Internal Bracing as a Biological 'Safety Belt' in Protected ACL Graft Survival After High-Impact Trauma in Revision Reconstruction: A Case Report

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ABSTRACT

Anterior cruciate ligament (ACL) revision surgeries remain challenging, with higher failure rates than primary reconstructions. This case report aims to demonstrate the clinical outcomes of revision ACL reconstruction using the Modified UKM Internal Bracing (MUIB) technique and evaluate its protective role in maintaining graft integrity after high-impact trauma. This case report describes a 37-year-old male with recurrent ACL graft failure who underwent revision reconstruction using the MUIB technique. Post-operatively, the patient achieved excellent knee stability with no functional limitations at the post-operative nine month. Following a high-energy motorcycle accident, a second-look arthroscopy after one year from the last reconstruction revealed only a small tear of the ACL graft and just one of the strands of MUIB ruptured. There was also no evidence of tunnel widening, a common complication in revision cases. These findings demonstrate that MUIB effectively protected the graft from complete failure despite significant trauma. Additionally, suture tape reinforcement using the MUIB technique improves outcomes in revision ACL reconstructions by preventing graft elongation, tunnel widening, and stress shielding while also providing protective reinforcement.

Keywords:
anterior cruciate ligament, ACL reconstruction, revision ACL reconstruction, tunnel malalignment, suture tape reinforcement

INTRODUCTION

Anterior Cruciate Ligament (ACL) injuries are among the most frequently encountered sports-related injuries, and reconstruction remains the gold standard for restoring knee stability and function. Although primary reconstructions are usually successful, failure rates range from 4.1% to 13.3%[1].

To mitigate this, the concept of suture tape reinforcement was introduced. Conventional suture taping places the suture tape outside the ACL graft, which can contribute to tunnel widening, increased laxity, and subsequent instability. To address this, suture tape augmentation was developed with suture tape placed within the allograft itself. However, the original suture tape augmentation technique placed the suture tape independent of the graft, leading to a bungee and wiper effect, causing tunnel widening. We improvise the technique by placing the suture tape inside the graft, called MUIB (Modified UKM Internal Bracing). This strengthens grafts, reduces elongation, and shortens the return-to-sport timeline.

This case report aims to demonstrate the clinical outcomes of revision ACL reconstruction using the MUIB technique.

CASE REPORT

A 37-year-old male patient had an alleged twisting injury in 2005, sustaining a right knee ACL tear with a medial meniscus tear. His first surgery, a right knee ACL reconstruction and partial meniscectomy, took place in 2018. However, pain and locking persisted. His second surgery took place in 2020 and was an arthroscopic medial meniscus repair and Lemaire procedure. Despite this, the patient's knee still felt unstable. An MRI done in 2022 showed tibial tunnel widening and graft impingement, indicating graft failure. A third procedure, arthroscopic-to-open conversion with femoral and tibial tunnel bone grafting, was done in January 2023. Intra-operatively, a completely torn ACL graft was noted with medial meniscus body and posterior horn

