

Medial femoral condyle fracture as a complication of antegrade intramedullary nailing

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Abstract A 49-year-old man suffered a closed oblique fracture of the middle third of his left femur. Closed reduction and internal fixation by intramedullary (IM) nailing were performed. Per-operative fluoroscopic imaging and initial postoperative X-rays were judged normal and the patient followed the usual rehabilitation protocol. At 3-month follow-up the patient still demonstrated poor knee function and pain. A plain X-ray and a CT scan of the left knee revealed a displaced fracture of the medial femoral condyle. Analysis of the postoperative imaging suggests that the fracture occurred during the insertion of the IM nail. The nail possibly hit the Steinmann traction pin in the distal femur causing the medial condyle fracture. The patient was reoperated; open reduction and internal plate and screw fixation were performed with satisfactory clinical progress postoperatively. The description and illustration of this case is intended to make trauma surgeons aware of this rare but serious complication of IM femoral nailing.

Keywords Fracture · Femoral · Intramedullary nailing · Complication · Condyle

Introduction

Closed reduction and locked intramedullary (IM) nailing is a well-established treatment of diaphyseal femoral fractures. It yields high union and low complication rates [1]. Common complications reported are non-union and

mal-union, leg length discrepancy, pulmonary fat embolism and infection [2, 3]. Other rather technical complications, such as material failure and peri-operative fractures are infrequent and have only been described in case reports [4–7]. We report a peri-operative distal femoral fracture as a previously undescribed complication of IM femoral nailing.

Case report

A 49-year-old man was admitted to our emergency department after a fall from a rooftop. Physical examination and standard radiographs revealed an isolated closed oblique midshaft fracture of his left femur (AO 32 A2; Fig. 1). The closed reduction on a fracture table under fluoroscopic control was performed under general anaesthesia. Skeletal traction by means of a supracondylar 4 mm Steinmann pin was used. In our institution, a femoral traction pin is usually introduced through the distal femur from medial to lateral at the level of the superior pole of the patella under fluoroscopic control. Internal fixation was accomplished with a reamed antegrade locked IM nail. Intraoperative fluoroscopic imaging and initial postoperative X-rays of the femur showed satisfactory fracture reduction and nail position (Fig. 2). The patient followed the usual rehabilitation programme with early mobilisation and partial weight bearing. Clinical examination at 3 months follow-up revealed persisting pain, joint effusion and limited mobility of the left knee. A CT scan demonstrated a displaced fracture of the medial femoral condyle (AO B2.1) with mal-union (Fig. 3). The femoral shaft fracture was healed. Critical analysis of the imaging results concluded that the fracture occurred during insertion of the IM nail and was due to a conflict between the

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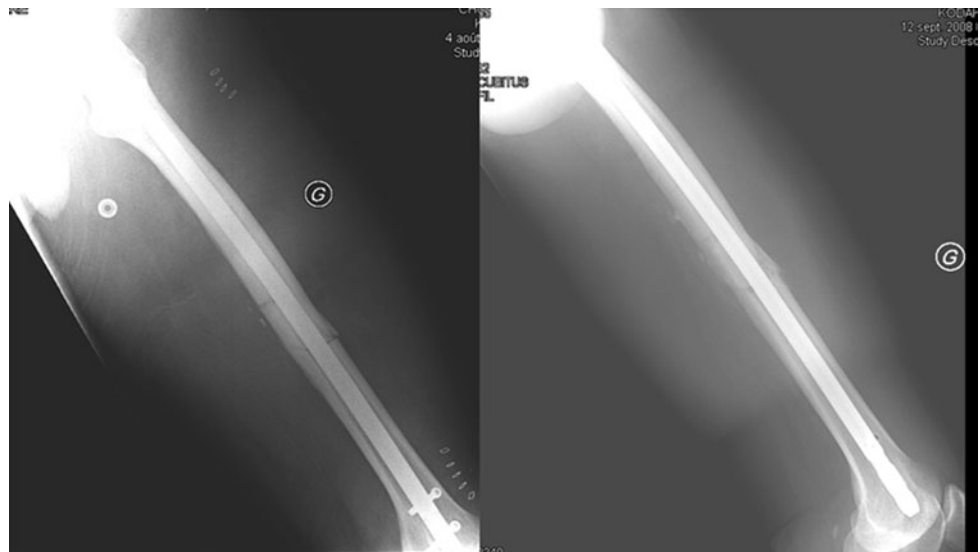
distal nail tip and the too distally placed Steinmann traction pin (see “[Discussion](#)”).

