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Case Report

Proximal Migration of the Femoral Fixation Anchor After Medial Patellofemoral Ligament Reconstruction in a Skeletally Immature Patient: A Case Report

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ABSTRACT

The success of medial patellofemoral ligament (MPFL) reconstruction is highly dependent on the accurate placement of the graft on the femoral attachment. Fixation of the graft on the femoral side can be challenging in skeletally immature patients due to the close proximity of the MPFL footprint and the distal femoral physis, which remains open during skeletal growth. Fixation of the graft to the proximal metaphysis may lead to proximal migration of the femoral fixation materials or tunnel during skeletal growth. In this unique case, a 12-year-old patient who underwent MPFL reconstruction experienced re-dislocation at the age of 15, necessitating revision of MPFL reconstruction. Despite the proximal migration of the femoral fixation anchor due to skeletal growth, the graft material remained in its original location. This finding is significant as it suggests that the MPFL graft can demonstrate tight healing with soft tissues and the periosteum at the attachment site, maintaining its position despite the migration of the tunnel or fixation materials within the bone.

Keywords: Anchor migration, femoral fixation, medial patellofemoral ligament, medial patellofemoral ligament reconstruction, skeletally immature patients

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INTRODUCTION

Patellofemoral dislocation is a prevalent disorder in skeletally immature individuals, often resulting from underlying risk factors such as trochlear dysplasia, patella alta, increased Q angle, excessive tibial tubercle lateralization, and ligamentous laxity. Conservative treatment is typically preferred for initial patellar dislocations, but a significant proportion of patients experience recurrent dislocation or persistent patellofemoral instability, necessitating surgical intervention. The medial patellofemoral ligament (MPFL) plays a crucial role as the primary medial stabilizer of the patella, contributing to 60% of the resistance against lateral dislocation [1,2]. Consequently, MPFL reconstruction (MPFLR) has become a cornerstone in the management of recurrent patellofemoral instability. However, achieving optimal outcomes in MPFLR is contingent on the precise anatomical placement of the graft, particularly at the femoral attachment site. Misplacement of the femoral attachment can disrupt ligament isometry, leading to complications such as patellofemoral arthrosis and stiffness and often associated with inferior clinical outcomes [3,4].

In skeletally immature patients, the proximity of the MPFL attachment site to the distal

femoral physis poses additional challenges. The femoral physis remains open during growth, and the MPFL anatomic footprint is located approximately 7 mm distal to the physis, making it susceptible to injury during the surgery [5]. As children grow, the tunnels and fixation materials used in MPFLR may migrate, potentially compromising the stability and function of the reconstruction. This case report presents a unique instance of proximal migration of a metallic suture anchor used for femoral fixation during MPFL reconstruction in a skeletally immature patient. The current literature contains a limited number of case reports on implant migration in MPFLR [6,7]. The report highlights the implications of skeletal growth on the stability of fixation materials and discusses the management and outcomes of this uncommon phenomenon.

CASE REPORT

A 12-year-old boy presented to the emergency department (ED) with a second occurrence of patellar dislocation, accompanied by pain and swelling in his left knee. He had his first patellar dislocation a year earlier, which was treated conservatively. On physical examination, there was effusion within the knee joint, and the medial side of the patella was tender upon palpation. The patellar apprehension test was positive, and the range of motion was limited and painful. Direct knee radiographs and magnetic resonance imaging (MRI) revealed Dejour Type C trochlear dysplasia, hemarthrosis, and a ruptured medial patellofemoral ligament (MPFL) without osteochondral fracture. Patellar height (Caton-Deschamps index: 0.83) was normal, and the tibial tuberosity-trochlear groove (TT-TG) distance was 20.5 mm. Given the recurrent dislocation and anatomical findings, surgical treatment was decided, focusing solely on MPFL reconstruction due to open epiphyses.

