Use of the suprapatellar approach in intramedullary nailing of a multi-fragmentary dislocated tibia fracture with a hypermobile intermediate fragment in a young patient

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Abstract

A case of an adolescent female patient who suffered from first grade open multi-fragment fracture of the tibia (AO42-C2) with a large hypermobile intermediate fragment is presented in this case report. Intramedullary nailing of the tibia remains the treatment of choice despite a high risk of malformation and anterior knee pain especially in multi-fragment fractures. Here the suprapatellar approach as a semiextended nailing technique seems favorable. The specialty in our case was an early change of procedures necessary due to persistent swelling during external fixation based on the hypermobile intermediate fragment. Decision in favor of this surgical technique was conducted in order to achieve beneficial alignment and union while protecting the soft-tissue despite the hypermobile intermediate fragment and decrease the risk of anterior knee pain. In our case we achieved successful alignment and proper bone healing without any signs of anterior knee pain or limitations in the range of motion of the knee. With this report we would like to recommend the suprapatellar approach as a favorable alternative in intramedullary nailing in this type of fracture also in young patients.

Introduction

Tibia shaft fractures remain a common traumatic injury in younger patients. Preoperative decision of timing and which surgical approach and method of fixation provides a favorable reduction and fixation of the fracture has to be based on soft tissue damage, imminent compartment syndrome, localization of fracture (proximal, shaft or distal) and chain injuries,[1] in particular if there is a multi-fragment or dislocated fracture. Intramedullary tibial nailing was shown to be the treatment of choice and in the past years several techniques have been introduced,[2] whereas the infrapatellary approach remains the surgical standard. When using the infrapatellary approach it is necessary to flex the knee at least 90°, thereby leaving a high risk of malreduction of the fracture[3] and jeopardizing optimal fracture treatment by altering the mechanical axis[2] and leaving an increased risk for arthrosis in adjacent joints. In order to overcome the risk of malreduction as the main disadvantage of the infrapatellar nailing a semi-extended nailing technique was developed using a midline quadriceps tendon insertion leaving the risk of iatrogenic damage to the patellofemoral joint.[2] Difficulties remain in the intramedullary nailing of multi-level tibia fractures, in particular in proximal fractures of the tibia. Intraoperative dislocation of the hypermobile intermediate bone fragment with the need of additional methods, such as Poller screws,[4] challenges the correct reduction and alignment of the bone. In this case report we would like to discuss the use of the suprapatellar approach as a suitable surgical technique in this demanding fracture.

Case Report

A case of a 16 year old female patient who suffered from first grade open multi-fragment fracture of the tibia (AO42-C2) due to a complicated horseback riding accident is presented in this case report.

On admission the patient had extensive soft tissue swelling and a first grade open fracture was detected. Initial radiological assessment showed a multi-fragmentary tibia shaft fracture (AO42-C2) with a long intermediate segment (Figure 1). We decided in favor of temporary external fracture fixation concept due to the extensive soft tissue swelling. Intraoperative we encountered some difficulties achieving a satisfactory alignment of the bone due to a hypermobility of the intermediate segment, however because of the extensive soft tissue swelling internal fixation was not feasible. In the end a satisfactory alignment and reduction could be achieved by an extended position of the lower limp and application of longitudinal traction. Postoperative the patient was treated with strict confinement to bed and additional physical treatments like RICE (rest, ice, compression, elevation) in order to prevent further soft tissue swelling. There was no evidence of a compartment syndrome.

It is inherent to the system that external fixation of the hypermobile intermediate fragment is difficult and despite complete immobilization the postoperative radiological assessment showed a secondary dislocation of the hypermobile fragment (Figure 2). Coherently we encountered insufficient detumescence; therefore we decided to an early change of procedure. In respect of the difficulties encountered during the first surgery we decided in favor of intramedullary nailing of the tibia, to minimize the risk of malunion or deformity in our female patient we utilized the suprapatellar approach.

