weeks following which gradual weight-bearing was initiated for 3rd week onwards with support. At 6th week post-operatively (Figure 17), patient could bear full weight over his right lower-limb and his knee range of movement was 0 to 90 degrees. Shortening of 6 cm was reduced to about 3 cm post operatively. At 3 months follow-up after second surgery, patient had no fixed flexion deformity. His knee range of movement was up to 100 degrees, hip range of movement was 0 to 110 degrees. At this point, patient was able to walk full weight bearing without support (Figure 18A, 18B, 18C, 18D, 19A, 19B, 19C, 19D).

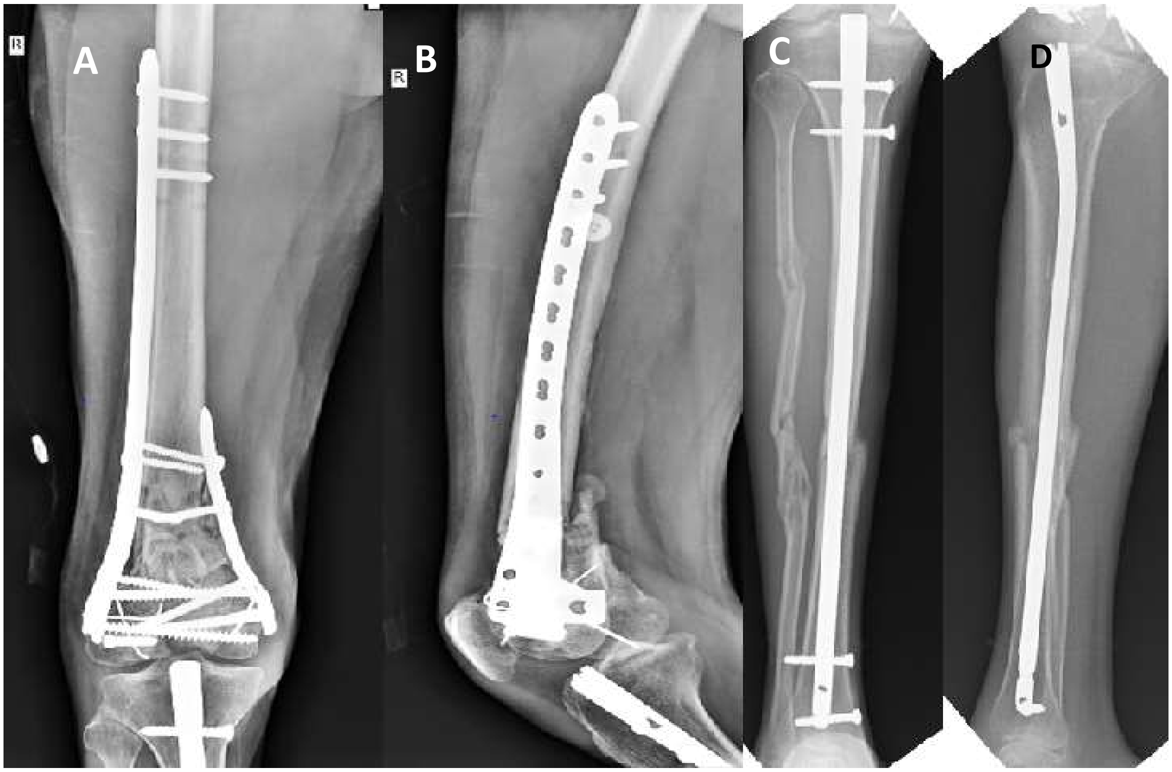

Figure 14 Day 2 post-operative radiographs after stage 2 surgery; A and B: Distal femur fracture revised with bi-columnar dual plating with bone grafting; C and D: Uniting fracture of mid-shaft tibia managed with intra-medullary nail and mal-uniting segmental shaft fibula fracture

Figure 15 Showing pelvis with both hips antero-posterior view with neck femur fracture managed with cancellous screws right hip showing union

Figure 16 Showing pelvis with both hips lateral view with neck femur fracture managed with cancellous screws right hip showing union

