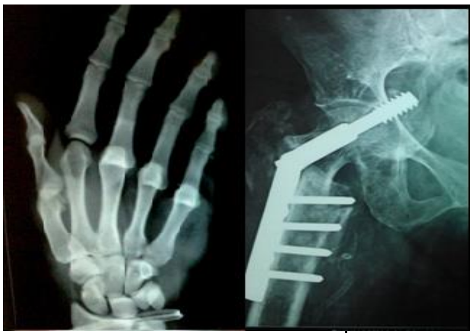

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Double segmental femur fracture: Two case reports with a technical note and perioperative illustration

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Abstract
Double segmental femur shaft fractures are rare and are challenging in terms of closed reduction and intramedullary nailing. These fractures are further complicated by non-union and malalignment. Here, we present two such cases with a technical note, pre- and postoperative radiographs, perioperative illustrations and the successful management of non-union (in one case).

Keywords: Double segmental femur fracture, intramedullary nailing, nonunion, complex femur fracture

Introduction

Complex double segmental femur shaft fractures are rare injuries and pose a great challenge for trauma surgeons[1]. Closed intramedullary nailing is the preferred method of fixation for femur shaft fractures[2, 3]. There are four main fracture fragments involved in double segmental femur fractures. The proximal fragment exhibits the typical deformities of flexion, abduction and external rotation due to strong muscular forces. The two intermediate segments exhibit adduction deformity, and the distal most fracture segment will be in flexion. Due to these complex deformities, these fractures are usually not amenable to closed reduction. Here, we present two such cases—a 40-year-old male and a 45-year-old male treated by intramedullary nailing using percutaneous joysticks and a minimally invasive clamp-assisted reduction technique supported by radiographs and perioperative illustrations.

Case 1

A 40-year-old man presented with a closed double segmental femur shaft fracture (figure-1A, B, C) following a high-velocity road traffic accident. He was hypotensive on arrival with blood pressure of 90/60 mmHg and a serum lactate level of 4.3 mmol/L. After fluid resuscitation, he underwent damage control surgery, and a femur external fixator was applied (figure-1D). Definitive fixation with intramedullary reconstruction nailing was planned after three days.

Technical note

The patient was placed in a supine position on a traction table. Fracture fragments exhibited the typical deformities due to strong muscle forces. The flexion, abduction and external rotation deformities of the proximal fragment were corrected with a minimally invasive clamp-assisted reduction technique using a 3 cm skin incision. The adduction deformity of the two intermediate fragments was corrected using Schanz pins with a T-handle attachment (figure-2). The flexion deformity of the distal fragment was then corrected using another Schanz pin with a T-handle attachment. Using these minimally invasive devices, the length, rotation and alignment of femur were achieved. An entry awl was used to open the canal, taking care to place the entry point more medial to the trochanter to prevent the varus deformity of proximal fragment, and the guide wire was passed across the fracture site. The critical step is to centre the guide wire in the distal femur in both orthogonal views to prevent any varus,valgus or flexion deformity. Next, the Schanz pins were made unicortical, and gentle serial reaming was performed while maintaining the reduction.

Unicortical Schanz pins also prevents the spinning of middle fragments while reaming. Excessive reaming should be avoided, as it may cause further devascularization of critical intermediate fragments. Finally, an intramedullary nail 9 mm in diameter was used to stabilize the fracture (figure-1E, F).

The postoperative treatment consisted of non-weight bearing mobilization in a walker for four weeks, followed by partial weight bearing. After that, radiographs are repeated and full weight bearing was started. At 9 months, the patient had a persistent limp and pain on weight bearing. On plain radiographs, the fracture gap was seen at the proximal and intermediate segments (figure-1G, H). A CT scan at this stage showed non-union at the proximal and intermediate fragments and also between the two intermediate fragments (figure-1I, J). Union was achieved between the intermediate and distal fragments. Iliac crest bone grafting and augmentation plating (a dynamic compression plate) was done at this stage (figure-1K, L, M). Complete radiological union was achieved after 6 months following bone grafting, with a full range of hip and knee motion (figure-1N).

Case 2:

In 2017, a 45-year-old male sustained a high-velocity road traffic accident and presented with a closed double segmental femur fracture (figure-2A, B). He presented to the emergency room within 3 hours. He was hemodynamically stable on arrival with a serum lactate level of 3.5 mmol/L. His distal neurovascular status was intact. He is a known diabetic. Surgery was scheduled for the next day once the patient's serum lactate level normalized; closed reduction and intramedullary nailing was planned.