Revision surgery was carried out under spinal anaesthesia with a tourniquet on the proximal left thigh. A standard anterior surgical approach with medial para-patellar arthrotomy was performed (Fig. 4). The fracture was anatomically reduced leaving the IM nail in place. Stable fixation was achieved by a 3.5 mm tubular banding plate and interfragmentary screws (Fig. 5).



Fig. 1 Plain X-rays of the diaphysal femoral fracture (AO 32 A2)

Fig. 2 Plain X-rays after osteosynthesis by an anterograde IM nail with satisfactory alignment



Limited weight bearing and knee mobilisation was resumed on the first postoperative day. At 3-month follow-up the patient had resumed pain-free full weight bearing. Standard radiographs confirmed fracture consolidation in anatomic position (Fig. 6). At 18 months the femoral nail was removed. Full leg X-rays showed physiological alignment of the leg (Fig. 7). At 2-year final follow-up the patient was satisfied with the overall result. He complained only of occasional anterior knee pain during sport activities. Subjective scoring scales showed good results (IKDC score [8]: 71.3, Tegner–Lysholm Knee score [9]: 85 %). The patient had full range of motion and stable knee on physical examination, the Knee Society Score [10] showed good results (70 %).

Discussion

Closed IM nailing has been considered to be the preferred treatment for diaphyseal femoral fractures [1, 11]. The aim of this case report was to discuss the yet undescribed complication of a per-operative medial condyle fracture. Common complications reported are non-union in up to 9.6 % in severely comminuted fractures [3]. Mal-union, most frequently rotational, is seen in 28 % ($>15^\circ$) [12], leg length discrepancy in 2 % (>2 cm) [2] and infection (0.9 %) [2]. Pulmonary fat embolism in the polytrauma patient is associated with IM femoral nailing and it is still debated, whether IM reaming enhances the risk compared to a non-reaming technique [13, 14]. Severe heterotopic ossification of the hip following IM femoral nailing occurs in up to 5 % of cases [15].

Also technical complications in IM nailing, such as breakage of the plastic medullary tube have been described

Fig. 3 CT scan reconstruction of the media condyle fracture (AO 33 B2.1)