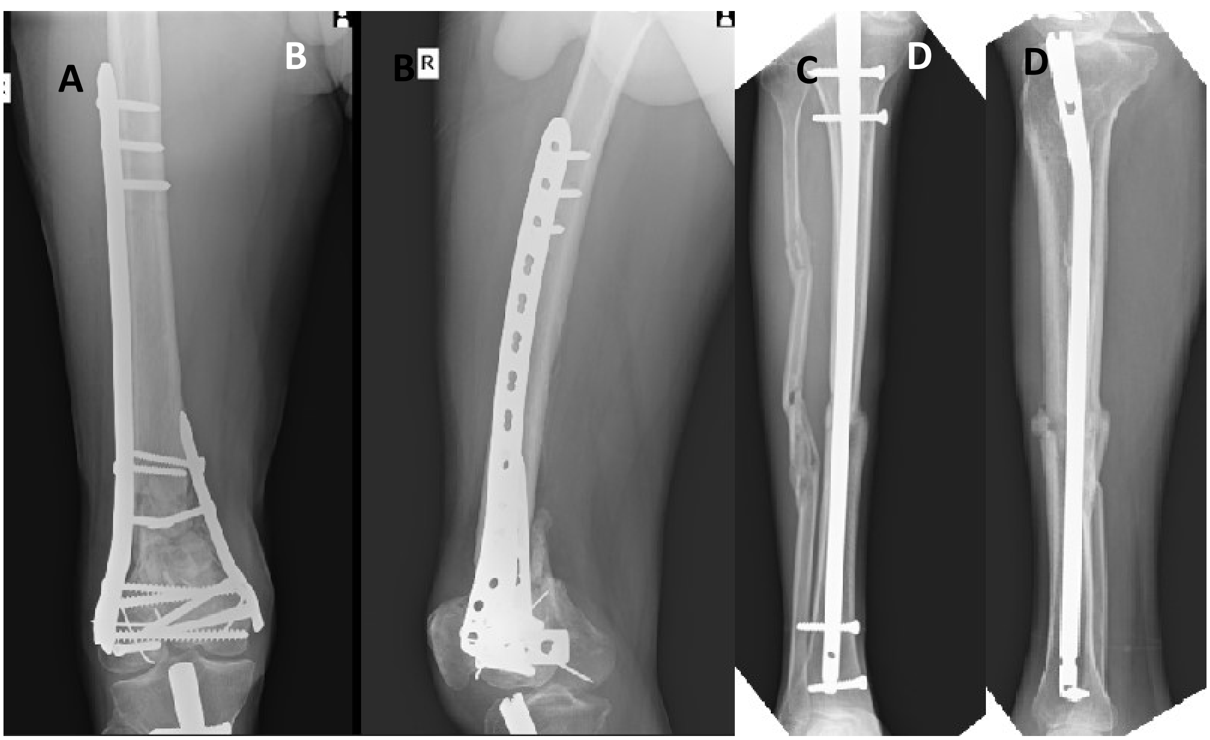

Figure 17 6 weeks post-operative following stage 2 surgery showing good signs of union with no varus or valgus mal-alignment of knee