The patient was positioned supine on the radiolucent table. First the external fixator was removed while maintaining axial tension on the injured leg. Hereafter the knee was positioned in an extended position on a sterile pillow and subsequently the knee was flexed approximately 15° (Figure 3a). Then the image intensifier was positioned so that visualization of the knee and tibia including the articular surface of the proximal tibia in both AP and lateral views were possible. Afterwards a 2 cm longitudinal skin incision about 3 cm

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proximal to the superior pole of the patella was made (Figure 3b) and followed by a deep incision of the quadriceps tendon, longitudinal just above the superior pole of the patella. The knee was entered through the suprapatellar pouch. Blunt dissection was used to loosen the patella in order to facilitate placement of the protection sleeve. To achieve optimal alignment especially in proximal and metaphyseal fractures of the tibia it is important to accomplish an ideal positioning of the nail by choosing the right entry point. Hereafter the handle (consisting of the handle, outer protection sleeve and inner trocar) was carefully inserted into the joint by gliding through the femoropatellar groove (Figure 4a). After reaching the tibia the trocar was removed and the centering sleeve inserted. Before placing the guide wire optimal positioning of the centering sleeve in accordance with the entry point was confirmed through the image intensifier (Figure 4b,c). Now the guide wire was inserted about 10 cm intramedullary under imaging in both AP and lateral views. Afterwards the handle was temporarily fixated onto the femoral condyles using a guide wire (Figure 4d). Then the drill bit was placed over the guide wire and the intramedullary canal was opened. Now a reaming rod replaced the guide wire and subsequently the fragments of the multifragmentary fracture were aligned onto the reaming rod. Optimal placement of the reaming rod in the distal tibia was confirmed under imaging (Figure 5a). The nail was placed over the reaming rod and inserted in semiextended position (15° flexion of the knee). However the radiological control showed an apex anterior malreduction. Therefore a temporary Poller wire was utilized while aligning the fracture as supplementary procedure in order to achieve

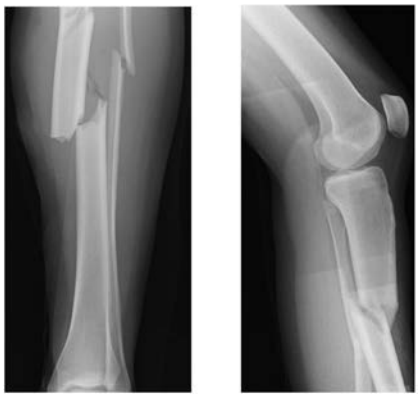

Figure 1. X-ray of the tibia of the patient ad admission showing the multi-fragment fracture of the tibia (AO42-C2) and the intermediate fragment (06.01.2015).

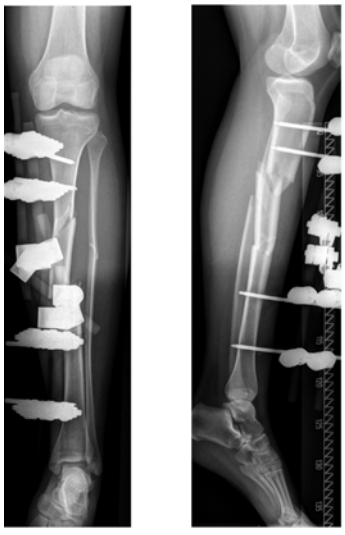

Figure 2. Postoperative x-ray of the tibia showing a secondary dislocated tibia fracture while fixated externally (07.01.2015).

