

PCL reconstruction with the tibial inlay technique following intra-medullary nail fixation of an ipsilateral tibial shaft fracture: a treatment algorithm

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Abstract Our case report highlights the complexity of treating multi-ligament knee injuries in the setting of ipsilateral long bone trauma. We describe the use of the tibial inlay technique for PCL reconstruction in the setting of a tibial shaft fracture treated with an intramedullary nail. We also present a comprehensive treatment algorithm for the treatment of ligamentous knee injuries in the setting of long bone trauma.

Keywords Multi-ligament · Knee dislocation · Tibial inlay · Posterior cruciate ligament

Introduction

The presence of multi-ligament knee injuries in the setting of lower extremity long bone fractures can pose diagnostic and therapeutic challenges for the treating surgeon. Several studies have shown that there is a significant delay in the diagnosis of these ligamentous injuries in patients with

ipsilateral femoral or tibial shaft fractures [8, 9, 11]. Furthermore, methods of fixation of concomitant long bone fractures affect future ligament reconstruction options.

We present the case of a patient who sustained a high-grade multi-ligament knee injury with an ipsilateral tibial shaft fracture. Following long bone stabilization, this individual was treated with a posterior cruciate ligament (PCL) reconstruction with the tibial inlay technique. An algorithm is suggested to guide the treatment of the aforementioned combined injury patterns.

Case report

A 31-year-old male was involved in a motor vehicle accident. Following resuscitation according to the Advanced Trauma Life Support (ATLS) protocol, the secondary survey revealed; right Weber A ankle fracture, left midshaft clavicle fracture, and a closed spiral tibial midshaft fracture on the left side with an associated proximal fibula fracture. The neurovascular examination was unremarkable. The Ankle-Brachial Index (ABI) was 1.0 on the injured side.

Several hours later, in the operating theatre, an examination under anesthesia (EUA) demonstrated excessive antero-posterior laxity as well medial laxity. Fluoroscopic examination confirmed gross medial opening and gross posterior laxity consistent with a high-grade medial collateral ligament (MCL) and PCL injury (Fig. 1a, b). The tibial fracture was treated with an intramedullary (IM) nail. The starting point of the IM nail was placed slightly distal to the usual location to avoid the footprint of the native anterior cruciate ligament (ACL). This would avoid interference with a potential ACL reconstruction in the future and allow for a higher quality MRI postoperatively. Locking screws in

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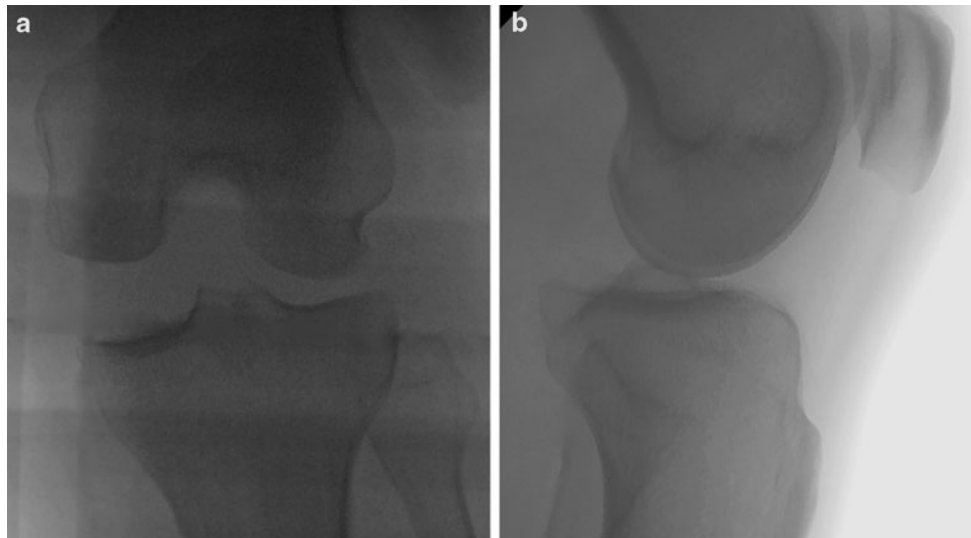


Fig. 1 **a** Intra-operative stress radiograph demonstrating gross medial opening with the application of valgus stress to the knee. **b** Intra-operative stress radiograph demonstrating posterior subluxation of the tibia with the application of a posterior force

the tibia were inserted from the lateral side to avoid compromise of possible future surgical incisions, hamstring graft harvest, and ACL tibial tunnel integrity.

The postoperative MRI demonstrated a high-grade partial ACL injury, a near-complete tear involving proximal third of the PCL, and a complete midsubstance tear of the MCL. The medial patellar retinaculum was also disrupted. The posterolateral corner (PLC) as well as the medial and lateral menisci were intact.