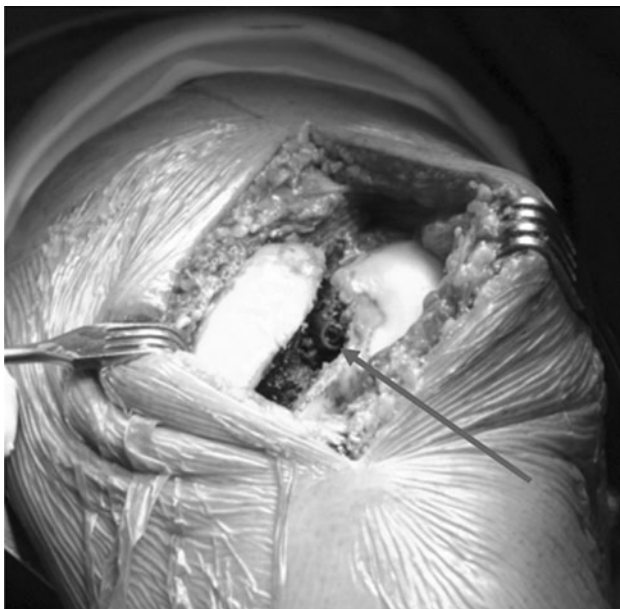
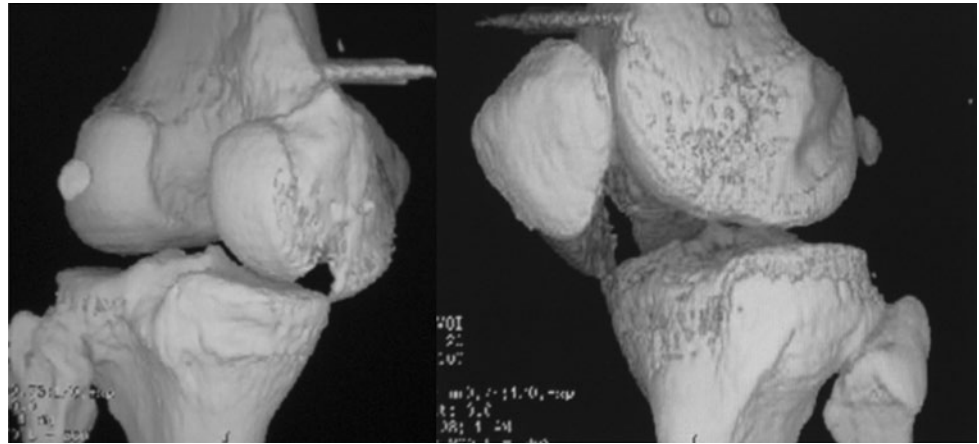
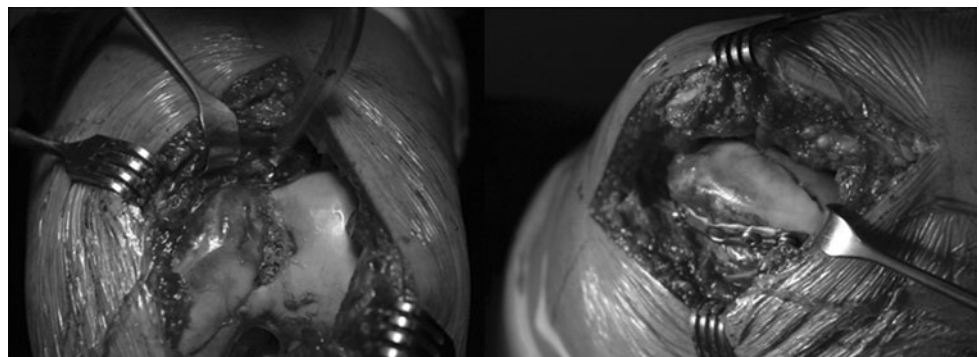


Fig. 4 Intra-operative images during revision surgery of the media condyle fracture, the tip of the IM nail is visible on the fracture site (see arrow)

Fig. 5 Intra-operative images during revision surgery after reconstruction of the media condyle fracture showing anatomic reduction and osteosynthesis by a 3.5 mm tubular banding plate and interfragmentary screws



[4, 5]. Intra-operative comminution of the fracture site during nail insertion is also a known complication [1]. Femoral neck fractures may be initially associated with an ipsilateral femoral midshaft fracture in up to 9 % of cases [16]. However, there are also reports of iatrogenic femoral neck fractures during femoral IM nailing [6, 17]. Grala et al. [18] reported two cases of femoral neck fractures after misplaced nail end caps and their unsuccessful manoeuvres to retrieve those. Finally, Grimme et al. [7] presented one case of a medial femoral condyle fracture during extraction of a retrograde IM femoral nail.

In our case, we see three possibilities for the origin of the medial condyle fracture: undetected pre-operative, intra-operative iatrogenic or a new post-operative insult. An undetected pre-operative fracture could be excluded by careful evaluation of the initial radiographs (see Fig. 1). A post-operative new incident was not reported by the patient and therefore seems unlikely. Unfortunately, only the intra-operative fluoroscopic views of the diaphyseal fracture site and the proximal and distal locking screws were printed and saved. The femoral condyles can not be evaluated on these prints. The CT scan images obtained 3 months after



Fig. 6 Plain X-rays after reconstruction of the medial condyle fracture showing anatomic reduction



Fig. 7 Total leg standing X-ray showing physiologic alignment



Fig. 8 Sagittal reconstruction of the post-operative CT scan of the left knee: the *arrow* shows the remaining hole of the previously used traction pin; distal to the recommended anterior metaphyseal position

the initial operation suggest an overly distal trajectory of the temporary Steinmann traction pin (see Figs. 8, 9).

During insertion, the advancing IM nail may have hit the Steinmann pin causing the large medial condylar fracture (see Fig. 10). It is highly unlikely that axial traction alone on the Steinmann pin was sufficient to cause this fracture. However, the CT images show a direct contact of the distal end of the femoral nail and the trajectory of the Steinmann pin (see Fig. 9). Another possible pathomechanism might be that the IM nail bypassed the Steinmann pin and was driven too far and into the knee joint. In such a situation, we would expect the fracture to occur at the intercondylar notch and to be of a smaller size (see Fig. 11).