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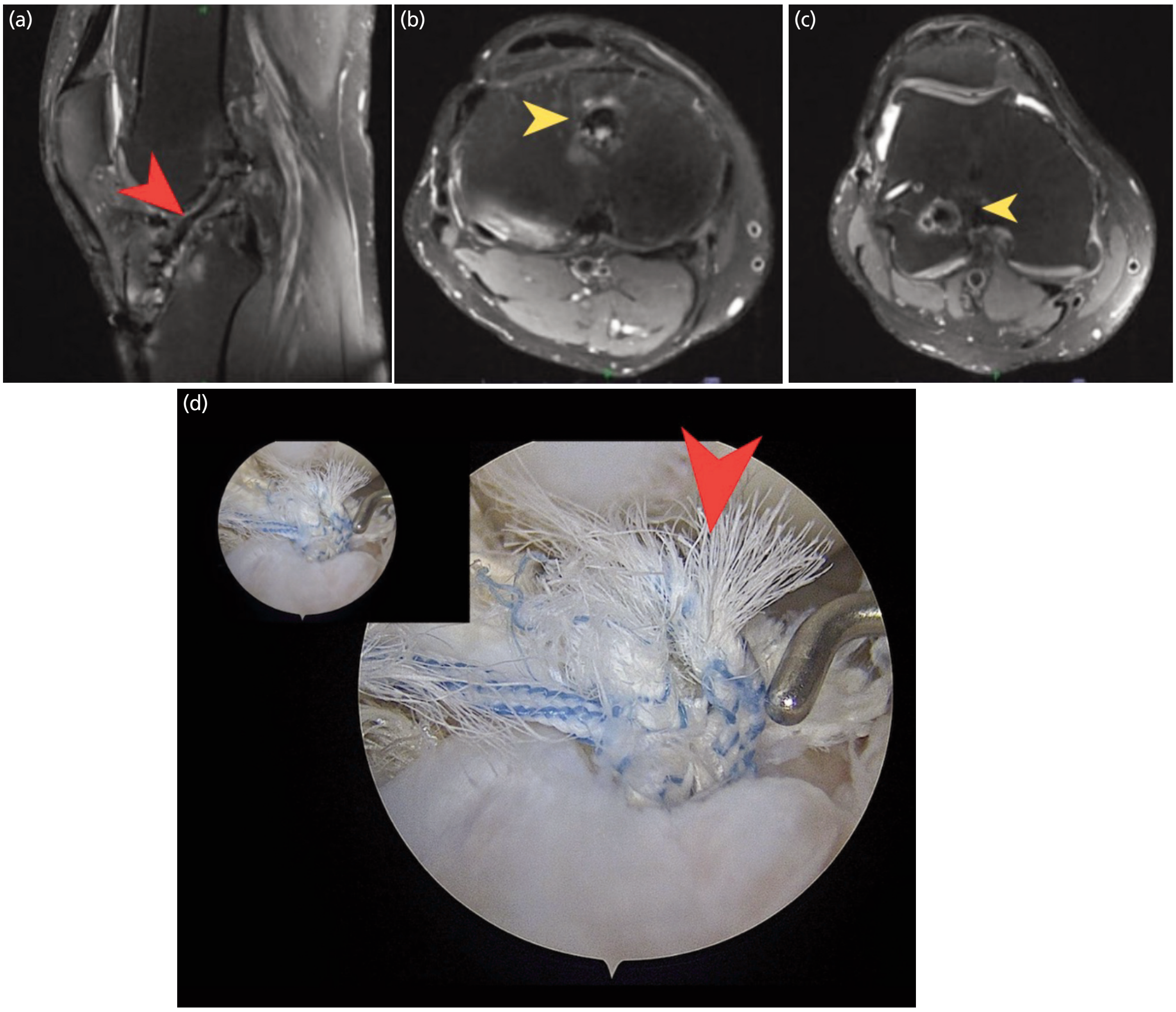


Fig. 1: MRI images of the right knee one year after revision ACL reconstruction with the MUIB technique. (a) Sagittal image shows an intact and well-incorporated ACL graft with normal signal intensity and proper anatomical alignment, without evidence of graft disruption (red arrowhead). (b) Axial images at the levels of the tibial and (c) femoral tunnels demonstrate well-preserved tunnel morphology (yellow arrowhead), with no signs of tunnel widening, peri-tunnel osteolysis, or cystic changes. (d) The intra-operative arthroscopic image demonstrates a torn suture tape (red arrowhead), while the ACL graft itself remains largely intact. Careful inspection also shows well-preserved femoral and tibial tunnels, with no evidence of tunnel widening or peri-tunnel bone loss.

tears. All hardware was removed, and the tunnels were filled with bone graft in preparation for his revision ACL surgery, which took place in January 2024 using a peroneus longus allograft with MUIB. This fourth surgery was successful in relieving his symptoms and improving his function as patients reported no instability and were able to perform daily tasks (pre-operatively, KOOS score was 50, increased to 95% at post op 9-month, before the accident).

Unfortunately, in September 2024, he was involved in a motorbike accident, sustaining T6 and T7 vertebral fractures along with trauma to his right knee. Following the injury, he again began experiencing locking, pain, and intermittent swelling of his right knee, especially during squatting and prolonged activity. He remained independently ambulant but reported difficulty performing prayer in the standard position and pain, especially when descending stairs. However, he did not report any instability symptoms. Clinical examination revealed a full range of motion (0° – 130°) with subtle quadriceps muscle wasting. Anterior drawer and Lachman tests were Grade 1. McMurray's test was positive for the medial meniscus. MRI done in February 2025 (Fig. 1a, 1b, and 1c) showed an ACL graft sprain with a complex posterior horn tear of the medial meniscus and a loose body in the patellofemoral joint space.

In July 2025, he underwent a diagnostic arthroscopy of the right knee. Interestingly, second-look arthroscopy revealed only a small tear in the ACL graft, along with a complete rupture of one of the strands of MUIB, while the remaining strands remained lax despite the high-energy trauma. No tunnel widening was observed during this procedure. The torn suture tape was removed (Fig. 1d), and just thermal shrinkage was used to treat the small graft tear. Fig. 2 outlines the chronology of the events of the patient.