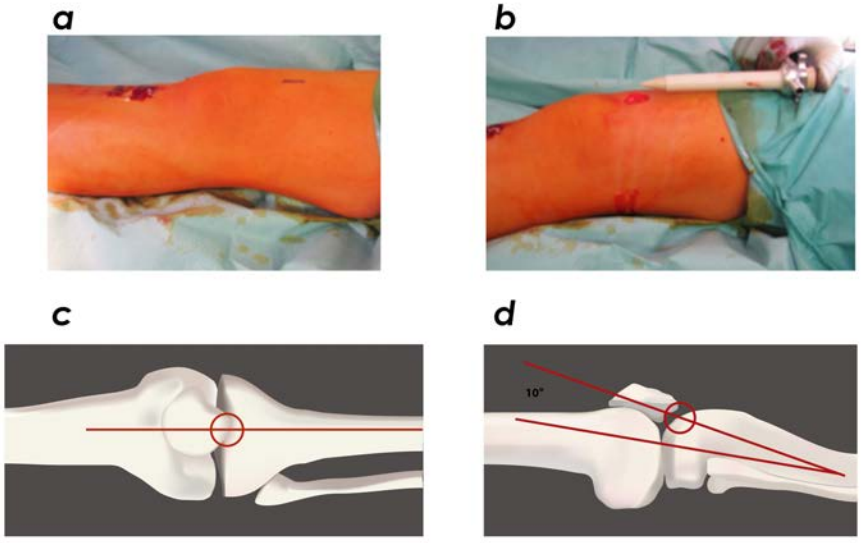

Figure 3. a and b) Intraoperative pictures of the exact location of the skin incision and the insertion of the handle. 3c and d) schematic graphic display of the ideal insertion point of the nail.

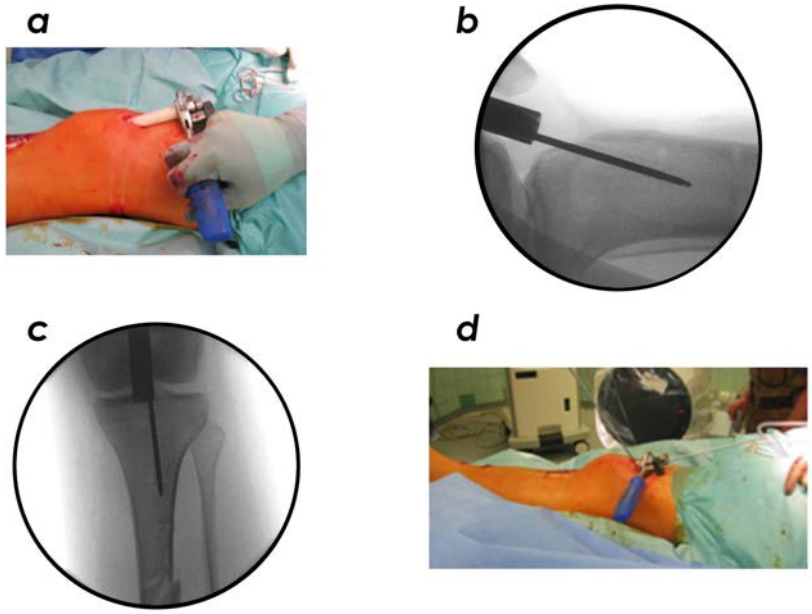

Figure 4. a) Intraoperative picture of the ideal positioning of handle once inside the femoropatellar joint. b and c) Confirmation of the correct placement of the guide wire through intraoperative image intensifying. d) Stabilization of the handle by temporarily fixation of the handle onto the femoral condyles using a guide wire

satisfactory alignment of the bone (Figure 5b), now accomplishing a good alignment of the fracture and achieving optimal fracture treatment.[4] Blocking screws were applied in the proximal and distal end of the nail. Reduction and fixation were confirmed both radiologically and clinically (Figure 6a).

Postoperatively our patient was treated with partial weight bearing of 20 kg for 6 weeks. The would healing was regular and timely and follow-up for clinical and radiological assessment was scheduled at 6 weeks, 3 months and 6 months postoperatively. Pain free weight bearing of 20 kilograms was achieved 6 weeks after the surgical treatment and gradually increase of the weight bearing was allowed. No signs of both pain during increased weight-bearing occurred and anterior knee pain were detected at any time. Full weight bearing and physiological range of motion was reached 10 weeks after the surgery. Radiological assessment showed proper consolidation of the fracture (Figure 6b). A full recovery and resumption of regular activities of the daily life and sport was accomplished 4 months after surgery.

Tips and tricks for successful applying the suprapatellar approach

We recommend to place a sterile pillow under the knee to achieve a flexion of approximately 10-15° in order to get a perfect exposure of the suprapatellar entry. From there on no further movement of the lower leg during nailing is necessary.