Ideally, the distal nail end should be placed at the level of the distal physal scar; therefore our femoral nail appears to be too distal [19]. However, according to Nork [20], the anterograde femoral nail can be advanced distally through the femoral epiphysis, particularly for the treatment of distal femoral fractures. Also according to the AO Association, the distal tip of the femoral IM nail can be positioned as far as 5 mm proximal to intercondylar notch on the AP fluoroscopic per-operative imaging [21].

The Steinmann traction pin is introduced from medial to lateral, in an extra-articular position [20]. Placing the pin in the anterior part of the distal femoral metaphysis will avoid a conflict with the passing IM nail [20]. Kwon et al. [22] demonstrated that pin introduction from lateral to medial is also a safe procedure, containing only a theoretical risk of damage to the superior medial geniculate

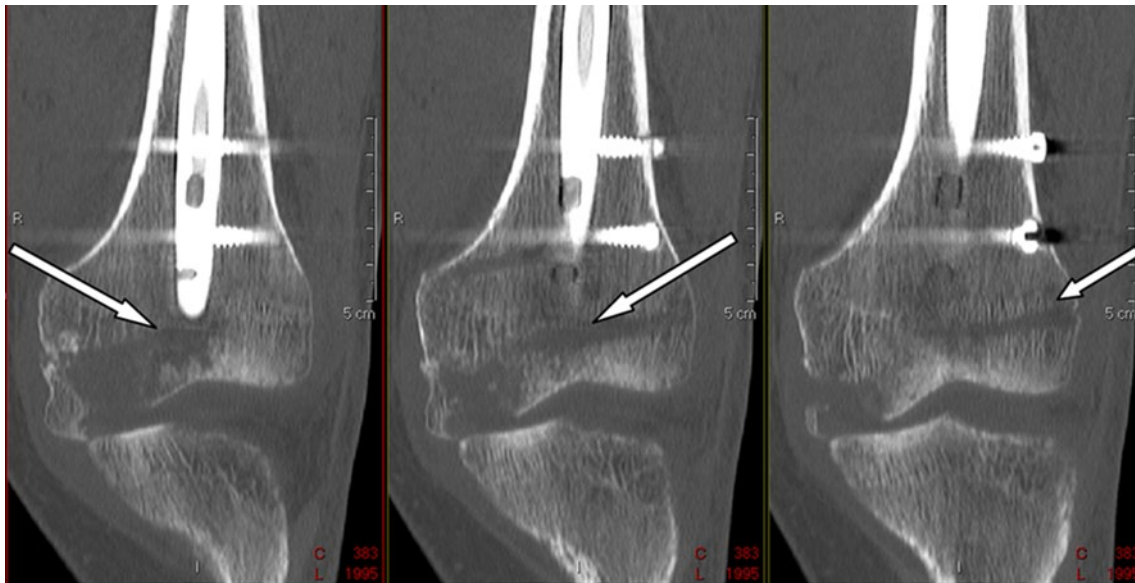


Fig. 9 Parietal reconstruction of the post-operative CT scan of the left knee: the *arrows* show the position of the formerly used traction pin; there seem to have been a conflict with the advancing IM nail, possibly causing the medial condyle fracture