Eight days after the original trauma, the patient was brought to the operating room for treatment of his ligamentous injuries. A second EUA confirmed that there was a grade III PCL and MCL injury. However, there was only a partial low-grade ACL injury that was clinically apparent as demonstrated by a grade I Lachman and the absence of a pivot shift.

The patient was positioned in a modified lateral-type position with the use of a bean-bag [1]. For posterior access, the hip was internally rotated and the knee was extended. The leg was then placed on a sterilely draped mayo stand and the operating table was tilted away from the surgeon. A curvilinear incision was made in the popliteal fossa extending slightly inferomedially—the interval between the medial head of the gastrocnemius and semi-membranosus was identified and developed as described by Burks and Schaffer [2]. The underlying popliteus muscle was then reflected distally and inferiorly. After incision of the posterior capsule, a bony trough was made in the PCL insertion site (width 1.0 cm, length 2.5 cm, depth 1.0 cm). A tendo-achilles allograft was fashioned with a bone block distally to fit the bony trough in the tibia and was secured with two 3.5 mm cortical screws. The hip was then externally rotated, the knee was flexed and the mayo stand

was removed, allowing for passage of the graft anteriorly through the knee joint. The graft was pulled into a tunnel that was drilled into the medial femoral condyle native PCL insertion site and was fixed with a 10 mm × 28 mm biointerference screw.

Next, an anteromedial incision was made in a curvilinear fashion. Two suture anchors were used just distal to the medial epicondyle; posterior imbrications sutures were placed in the posteromedial corner. The generous length of



Fig. 2 Postoperative lateral radiograph of the knee joint following tibial IM nail fixation and PCL reconstruction

the tendo-achilles allograft used for PCL reconstruction allowed us to bring the excess portion of the allograft out through the medial condyle and augment our medial repair with an allograft reconstruction of the MCL [10]. The graft was secured distally to the tibia in an area of the symmetric point with an AO large fragment screw and a soft tissue washer around which the graft was wrapped (Fig. 2).

Discussion

The most pertinent aspect of this case report is the decision-making process that underlies the treatment of combined long bone trauma and multi-ligament knee injury. We are not aware of any other cases in the literature that describe a PCL reconstruction using the tibial inlay technique in a patient with an ipsilateral tibial shaft fracture that was treated with an intramedullary nail.

Huang et al. [4] recently described two cases of isolated PCL injury in the setting of tibial shaft fractures. In one case the tibial fracture was treated with open reduction and

internal fixation using plates and screws while the PCL was reconstructed by using the transtibial technique. In the second case, the tibial shaft fracture was treated with an IM nail and the PCL injury was treated with rehabilitation and bracing. The authors highlighted the need to consider four factors: (1) the necessity of the PCL reconstruction at the time of initial fracture management, (2) How to and when to reconstruct the PCL, (3) How to fix the tibial fracture according to the choice of PCL technique, and (4) How to arrange the postop rehab in different treatment options.

The present case study demonstrates a patient with a tibial shaft fracture and ipsilateral ACL/MCL/PCL injuries. In a prospective study of patients with lower extremity fractures, knee ligament injuries were observed in 11–17% of cases [5, 6]. Isolated tibial diaphyseal fractures have been associated with ligamentous injuries in 22–36% of individuals [7, 8]. The association of tibial diaphyseal fractures with dislocated knees is less common and has been estimated to be approximately 2% [7, 8]. The most frequently injured knee ligament in the setting of tibial and femoral shaft fractures is the MCL [7–9, 11]. With respect

