Novel surgical technique for soft tissue distal avulsion of the anterior cruciate ligament: Technical Note

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The most popular surgical treatment for anterior cruciate ligament (ACL) injuries is reconstruction. However, different native tissue preservation and repair techniques have recently become popular. Among the different types of ACL injuries, the least frequent is the tibial-sided soft-tissue avulsion type. Which can be managed with primary repair as an alternative to reconstruction. However, there aren't many procedures reported for treating these rare injuries. As a result, a repair technique is presented using a suture anchor in the tibial footprint, with a double-row construct. We present a prospective intervention cohort of two cases where this procedure was used with adequate clinical evolution and stable fixation at 24 months of follow-up. Likewise, there were no complications or reinterventions performed during follow-up. This technique had not been reported before in the literature for these lesions and combines the benefits of using a suture anchor with a double-row construct and preserves the native tissue and ACL insertion site. Therefore, in these uncommon lesions, a double-row suture anchor technique can be useful to repair acute distal soft tissue avulsion-type ACL injuries.

Novelty of the new technique

- Suture anchors are used with a double-row construct, allowing for good and stable fixation that leads to healing
- The double-row suture anchor technique has not been previously reported for ACL tibial-sided soft tissue avulsion

Advantages and disadvantages

- It allows for preserving the tibial insertion site of the ACL, the native tissue, and theoretically the proprioceptive function
- A biological stimulus is generated that favors healing
- Cost of Implants
- The patient must be carefully selected to use this technique
Outline of the clinical problem

Anterior cruciate ligament (ACL) injuries are classified into several categories, with distal injuries, also known as type V tears, being the least prevalent. These injuries are frequently treated with reconstruction [1]. But given the potential benefits of preserving original tissue and reducing surgical morbidity [2], some repair techniques have been identified. However, none have shown superiority; hence, a technique is presented that, in theory, provides a better biomechanical profile than those previously reported that use transosseous tunnels [3,4].

Surgical indications and contraindications

Indications

• Acute ACL tibial-sided soft tissue avulsion
• Acute ACL tear type V
• Adequate tissue quality to hold sutures

Contraindications

• Chronic ACL tear
• ACL tissue with no healing capabilities
• High-performance athletes, elite military, and smoking patients

Current surgical techniques

Type V tears, specifically soft tissue avulsion-type tears, are rare injuries, and there are few descriptions in the literature about their management. They are usually treated with reconstruction [1], although there are some reports where they are repaired using sutures with transosseous tunnels [3,4]. There is not enough clinical evidence or previous reports of failure using the transosseous tunneling technique to repair type V tears, perhaps due to the infrequency of the injuries and the few reports of their repair [3,4]. However, suture anchors are biomechanically superior to the conventional transosseous method [5]. Therefore, the technique presented is proposed to reduce the theoretical risk of failure.

Novelty of the new technique

With this surgical technique, we aim to preserve the native tissue of the ACL in tibial-sided injuries using suture anchors with a double-row construct, since biomechanically the double-row provides greater stability. This technique could also be used for bony and soft tissue avulsions [5]. Furthermore, the patient must be
properly selected for the repair, and the cost of the implant must be considered. To our knowledge, no surgical techniques using this construct to repair an ACL tibial-sided soft tissue avulsion have been described until today.

**Surgical technique**

The patient is placed in the supine position, and a tourniquet is applied to the appropriate lower extremity. Standard knee arthroscopy equipment is employed, and a medial and high lateral portal adjacent to the junction of the patellar tendon with the patella and a central transpatellar portal is made. The camera is inserted through the high lateral portal, and a cannula (7-mm-diameter) is inserted through the medial portal for hand instruments; an arthroscopic exploration is performed. Adequate cleaning of the joint is performed for better visualization. A visual inspection of the knee is also performed to discard associated lesions.

A shaver is used for tibial footprint preparation, and a pilot hole is created at the anatomic position using an awl for the suture anchor. A screw-type double-loaded anchor (5.5 mm diameter) that carries two sutures (four strands) is inserted in the tibial footprint through the transpatellar portal to obtain a trajectory with an ideal angle of 45°. The four suture strands remain in the transpatellar portal, after which each suture strand is retrieved through the cannula using a suture retriever. And using suture-passing forceps and a 90° suture passer, two mattress stitches are performed using one strand of suture at a time. Subsequently, the ligament is reduced, and the Seoul Medical Center (SMC) self-locking slip knot is made and tied without cutting the suture strands.

The ACL tibial tunnel guide is then used to make two tibial tunnels at an angle of 55° at the anteromedial and anterolateral edges of the tibial footprint with initially a 2.4-mm-diameter pin and then with a 4.5-mm-diameter cannulated drill bit. Through each tunnel, two suture strands of different colors are passed using a nitinol suture passer. Both sutures are manually tensioned under direct visualization, and to prevent tissue overtension, a probe is used, and suture strands are loaded into the eyelet of a Knotless Anchor (5.5 mm diameter), which is inserted in the anteromedial tibial cortex with the knee in extension, creating a double-row construct as a result. Finally, it is confirmed that there is no impingement and that the construct presents adequate tension and stiffness, and an intraoperative Lachman test is performed to assess knee stability.