During the incision it is important to split the quadriceps tendon in midsubstance. Afterwards use your finger to carefully feel for the retropatellar nook in order to be sure to be inside the femoropatellar joint.

It is important, once inside the joint, to just use careful blunt dissection in order to avoid damage to the cartilage.

In order to avoid damage to the cartilage it is important to carefully insert the handle into the joint by gliding through the femoropatellar groove (Figure 4a) until it reaches the tibia. A solid connection between the handle and the tibia has to be confirmed through the image intensifier (lateral view).

Once placing the guide wire it is important to know that the centering sleeve has a concentrical and excentrical option. If the first placement of the guide wire through the concentrical option is not perfect than you can use the excentrical option to place a second guide wire in the optimal position and afterwards remove the initial guide wire.

It is important to accomplish an ideal positioning of the nail by choosing the right entry point which is in line with the axis of the intramedullary canal and with the lateral tubercule of the intercondylar eminence (AP view) as well as at the ventral edge of the tibial plateau (lateral view)(Figures 3c,d).

During reaming in preparation for the intramedullary nailing it is important to minimize the risk of secondary damage to the cartilage by connecting the suction to the protection sleeve to prevent reaming material from entering the joint.

Before definite placement of the nail it is important to remove the handle.

Poller screws or Poller wires are helpful and often necessary tools during reposition and reduction of metaphyseal tibia and femur fractures.[4]

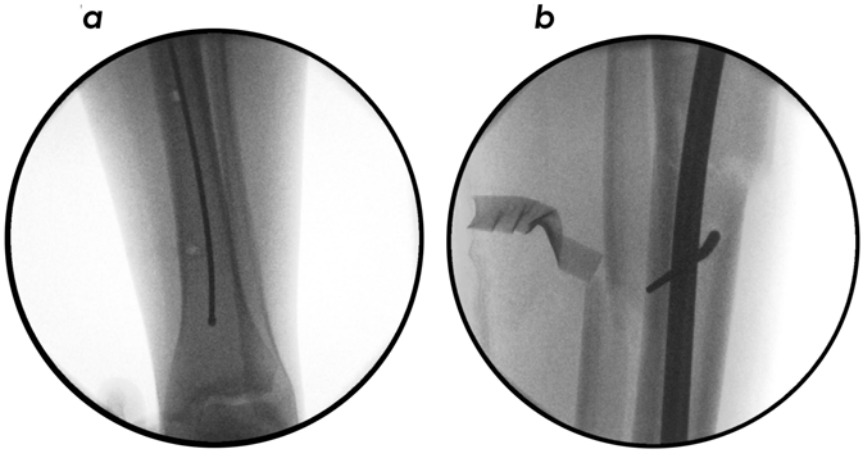

Figure 5. a) Optimal placement of the reaming rod in the distal tibia was confirmed under imaging. b) Intraoperative radiographic image of the utilization of a temporary poller wire while aligning the fracture as supplementary procedure.

