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A new procedure for tibial spine avulsion fracture fixation

Matthew A. Mann · Nicholas M. Desy · Paul A. Martineau

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Abstract Several techniques have been described to repair tibial spine avulsion fractures. Most of these methods use either internal fixation with a screw or suture fixation over a tibial tunnel bone bridge. This article presents a new technique for the surgical management of tibial spine avulsion fractures. The technique involves the creation of a suture mattress to compress and reduce the tibial spine into its fracture bed. The advantages of this technique are that it creates four points of fixation, aids with reduction, and allows for compression of the tibial spine fragment anatomically in its fracture bed.
Level of evidence V.

Keywords Arthroscopy · Tibial spine fracture · Knee · Anterior cruciate ligament · Suture mattress

Introduction

Isolated tibial spine avulsion fractures are relatively uncommon with an incidence of approximately 3 per 100,000/year [6]. This fracture typically occurs in the skeletally immature patient but the prevalence in the young adult has been increasing. Similar to anterior cruciate ligament (ACL) tears, tibial spine fractures can occur from multiple injuries such as falls, skiing, soccer and football injuries, and motor vehicle accidents [1, 5].

Classification of these fractures is based on the Meyers and McKeever classification system, which was later modified by Zaricznyj [12, 22]. Type I fractures are minimally or non-displaced fractures, type II are partially displaced or hinged, type III are completely displaced with no cortical contact, and type IV fractures are completely displaced and comminuted. Surgical management is often reserved for type II fractures with greater than 2 mm displacement as well as type III and type IV injuries. Other surgical indications include a mechanical block with diminished range of motion and patients presenting with a locked knee.

This injury can be addressed by open reduction and internal fixation [7, 16]; however, arthroscopically assisted reduction and fixation has gained in popularity. Several methods of arthroscopic treatment have been described with relatively high success rates [2, 3, 10–12, 15, 17, 20, 21]. These techniques include the use of various fixation devices such as wires [4, 14], screws [3, 17], sutures [2, 10, 15, 19, 21], and suture anchors [11, 20]. They often rely on a single point of fixation or tethering the ACL until taught. However, we have found that tibial spine avulsions are frequently comminuted or can have only a small bony fragment, making screw fixation not possible in many cases. Additionally, most other fixation methods can be technically challenging and can result in malreduction of the tibial spine fracture.

This article describes a new technique to address tibial spine avulsions that is analogous to the double-row, transosseous equivalent or suture bridge techniques initially developed for arthroscopic rotator cuff repair and later

M. A. Mann (✉) · N. M. Desy
Division of Orthopaedic Surgery, Montreal General Hospital, McGill University Health Center, 1650 Cedar Avenue Room B5.159, Montreal, QC H3G 1A4, Canada
e-mail: matthew.mann@mail.mcgill.ca

N. M. Desy
e-mail: nicholas.desy@mail.mcgill.ca

P. A. Martineau
Division of Orthopaedic Surgery, Montreal General Hospital, McGill University Health Center, 1650 Cedar Avenue Room A5-175.1, Montreal, QC H3G 1A4, Canada
e-mail: paul.martineau@mcgill.ca

adapted for internal reduction and fixation of greater tuberosity fractures [8, 9, 18]. This procedure provides four points of fixation which, in the same fashion as it does in rotator cuff repair, increases the area of contact [13], and is a concept that is already familiar to arthroscopic surgeons. This technique is applicable to all types of avulsion fractures. It allows for a simple reproducible anatomic reduction and compression of the fracture fragment and tensioning of the ACL employing commonly used arthroscopic maneuvers and instruments.

Technical note

The procedure begins with a standard diagnostic arthroscopy to rule out any coexisting intra-articular pathology and exclude intra-substance tearing of the ACL. Once complete, attention is shifted to debridement of the bed of the fractured tibial spine, debriding it of any blood clot or fibrous tissue. An arthroscopic shaver (Dyonics 4.5 mm Incisor Plus, Smith & Nephew Andover, US) is used for debridement. Soft tissues, such as the anterior horn of the meniscus or the intermeniscal ligament, may also impede reduction and may need to be manipulated in order to reduce the fractured tibial spine. A trial reduction is attempted in order to ensure an anatomic reduction either with an arthroscopic probe or with percutaneous Kirschner wires. Knee extension aids in reduction of the fragment. Once satisfied with reduction, arthroscopic cannulae (8.5 mm Clear-Trac cannula, Smith & Nephew Andover, US) are used in the medial and lateral inferopatellar portals to aid with subsequent suture management. Two suture anchors (Twin Fix Ab 4.5 mm, Smith & Nephew, Andover, US) are inserted through the medial and lateral parapatellar