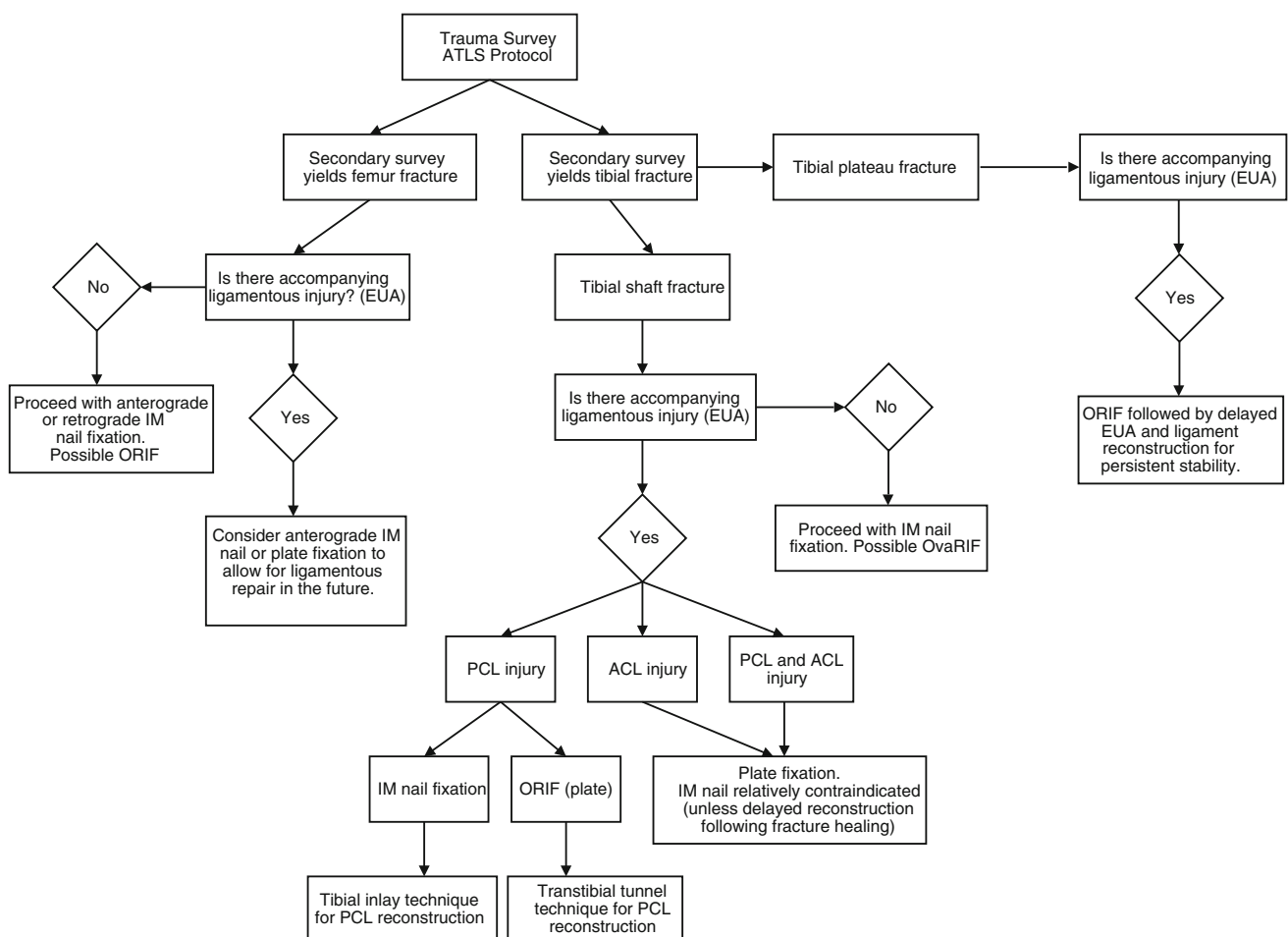


Fig. 3 Treatment algorithm for lower extremity long bone trauma with concomitant knee ligamentous injury

to combined injuries, the ACL and MCL are most often injured together [7, 8]. Thiagarajan et al. [8] demonstrated that 5/18 patients with knee ligamentous injuries (with ipsilateral tibial shaft fractures) had injured their PCL.

In the setting of ligamentous knee injuries and ipsilateral tibial shaft fractures, there are several issues to consider. First, the possibility of future ligamentous reconstruction(s) must be considered. In the case presented above, we initially wanted our starting point for the tibial nail slightly distal to the usual location in order to preserve the native ACL footprint in the event that a future ACL reconstruction should be required (arguably, however, our start point may still have been somewhat proximal as assessed by subsequent imaging). Second, we felt that the optimum treatment for the midshaft tibia fracture was an IM nail. Once this was done, however, our options for PCL reconstruction were limited. A transtibial PCL reconstruction would have been extremely difficult due to the presence of the tibial nail in the intramedullary canal. Unlike that for the tibial ACL tunnel, the transtibial tunnel for PCL reconstruction often spans the entire anteroposterior diameter of the proximal tibia in an oblique fashion. An IM nail limits the placement of this tunnel in an optimal location. The inlay technique avoids the need for a transtibial tunnel and allows for direct access to the posterior aspect of the tibia. In the case presented, patient positioning was also a challenge. A modified lateral decubitus position was used to allow simultaneous access to the posterior and anterior aspects of the knee. Anterior access was required to perform the diagnostic arthroscopy, intra-articular procedures (ex. PCL femoral tunnel drilling), and MCL repair/reconstruction. In the original description of the posterior inlay technique by Berg, the decubitus position was utilized—it was emphasized that in this position all of the advantages of anterior knee surgery are maintained while allowing concomitant posterior knee exposure [1]. Recently, Campbell et al. [3] have demonstrated that it is possible to perform a tibial inlay technique with an all-arthroscopic approach.

There are no large case series in the literature that have looked at the outcomes following reconstruction of ligamentous injuries of the knee in the setting of ipsilateral long bone trauma. Decision-making is based on limited reports available in the literature and on surgeon-

experience. An algorithm is suggested for the management of these not uncommon injury patterns (Fig. 3).

This case report highlights the complexity of treating multi-ligament knee injuries in the setting of ipsilateral long bone trauma. Preoperative planning must take into account the fixation technique for the long bone fracture as well as how these techniques will affect future ligament reconstruction options. Further research on functional outcomes following these combined injury patterns is required.

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