**Materials and methods**

The surgical technique is described, and a prospective intervention cohort is presented. The inclusion criteria were patients older than 18 years old with an acute ACL tibial-sided soft tissue avulsion diagnosis by magnetic resonance imaging (MRI)
who were treated with the same surgical treatment in a specialized hospital. Patients with a history of systemic diseases such as renal failure, rheumatologic diseases, previous fractures, previous surgical procedures in the knee to be intervened were taken as exclusion criteria. Also, high-performance athletes, top military members, and smokers were excluded. To determine the clinical outcomes, the International Knee Documentation Committee (IKDC) score was obtained pre-surgery and at 24 months of follow-up. The study was conducted from 2019 to 2022 in a specialized hospital. Non-probabilistic sampling was used, and all patients who met the selection criteria were included. A total of 5 patients were initially considered for this study; 2 were excluded based on the selection criteria, and 1 was lost to follow-up. Finally, two patients met adequate follow-up and inclusion/exclusion criteria.

Rehabilitation

Patients use crutches for 6 weeks after surgery, and weight-bearing and progressive flexion are allowed as tolerated. Full knee extension and up to 120° flexion are achieved during weeks 6 to 8. Return to low-impact sports is permitted after 6 months; pivot sports are permitted after month 9.

Ethics

The study was approved by the ethics committee of the hospital and conducted following the principles expressed in the Declaration of Helsinki. All patients were able to understand the nature of their treatment, and written informed consent was obtained from the participants.

Outcomes of the novel technique

Two patients were followed using the same surgical technique as described, the ages of the patients were 26 and 30 years old at the time of the surgery; both were male. The IKDC scores pre-surgery were 45 and 55. No patient presented any type of reintervention or complication during the follow-up period and presented post-surgery IKDC scores of 86 and 92, respectively. At 24 months after surgery, the pivot shift test and Lachman test were negative, and there was no limitation in the range of motion in both patients.

Conclusion and future perspectives

Traditionally, four types of ACL injuries have been described according to their anatomical location [6]. Though, this classification did not include distal tibial soft tissue avulsion tears. Therefore, this type of injury has recently been reported as a type V tear [6], [7]. However, the authors in this classification combine soft tissue injuries and bony avulsions and group them into type V tears [6,7]. This should be viewed with caution because tibial spine avulsion fractures are a different type of
injury, and fixation of the bone fragment stabilizes the ACL, but the ligament is not injured. In contrast, fixation of the anterior cruciate ligament is required at the distal level in soft-tissue avulsion type, and the epidemiology, mechanism of injury, treatment, healing, and rehabilitation are not entirely the same [5]. Although ACL tears have a high prevalence, type V tears are the least frequent, with an estimated incidence of 0.6 % for soft tissue avulsion-type [6].

The role of repair over reconstruction in ACL injuries has been discussed due to failures with some repair methods, and there is evidence of high rates of failure in ACL repairs in athletes, the military population, and smokers [8,9]. Consequently, the procedure was not performed in patients with these characteristics. Furthermore, the repair allows for the preservation of the ACL's tibial insertion site and native tissue, which theoretically saves nerve structures and aids in the preservation of knee proprioception and some reports indicated that repair procedures can restore tissue vascularity, and there are encouraging outcomes with repair approaches in carefully selected individuals [2].

The anchoring of the tibial ACL footprint, particularly centrally and anteriorly, has also been demonstrated to restore sagittal plane laxity in ex-vivo studies [10]. Moreover, it is also crucial to provide appropriate suturing of the ligament bundles to prevent repair failure since the tibial ACL footprint is broader than its femoral footprint [7]. Therefore, in addition to using a suture anchor in the tibial footprint and suturing the ligament bundles with its strands, two tibial tunnels are made, through which the suture strands are crossed to obtain a double-row construct, improve the contact surface of the repair, and stimulate bone-marrow stem cell extravasation, which could improve healing processes. Besides, a previous report of the suggested construct in avulsion fractures of the tibial spine had positive clinical results, and it was hypothesized that similar results would be obtained using it in soft tissue avulsions in carefully selected patients [5], which was verified during the follow-up time.

Among the limitations of the study are the follow-up period, the lack of comparison with another repair method, and the small sample size. However, we believe that it can be a method that theoretically reduces the risks of failure presented by other repair techniques. To assess the long-term clinical outcomes of ACL type V tears, specifically soft tissue avulsion-type, more research is needed. Moreover, it is difficult to compare different repair methods or to compare them with reconstruction due to the infrequent nature of these lesions [6].

In conclusion, we describe an anatomical repair method for ACL avulsion of the soft tissue on the tibial side, which we hypothesize may be superior to the method described so far to repair these injuries; In addition, it was possible to show an adequate clinical evolution in the follow-up time.
Declaration of competing interest
No funds have been received in support of this work. No benefits in any form have been or will be received from a commercial party related to, directly or indirectly, the subject of this article.

References


Declaration of interests

☐ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☒ The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

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