The initial surgery involved single-bundle MPFL reconstruction using a gracilis tendon autograft, with fixation achieved by two 5 mm metal anchors at the patellar and femoral attachment sites. Approximately 28 months after the initial surgery, the patient experienced another episode of patellar dislocation and was admitted to the ED. The parents initially refused revision surgery, preferring conservative follow-up. Eleven months later, the patient experienced yet another patellar dislocation. The family eventually agreed to proceed with revision surgery.

Both CT and MRI examinations showed re-rupture of the graft (Fig. 1). The TT-TG distance had increased to 25.4 mm, but patellar height remained normal (Caton-Deschamps index: 0.88). During follow-up, progressive proximal migration of the metal anchor used for femoral fixation was clearly observed (Fig. 2). Under general anesthesia and a thigh tourniquet, a second MPFL reconstruction was performed using a semitendinosus tendon autograft. Patellar fixation was again

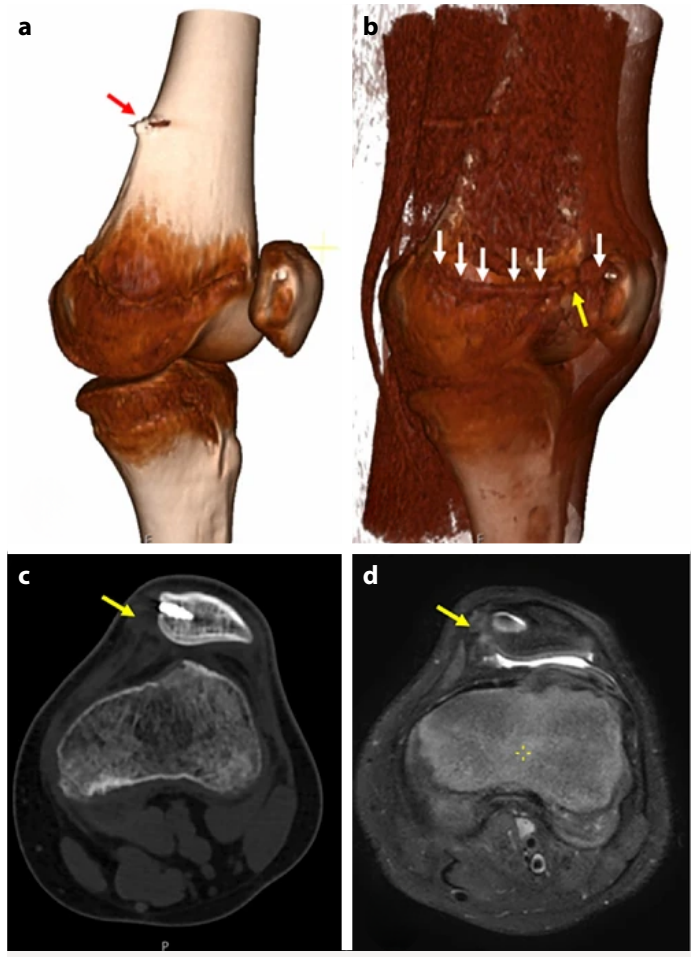

Figure 1. (a) 3D CT examination of the knee showing the metal anchor (red arrow) approximately 8 cm proximal to the distal femoral epiphysis. **(b)** 3D CT rendering showing the graft (white arrows) and the site of graft failure (yellow arrow). **(c)** Axial CT scan and **(d)** Proton density weighted (PDW) MRI examination showed graft failure at the patellar attachment.

achieved with a 5 mm metal anchor, while femoral fixation utilized a bioabsorbable interference screw. To correct the Q angle and restore the TT-TG distance, a Fulkerson osteotomy was also performed, secured with two 4.5 mm cannulated headless screws. The decision to perform a tibial tubercle osteotomy (TTO) in our skeletally immature patient was based on an assessment of bone age using radiographic criteria. We ensured that the growth plates were sufficiently developed to reduce the risk of growth disturbances. Furthermore, given the severity of patellar instability and the failure of prior MPFLR, TTO was deemed necessary to provide stability and prevent progressive joint damage. During surgery, the previous graft was found at the original femoral attachment site (Fig. 3). The