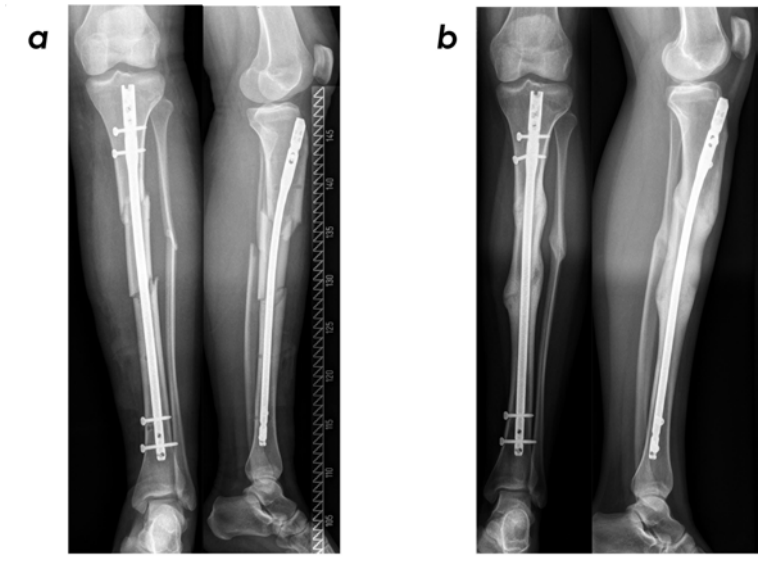

Figure 6. a) X-ray of the tibia of the patient before discharge showing proper alignment of the tibia (12.1.2015); b) X-ray of the tibia showing a consolidated fracture (19.11.2015).

Discussion

The patient in this case report suffered from first grade open multi-fragment fracture of the tibia (AO42-C2). During the initial surgical treatment that consisted of external fixation a hypermobile intermediate fragment was noticed. Success of the definitive surgical treatment depends on several factors, however a correct alignment of the fragments and prevention of malformation has been shown to be crucial. Regarding the young age of our patient, the high functional requirements and the demand for temporary recovery we employed the intramedullary nailing of the tibia, in order to provide minimal surgical dissection and preservation of the extraosseous blood supply.[5] To prevent malformation due to hypermobile intermediate fragment we decided in favor of the suprapatellar approach in the

semiextended position.

The decision which surgical technique provides optimal reduction and fixation of tibia fractures remains challenging for trauma surgeons. Caregivers remain concerned about the transarticular nail insertion regarding associated injuries to the patellofemoral cartilage and the long-term consequences associated with this.[5] Gelbke *et al*. showed in human cadaver specimens that despite increased intraarticular pressure during the suprapatellar approach the maximum pressure stayed well below the pressure at which apoptosis of chondrocytes occur.[6] Furthermore Courtney *et al.* postulated in the first retrospective cohort study of functional knee scores associated with traditional infrapatellary nailing and suprapatellar nailing that the suprapatellar entry portal is a safe alternative for tibia nailing with use of appropriate instrumentation.[7] Traditional technique for the intramedullary nailing of the tibia requires that the knee be resting in a flexed or fully flexed position. Thus increasing the risk of apex anterior deformities. Furthermore the entry point of the infrapatellar nailing has been reported to be associated with postoperative knee pain.[8] Here nailing in the semiextended position provides several advantages. It has been reported to facilitate fracture reduction by reducing the apex anterior angulation by eliminating the extension force of the quadriceps,[5] especially desirable in fractures with a hypermobile intermediate fragment. Another favorable aspect of the suprapatellar approach has been reported by Sanders *et al*. In this prospective clinical study no patient was identified with postoperative anterior knee pain at a minimum of 12 months of follow-up.[9] Furthermore Jones *et al.* showed significantly better reductions and more accurate starting points in the suprapatellar approach.[10] Concluding that the suprapatellar approach offers facilitated reduction in particular in proximal third tibia fractures, decreased postoperative anterior knee pain, excellent tibial alignment and union. Caregivers may remain reluctant to implement this novel, innovative technique due to concerns regarding iatrogenic damage to the patellofemoral joint especially in young patients.[5] Further prospective clinical studies are necessary to evaluate the impact of the suprapatellar approach on anterior knee pain, damage to the patellofemoral joint functional outcome of the knee.

Conclusions

In this report we present a case of young patient with a first grade open multi-fragment fracture of the tibia (AO42-C2) with a hypermobile intermediate segment. Successful surgical treatment was achieved by intramedullary nailing employing a suprapatellar approach in semiextended position of the leg. Decision in favor of this surgical technique was conducted in order to achieve optimal alignment and union despite the hypermobile intermediate fragment and decrease the risk of anterior knee pain. Another major benefit of the suprapatellar approach is an advantageous soft tissue protection due to the static positioning of the lower. With this report we would like to recommend the suprapatellar approach as a favorable alternative in intramedullary nailing in this type of fracture also in young patients despite persisting concerns regarding iatrogenic damage to the patellofemoral joint.

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