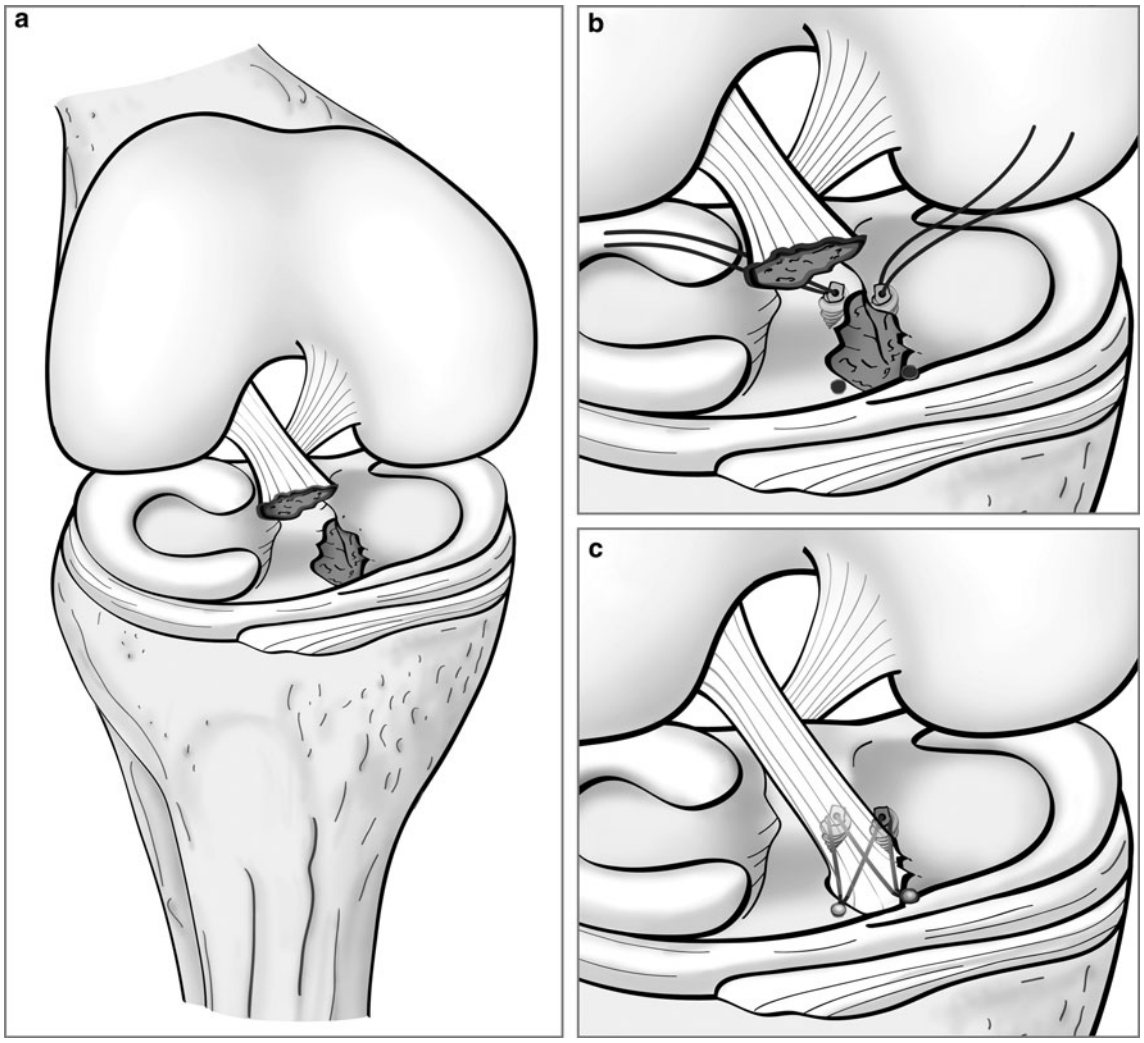

Fig. 1 Illustrative interpretation of the arthroscopic suture bridge technique for tibial spine fractures. **a** Demonstrates a typical displaced tibial spine fracture. **b** Placement of two suture anchors posterior to the fracture margin. **c** The final configuration of the suture bridge with placement and tensioning of knotless anchors anterior to the fracture site