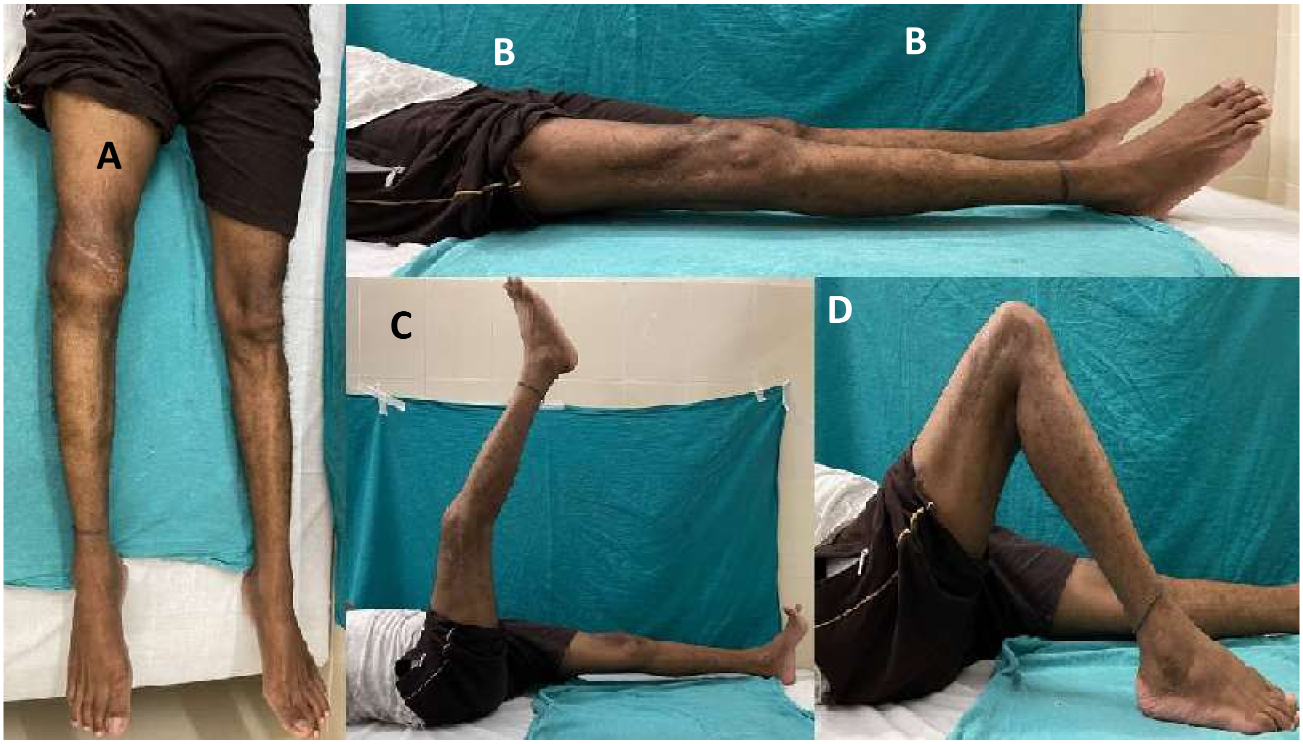

Figure 18 Clinical images showing hip and knee range of movements; A and B: full extension with no fixed flexion deformity, C: straight leg raising with hip range of movement upto 90 degrees; D: knee flexion upto 100 degrees

Figure 19 Clinical images showing hip and knee range of movements; A: Hip in 110-degree flexion; B: Knee flexion up to 90-degree in prone position; C and D: Hip rotations

3. DISCUSSION

Ipsilateral open fractures of femur neck, distal fourth shaft, as well as tibia and fibula fractures, are rare. Becher, (1951) was the first one to describe such injuries as a typical high-energy trauma. The situation where these two femoral fractures are further associated with shaft tibia and fibula fracture is extremely rare. Most of these cases when present with open injuries had to go for multiple operative procedures or amputations.

Palarčík et al., (1995) reported a stable per-trochanteric femur fracture along with a diaphyseal shaft femur transverse fracture and an undisplaced fracture of a distal femur. The surgeons used a reconstruction nail for fixing the per-trochanteric and diaphyseal fractures and the fractures involving distal femur fracture was operated with screws which locked the nail simultaneously (Palarčík et al., 1995). However, varus collapse and deformity at the per-trochanteric fracture occurred during union and a revision surgery was necessary.

There is currently no pre-determined concept on the ideal strategy for sequence of fixation of ipsilateral femoral neck, distal fourth femur shaft fractures and floating knee injuries. Many surgeons have preferred to first fixate the femoral neck fracture with either angled blade plate or a sliding hip screw to avoid high risk of complications (eg, avascular necrosis of the femoral head, non-union and varus deformity) (Swiontkowski et al., 1984; Bhandari et al., 2003; Wolinsky and Johnson, 1995; Singh et al., 2008; Boulton and Pollak, 2014). Some of the authors have advocated that first fixation of the shaft femur fracture should be done, which allows for improved manipulation of the distal fractures while fixing the more technically challenging femur neck fracture as was the scenario with current case.

While fixing the fractures involving distal femur, the fracture type and pattern should be taken into consideration. For type A fractures, it advisable to utilize retrograde intramedullary nails, in combination with Dynamic Hip Screw (DHS) or cannulated screws for fixation of the proximal femur fracture (Barei et al., 2003). Most of the authors were of the opinion that osteosynthesis using cancellous screws are enough for fixation of type B distal femur fractures (Bartonicek et al., 2000; Lambiris et al., 2003). Osteosynthesis of fracture with peri-articular Locking Compression Plate (LCP) may also be utilized in such cases. Most difficult scenarios are type C fractures of distal femur. Their management relies on the amount of destruction to articulating surface of distal femur and displacement of femoral condyles. For such fractures, combination of fixation intramedullary as well as extramedullary systems can be utilized such as LCP with retrograde femur nails (Käch, 1993).