Operative treatment under combined spinal and epidural anaesthesia was performed. Mini-open clamp-assisted reduction was used to correct the deformity of the proximal fragment. Subsequently, Schanz pins with a T- handle attachment was inserted into the intermediate and distal fragments to correct the adduction and flexion deformities, respectively. Once satisfactory reduction was achieved, a starting awl was used to open the canal, and a guide wire was negotiated across the fragments and centralized in the distal fragment. Gentle serial reaming was done, and a 9 mm diameter nail was inserted. After checking the alignment and rotation, proximal and distal locking was done.

The postoperative treatment consisted of mobilization in a walker for four weeks without weight bearing, followed by gradual weight bearing. The outcome was excellent with successful radiological fracture healing at 9 months (figure-2C, D). His clinical examination revealed a normal hip and knee motion without any limb length discrepancy or rotational malalignment (figure-2E). The patient was able to resume his pre-injury occupation.

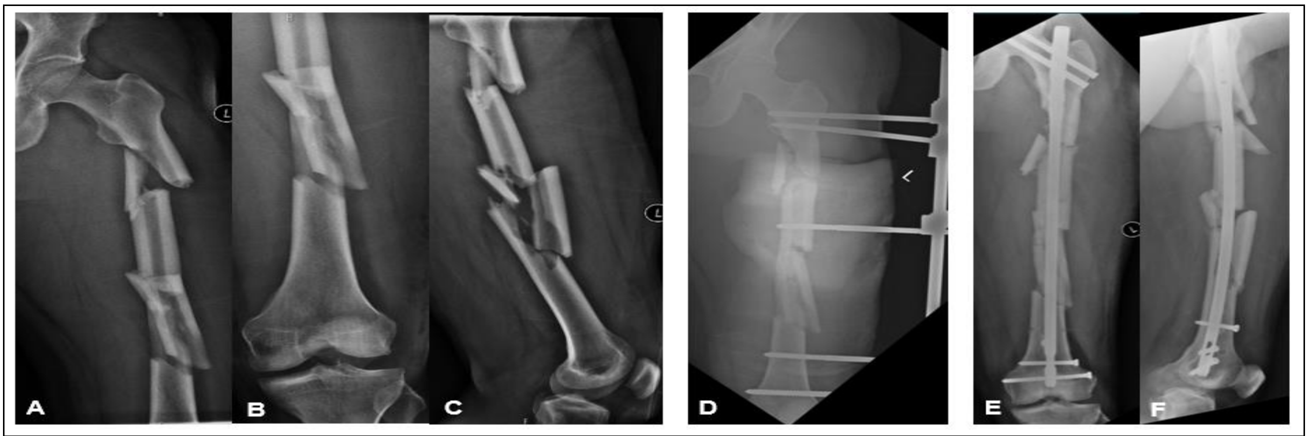
Discussion

Double segmental femur shaft fractures are rare injuries and have barely been reported in the literature. These are high-energy injuries and require careful systemic evaluation [4]. In this report, both patients had elevated serum lactate levels, and one patient presented with hypotension (therefore, damage control was performed). Adequate resuscitation should be done before definitive skeletal stabilization.

Double segmental femur shaft fractures have four main fracture fragments with complex deforming forces. These deformities make closed reduction and intramedullary nailing difficult, particularly in identifying the nail entry point. The most critical aspect of this operation is to reduce the fractures before nail placement. Many closed reduction techniques, such as the use of ball-spiked pushers, clamps and intramedullary reduction devices; minimally invasive clamp-assisted reduction[5]; minimally invasive reduction using haemostatic forceps[6]; and four-pin reduction technique[7] have been described in reducing the fragments. A combination of one or more of these reduction techniques may be needed to achieve successful closed reduction. We used minimally invasive clamp-assisted reduction to correct the flexion, external rotation and abduction deformity of the proximal fragment. Reduction clamp helps to get a better hold on the proximal fragment then a unicortical Schanz pin, to overcome the strong deforming forces, especially in young individuals. Overcorrecting the deformity of the proximal fracture segment by hyper-adducting using reduction clamp facilitates a better entry point trajectory of the nail. Further, literature had shown that open reduction of fracture at the subtrochanteric level was not associated with higher complication rates [8].