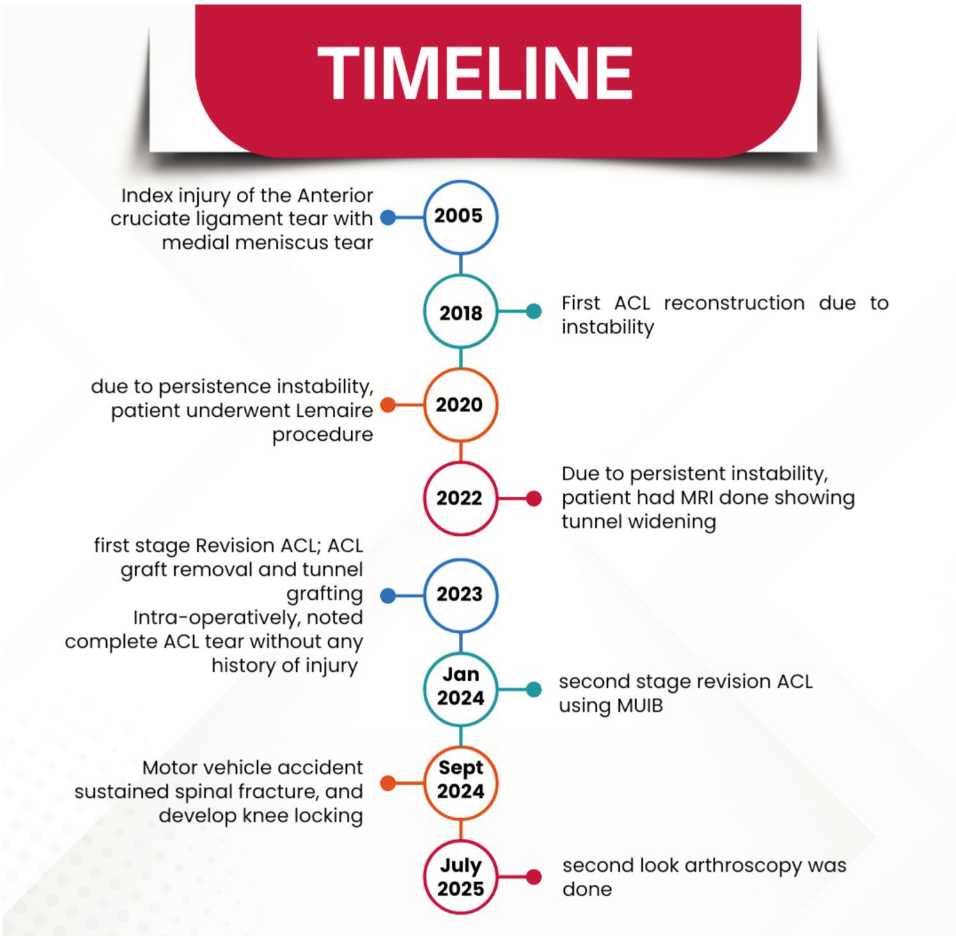


Fig. 2: Chronological clinical course from index injury to second-look arthroscopy (ACL = anterior cruciate ligament; MUIB = Modified UKM Internal Bracing; MRI = magnetic resonance imaging).

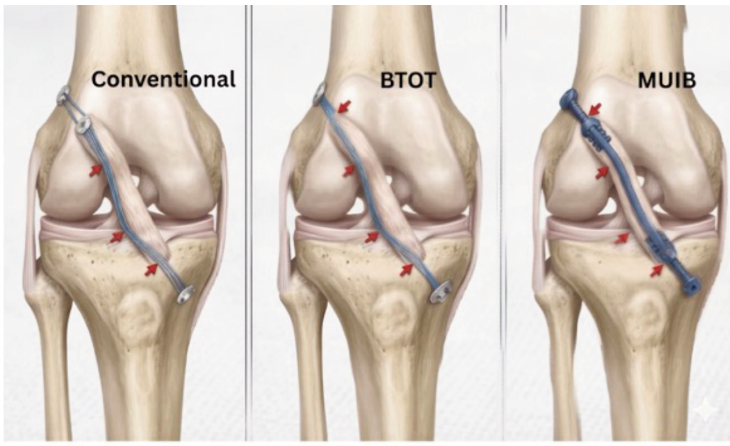
DISCUSSION

To our knowledge, this is the first report describing a second-look arthroscopy following revision ACL reconstruction using the MUIB technique. Despite the high-energy trauma, MUIB served as a primary restraint, or "seatbelt," protecting the allograft, as it was the first structure to fail rather than the graft itself.