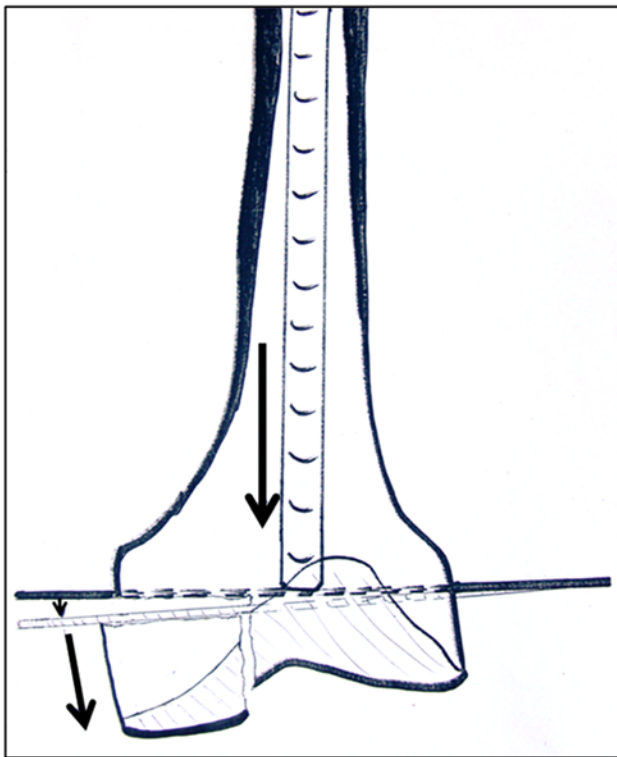


Fig. 10 Illustration of the suspected fracture pathomechanism: during insertion, the advancing nail hits the Steinmann traction pin. This creates a lever arm on the medial condyle causing a large fracture fragment

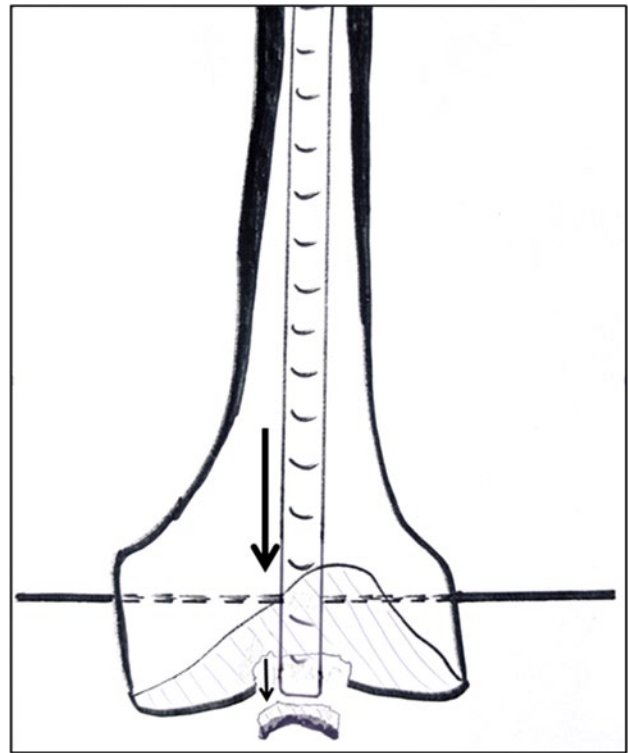


Fig. 11 Illustration of an alternative fracture pathomechanism: the advancing nail bypasses the Steinmann traction pin and is driven too far and into the knee joint. This should have caused a rather punched out fracture fragment from the intercondylar notch

artery. From lateral to medial the Steinmann pin should not be introduced more distally than the level of the superior pole of the patella [22]. In distal femoral fractures, when a very distal locking of the antegrade femoral nail is needed, Taglang et al. [23] proposed to use a temporary tibial skeletal traction using a Steinmann pin at the level of the anterior tibial tuberosity.

Wolinski et al. [24, 25] proposed reamed IM femoral nailing without the use of a fracture table and skeletal traction to reduce anaesthesia time. On the other hand, supracondylar skeletal traction using a Steinmann pin is a well-established technique for closed reduction during femoral IM nailing. The technique was proposed by the pioneers of IM nailing [2, 26] and remains the recommended procedure in recent trauma text books [27, 28]. However, the above-described per-operative complication has not yet been mentioned in literature. While advancing the nail the final centimetres, fluoroscopic control is usually focused on the fracture site or the proximal femur to assess fracture reduction and complete nail insertion. In the present case, excessive force during the final nail insertion without verifying its position distally lead to the above described iatrogenic fracture.

Conclusion

The goal of this case report is to describe the diagnosis and management of an iatrogenic medial condyle fracture as a rare complication of femoral IM nailing. A conflict between the nail tip and the supracondylar Steinmann pin was identified as the most likely cause of the fracture. Therefore, we recommend positioning of the Steinmann pin under fluoroscopic control prior to reduction and careful intraoperative monitoring of nail progression towards its final position. It is important to assess the position of the nail in 3 areas: proximally, distally and at the fracture site.

Conflict of interest On behalf of all the authors, we disclose any financial and personal relationships with other people, or organisations, that could inappropriately influence (bias) our work. There are no conflicts of interest.

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