Union achieved at 15 months and 9 months in our cases. This is higher than the average reported union time for femur fractures [9, 10]. Further, one of our cases required bone grafting to achieve union despite closed nailing using percutaneous techniques. This is attributed to the high energy mechanism of injury and the extent of soft tissue damage to the critical intermediate fragments. Patients should be cautioned regarding the chances of delayed-union and non-union in these cases.

In conclusion, double segmental femur shaft fractures are rare injuries and are not reported in the literature. Intramedullary nailing using minimally invasive techniques gives satisfactory results. However, chances of delayed union and non-union with subsequent need for bone grafting need to be explained to the patients.



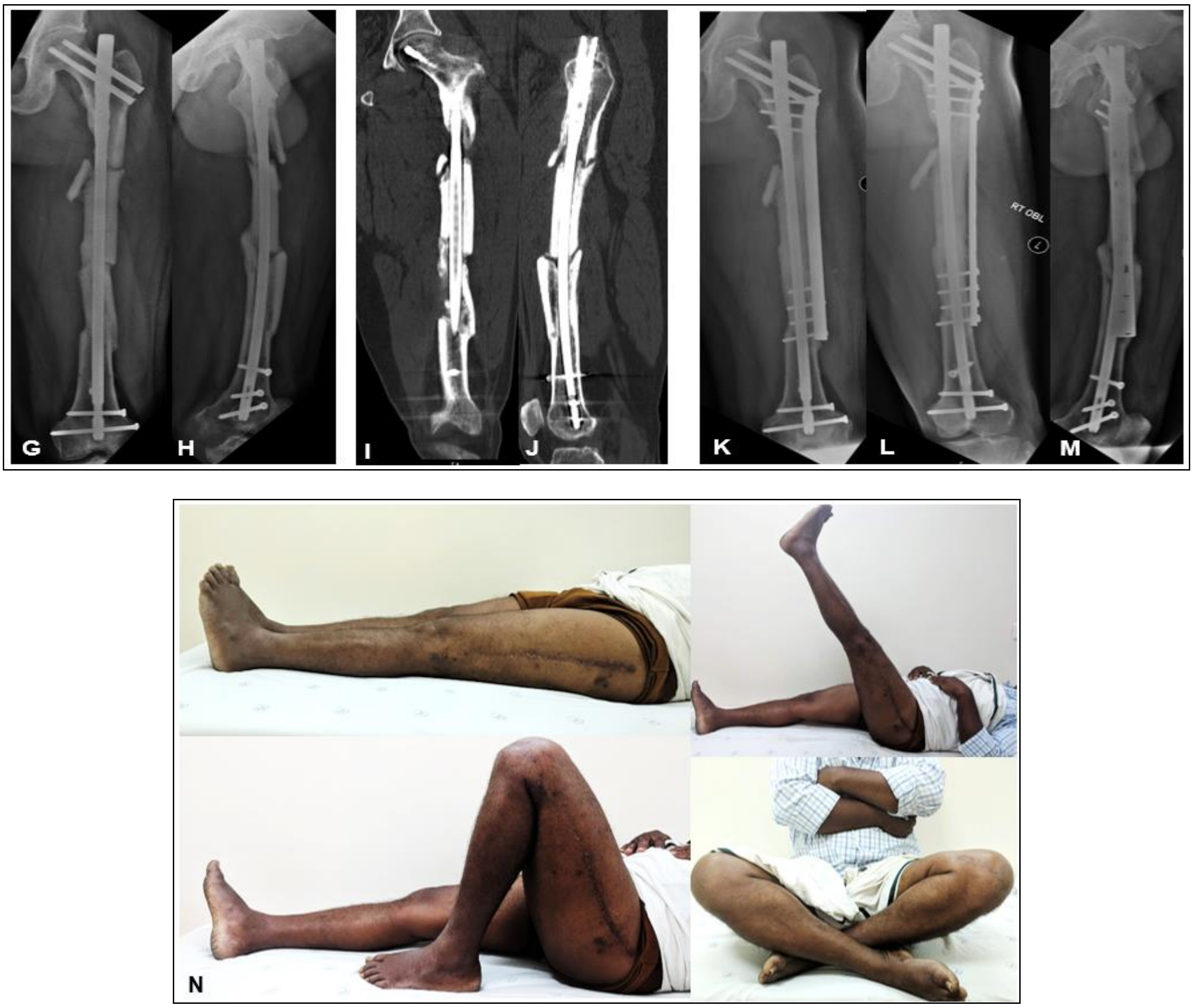


Fig 1: Representative radiographs of double segmental femur fracture in case-1. A, B, C – Pre-operative anteroposterior and lateral radiographs showing double segmental femur fracture with proximal fragment in typical flexion, abduction and internal rotation deformity. D – Radiograph showing initial damage control external fixator. E, F –Immediate post-operative anteroposterior and lateral radiographs following intramedullary nailing with good alignment. G, H – Radiographs at 9-months follow up showing nonunion