Suture taping in ACL reconstruction is biomechanically designed to enhance graft strength and stability during the crucial early phases of ligament healing. Like a "safety belt," the suture tape augmentation directly transfers mechanical loads to the graft, reducing elongation and preventing early overstretching. This load-sharing mechanism is particularly relevant in revision settings, where grafts often have reduced biomechanical integrity due to slower incorporation. Enhancing graft strength, stiffness, and resistance to cyclic displacement with suture taping makes ACL reconstructions more resilient[2].

One noteworthy finding in our case was the absence of tunnel widening during the second-look arthroscopy. Tunnel widening is a known complication following ACLR. The "bungee" and "windshield wiper" effects generate shear forces at the graft–bone interface, leading to peri-tunnel bone loss[2]. Conventional suture taping may reduce micromotion, but when the tape is positioned externally, it can abrade tunnel walls and paradoxically cause tunnel widening (Fig. 3). By placing the suture tape within the graft, MUIB keeps the restraint co-axial, avoids brace–tunnel wall contact, and reduces socket micromotion, all of which may explain why there was no tunnel widening in our case[3].

Stress shielding in ACL reconstructions occurs when the suture tape bears a disproportionate share of the tensile load, unloading the graft and depriving it of the cyclic mechanical stimulus necessary for ligamentization. Graft maturation progresses through necrosis, revascularization, cellular proliferation, and collagen remodelling, all dependent on appropriate microstrain[4]. In the first 6 – 8 weeks, graft tensile strength declines by ~50%, leaving it vulnerable to elongation if overloaded4. The MUIB technique reduces this risk by: (i) near-equal tensioning, which allows the graft to be the primary load bearer under normal conditions, with the suture tape acting only as a safety limiter during unexpected peaks, and (ii) intragraft, co-axial placement, which prevents



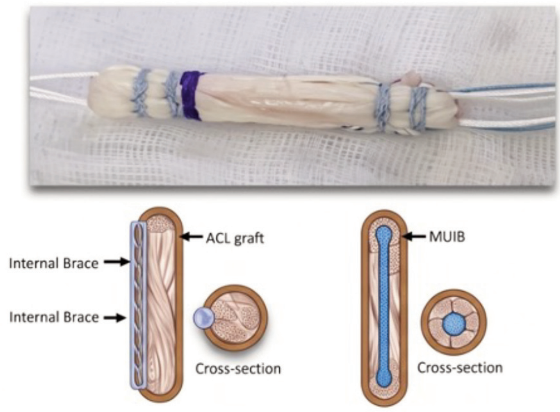


Fig. 3: (a) schematic diagram of conventional suture taping. The contact pressure from suture tape onto the tunnel through the windshield wiper and bungee effect will create tunnel widening (b): schematic diagram of suture taping using the revised technique called the button tie-over technique (BTOT). This technique increases the contact pressure, increasing the risk of further tunnel widening (c): schematic diagram of the MUIB technique. MUIB technique places the suture tape inside the graft, eliminating this issue. (d): Conventional suture taping (on the left) versus MUIB in ACL reconstruction. In conventional suture taping, suture tape is positioned externally, which may increase the risk of tunnel wall abrasion and contribute to tunnel widening or stress shielding if overtensioned. MUIB uses an intragraft placement to create a co-axial load-sharing construct that protects the graft during high loads while maintaining physiological microstrain for ligamentization, reducing tunnel widening and stress shielding.

the suture tape from acting as an external tether, resulting in synergistic load sharing[5]. As a result, MUIB protects only against catastrophic overload while not depriving the graft of the microstrain it needs for optimal ligamentization.

In Md-Yusoff *et al* preliminary biomechanical study, MUIB augmentation nearly doubled load-to-failure strength (1501N vs 760N, p=0.0003) and reduced dynamic elongation (1.38mm vs 4.28mm, p=0.0004), confirming superior cyclic stretching resistance[3]. The trifold intragraft arrangement outperformed end-to-end, reinforcing the benefit of central integration.

This case report demonstrates that MUIB has the potential for ACL graft protection, as evidenced during this second-look arthroscopy. The distinguishing feature of MUIB is the placement of suture tape within the substance of the allograft itself, rather than externally. By doing so and maintaining optimal load sharing, MUIB can potentially reduce the risk of adverse effects such as stress shielding, tunnel widening, and graft elongation. However, because this is just a single case with a relatively short follow-up period, a larger series over a longer period of time will be required to demonstrate superiority over other suture tape reinforcement configurations.

CONFLICT OF INTEREST

The authors declare no potential conflicts of interest.

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