Concerning the management of floating knee fractures, stabilization approach should be individualized to each patient's fracture type because no specific protocol exists. Intramedullary nailing for both femur and tibia fractures have been successfully utilized in type I floating knee injuries (Veith et al., 1984; Ostrum, 2000). As the unstable femur fracture can further induce more soft tissue injury while reducing and fixing tibia fracture, it has advocated that the fixation of femur should be done before the tibia. Furthermore, primary fixation of the distal femoral fracture allows for a more stability to approach the tibia fracture and allows access to the starting point (Ostrum, 2000; Lundy and Johnson, 2001).

In the current case, since the patient had compound grade III B injury, primary wound irrigation and debridement was done. Then the distal femur fracture was approached first to avoid any damage to popliteal vessels during manipulation while fixing other fractures. Secondly, shaft tibia fracture was addressed and fixed with intramedullary nail. Initial fixation of distal femur fracture allowed for easy manoeuvring of the tibia shaft fracture for reduction and fixation. Lastly, femur neck fracture was managed with three cannulated screws. At 3rd month following first surgery, patient had varus collapse at distal femur fracture site for which he was operated with secondary stabilization from medial aspect. Patient was managed with bi-columnar fixation for distal femur along with cortico-cancellous bone graft from iliac crest.

Davison, (2003) reported that lateral condylar buttressing plate permitted more than 5 degree of varus collapse to happen in about 42% comminuted fractures involving distal femur. Such cases needed second surgery within 6 months following primary treatment and needed medial column buttressing plate for better alignment and stability of distal femur fracture (Davison, 2003).

4. CONCLUSION

Ipsilateral open fractures of the proximal and distal ends of femur along with open fracture of shaft tibia and fibula are extremely rare injuries and are usually associated with very high velocity motor vehicle accidents. After stabilization of the long bone fracture, the sequence in which to fix the fractures is best left to the judgement of operating team and situations at hand. Primary stabilization of distal femur intra-articular fractures with bi-columnar plate osteosynthesis after adequate reduction of fracture should be advocated to prevent the varus collapse of distal femur. Such cases are very rare and extremely difficult to manage and every case needs an individualized tailored approach from case-to-case basis because no standard protocol exists.

Acknowledgement

The authors would like to thank Dr Aditya Kekatpure, Associate Professor, Department of Orthopaedics, DMIHER for operating such a complex case and proving us materials and formulating structure for writing this case report.

Author Contributions

Vivek Jadawala has collected information and prepared the manuscript which has been thoroughly reviewed by Aditya Kekatpure, Sanjay Deshpande and others. All the authors have read and agreed to the final manuscript.

Informed consent

Written & Oral informed consent was obtained from the patient included in the study.

Funding

This study has not received any external funding.

Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

REFERENCES AND NOTES

1. Adamson GJ, Wiss DA, Lowery GL, Peters CL. Type II floating knee: Ipsilateral femoral and tibial fractures with intra articular extension into the knee joint. J Orthop Trauma 1992; 6(3):333-339.
2. Barei DP, Schildhauer TA, Nork SE. Non-contiguous fractures of the femoral neck, femoral shaft and distal femur. J Trauma 2003; 55:80–86. doi: 10.1097/01.TA.0000046259.43886.25
3. Bartonicek J, Stehlík J, Douša P. Ipsilateral fractures of the hip, femoral shaft, distal femur and patella. Hip Int 2000; 10:174–177. doi: 10.1177/112070000001000307
4. Becher H. Nagelung der Schenkelhalsfraktur bei gleichzeitig bestehender Oberschenkelfraktur (Nailing of femur neck fracture nailing of femur neck fracture with a concomitant fracture of femur head). Zentralbl Chir 1951; 76(23):1609-1612.
5. Bhandari M, Tornetta P 3rd, Hanson B, Swiontkowski MF. Optimal internal fixation for femoral neck fractures: Multiple screws or sliding hip screws? J Orthop Trauma 2009; 23(6):403-7. doi: 10.1097/BOT.0b013e318176191f
6. Blake R, Mc-Bryde A Jr. The floating knee: Ipsilateral fractures of the tibia and femur. South Med J 1975; 68(1):13-16.
7. Boulton CL, Pollak AN. Special topic: Ipsilateral femoral neck and shaft fractures-does evidence give us the answer? Injury 2015; 46(3):478-483. doi: 10.1016/j.injury.2014.11.021
8. Davison BL. Varus collapse of comminuted distal femur fractures after open reduction and internal fixation with a lateral condylar buttress plate. Am J Orthop (Belle Mead NJ) 2003; 32(1):27-30.
9. Delaney WM, Street DM. Fracture of femoral shaft with fracture of neck of same femur; treatment with medullary nail for shaft and Knowles pins for neck. J Int Coll Surg 1953; 19(3):303-312.
10. Douša P, Bartoníček J, Krbec M. Ipsilateral fractures of the hip and femoral shaft (in Czech). Acta Chir Orthop Traum Cech 1998; 65:299–312.
11. Fraser RD, Hunter GA, Waddell JP. Ipsilateral fracture of the femur and tibia. J Bone Joint Surg Br 1978; 60-B(4):510-515. doi: 10.1302/0301-620X.60B4.711798
12. Gregory P, Di-Cicco J, Karpik K, Di-Pasquale T, Herscovici D, Sanders R. Ipsilateral fractures of the femur and tibia: Treatment with retrograde femoral nailing and unreamed tibial nailing. J Orthop Trauma 1996; 10(5):309-316. doi: 10.1097/00005131-199607000-00004
13. Käch K. Kombinierte Frakturen des Schenkelhalses mit Femurschaftfrakturen (Combined fractures of the femoral neck with femoral shaft fractures). Helv Chir Acta 1993; 59 (5-6):985-992.
14. Lambiris E, Giannikas D, Galanopoulos G, Tyllianakis M, Megas P. A new classification and treatment protocol for combined fractures of the femoral shaft with the proximal or distal femur with closed locked intramedullary nailing: Clinical experience of 63 fractures. Orthopaedics 2003; 26:305–309. doi: 10.3928/0147-7447-20030301-10
15. Lundy DW, Johnson KD. Floating knee injuries: Ipsilateral fractures of the femur and tibia. J Am Acad Orthop Surg 2001; 9(4):238-45. doi: 10.5435/00124635-200107000-00003
16. Ostrum RF. Treatment of floating knee injuries through a single percutaneous approach. Clin Orthop Relat Res 2000; (375):43-50. doi: 10.1097/00003086-200006000-00006
17. Palarčík J, Nestrojil P, Bucek P. Rekonstrukcní nitrodrenový femorální hreb (Nový implantát k syntéze soucasných zlomenin těla a krcku téhoz femoru firmy Medin, a.s.-predběžná informace (Reconstruction with intramedullary

femoral nailing (a new implant made by Medin, A.S. for synthesis of concurrent fractures of the femoral shaft and neck-preliminary report))). Rozhl Chir 1995; 74(6):305-308.

18. Pape HC, Tornetta III P, Tarkin I, Tzioupis C, Sabeson V, Olson SA. Timing of fracture fixation in multi trauma patients: The role of early total care and damage control surgery. J Am Acad Orthop Surg 2009; 17(9):541–9. doi: 10.5435/00124635-200909000-00001
19. Sands S, Siska PA, Tarkin IS. Reconstructive strategies for skeletal complications in the polytrauma patient. In: Pape HC, Sanders R, Borrelli J (Editors). The poly-traumatized patient with fractures. Heidelberg, Berlin: Springer-Verlag 2011.
20. Shukla R, Choudhari SG. Revision surgery in comminuted distal onethird femur fracture using retrograde intramedullary nail: A case report. Medical Science 2023; 27: e78ms2697. doi: 10.54905/disssi/v27i132/e78ms2697
21. Singh R, Rohilla R, Magu NK, Siwach R, Kadian V, Sangwan SS. Ipsilateral femoral neck and shaft fractures: A retrospective analysis of two treatment methods. J Orthop Traumatol 2008; 9(3):141-147. doi: 10.1007/s10195-008-0025-3
22. Swiontkowski MF, Winquist RA, Hansen ST Jr. Fractures of the femoral neck in patients between the ages of twelve and forty-nine years. J Bone Joint Surg Am 1984; 66(6):837-846. doi: 10.2106/00004623-198466060-00003
23. Veith RG, Winquist RA, Hansen ST Jr. Ipsilateral fractures of the femur and tibia. A report of fifty-seven consecutive cases. J Bone Joint Surg Am 1984; 66(7):991-1002.
24. Wolinsky PR, Johnson KD. Ipsilateral femoral neck and shaft fractures. Clin Orthop Relat Res 1995; (318):81-90.