at the proximal and intermediate fracture level. I, J – Representative CT scan (coronal and sagittal cuts respectively) showing gap at the proximal and intermediate segments. K, L, M – 6 months following bone grafting and augmentation plating with successful union. N – Clinical pictures showing good hip and knee functional range of movements.

Fig 2: Representative intraoperative clinical illustration showing minimally invasive clamp assisted reduction at subtrochanteric level (white arrow) and two shanz pins with T-attachment in the intermediate fracture segments to correct the adduction deformity (yellow arrow).

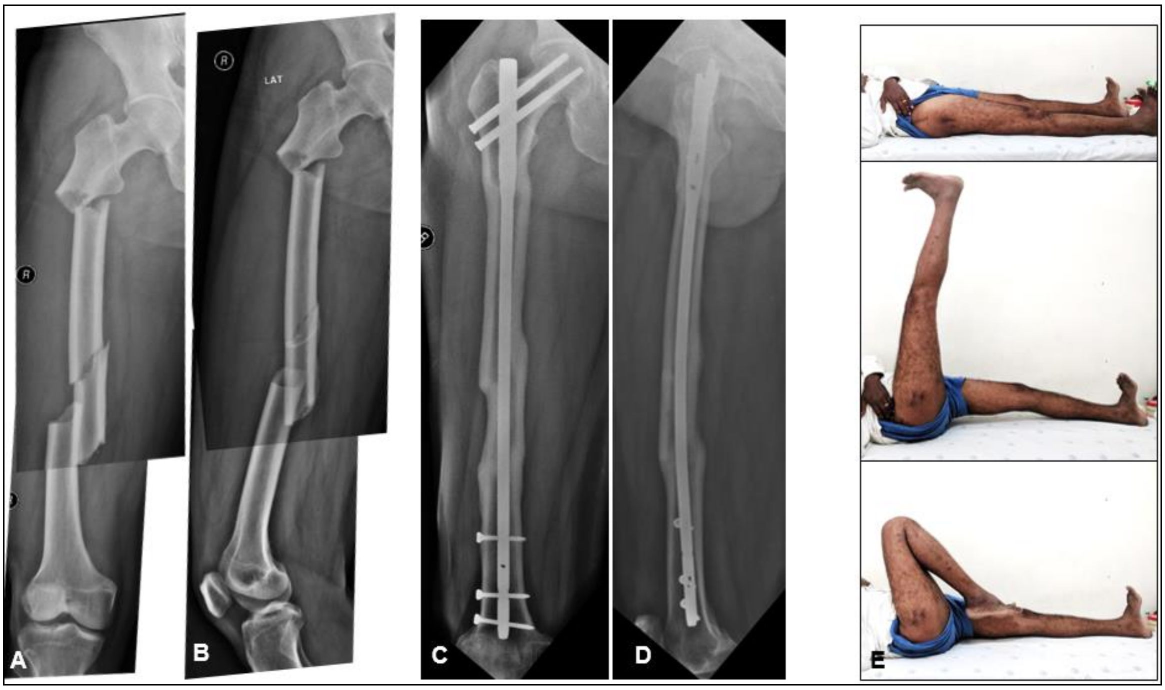


Fig 3: Representative radiographs of double segmental femur shaft fracture in case-2. A, B – Pre-operative anteroposterior and lateral radiographs showing double segmental femur fracture. C, D – 9 months post-operative anteroposterior and lateral radiographs showing successful union with good alignment. E – Clinical pictures showing good hip and knee functional range of movements.

Conflicts of Interest: The Authors declares that there is no conflict of interest

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Ethics and patient consent: Written informed consent for patient information and images for publication was provided by the patients.

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