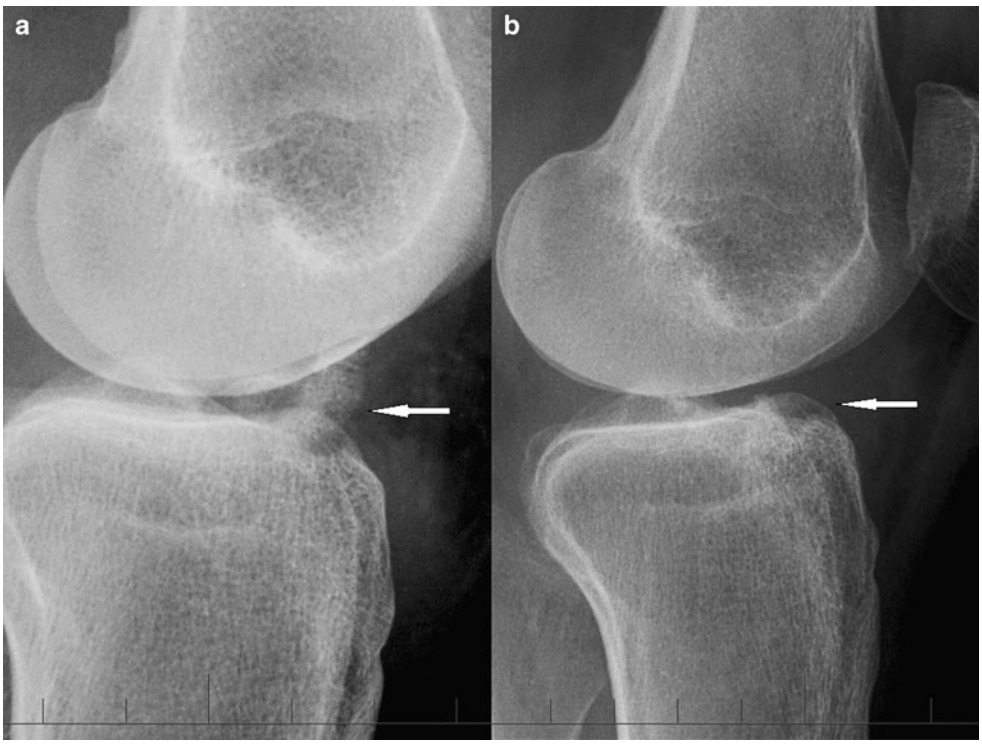

Fig. 2 **a** Pre-operative lateral plain film X-ray showing a displaced tibial spine fracture. **b** Post-operative lateral radiograph showing a healed avulsion fracture after arthroscopic surgical treatment using a suture bridge technique

portals respectively and placed in the posterior aspect of the fracture (Fig. 1).

Next, an arthroscopic suture passer (Accu-Pass, Smith & Nephew, Andover, US) is inserted into the knee through a transpatellar tendon portal. Each of the suture limbs from the anchors implanted posterior to the fragment is shuttled sequentially through a separate path through the substance of the ACL footprint creating a mattress type configuration. The tibial spine fragment is then reduced using a combination of manipulation of the fragment and knee extension. The sutures are then tensioned and fixed into the bone anterior to the reduced tibial spine fragment using two knotless anchors (3.5 mm Bio Push-lock anchors, Arthrex, Naples, US). One limb from each of the posterior anchors is threaded through each of the knotless anchors and inserted into pre-tapped holes anterior to the avulsion fracture completing the suture mattress (Fig. 1). The suture mattress provides a compressive force and secures the reduced tibial spine (Fig. 2).

Discussion

The most important difference from this technique compared to others is that it can be applied to all types of tibial spine avulsion fractures. Arthroscopic reduction and fixation of tibial spine injuries is an accepted treatment for displaced tibial spine avulsion fractures. Arthroscopically treated avulsion fractures show excellent results with Lysholm scores ranging from 92 to 100 [2, 11, 15, 20]. However, due to multiple factors including technical ease, the size of the fragment and comminution of the fragment, arthroscopic fixation can be challenging. In addition, since the injury is more common in the skeletally immature population, physeal sparring techniques may offer an advantage over transphyseal tunnel techniques. Finally, techniques using minimal fixation or resorbable fixation may be beneficial in terms of allowing for an easy revision to an arthroscopic ACL reconstruction in case of failure or suboptimal function. Given excellent results of arthroscopically treated ACL avulsion fractures, the morbidity of an open procedure can be justifiably avoided with the development of consistent and reproducible arthroscopic techniques.

This technique uses standard arthroscopy portals, does not require additional incisions related to conventional trans-tibial tunnel bone bridge procedures, and uses readily available suture anchors and a technique that is analogous to a commonly used suture bridge method in rotator cuff repair. Therefore, adapting this technique for use in the knee should be relatively simple for surgeons already facile in arthroscopic suture management.

The limitations of this technique are the facts that it has been used in relatively few patients to date and has

not been accompanied with clinical outcome scores. A prospective multi-centered trial would be of benefit to elucidate its efficacy compared to currently established techniques.

The technique applies the suture bridge principle with four-point fixation to the fracture fragment allowing for compression of the avulsed fragment and thus maximizes the surface area for bony healing. Not only does it apply the concept of tensioning the ACL with sutures through its substance, but also applies direct compressive forces to the osseous fragment without the risk of causing comminution. In fact, a comminuted tibial spine avulsion can theoretically be treated in the same fashion and hence the relevance of this new technique.

Conclusion

This new technique to repair tibial spine avulsion fractures has several advantages. It tensions the ACL, anatomically reduces and compresses the osseous fragment from the fractured tibial spine, and it incorporates arthroscopic maneuvers well practiced to the everyday arthroscopist.

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