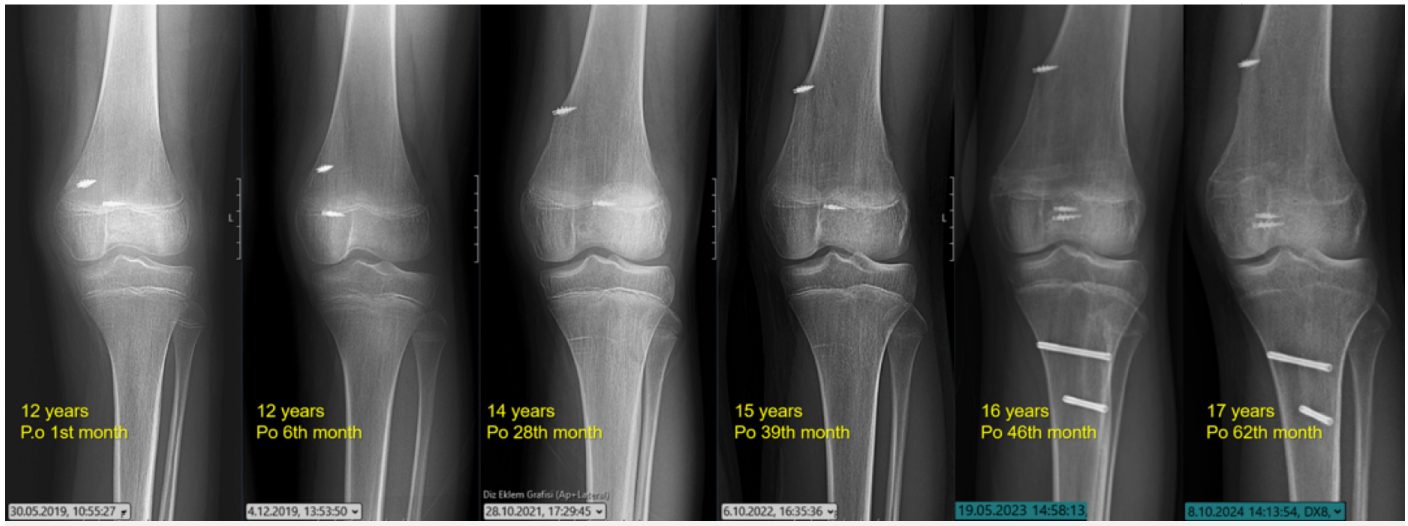

Figure 2. Consecutive follow-up direct radiographs of the anteroposterior knee radiographs showing the gradual proximal migration of the metal anchor through 46 months.

Figure 3. Intraoperative appearance of the initial graft during the revision MPFLR surgery. The graft was dissected over the MPFL femoral footprint.

postoperative period was uneventful. At the final follow-up, 18 months after the final surgery, the patient's knee range of motion was normal, the apprehension test was negative, and patellar mobility was normal. The Kujala score was 95 points, indicating a successful outcome.

DISCUSSION

The most important finding of this case was that although the metallic anchor within the bone migrated proximally, the graft remained in its anatomical position. The imaging studies and the dissection during the surgery confirmed this finding. Graft healing occurs at the periosteal level over the bone surface. Thus, soft tissue healing between the graft, retinaculum, and the periosteum appears to prevent graft migration. In this case, the anchor was likely placed proximal to the physis during the initial surgery. Additionally, the failure of the first MPFL reconstruction was likely influenced by the patient's advanced Dejour Type C trochlear dysplasia, which predisposes to instability, and the incorrect placement of the MPFL femoral attachment site. Since the metal anchor is positioned within the bone, it is believed that the anchor migrated superiorly due to skeletal growth.

Within the current literature, only two prior case reports have documented the proximal migration of metallic suture anchors during MPFL reconstruction. Kupczik et al. [6] described two cases where metal anchors used for femoral fixation in skeletally immature patients migrated proximally, resulting in graft failure and recurrence of patellar instability. They emphasized the need to account for skeletal growth when determining the femoral fixation site in pediatric patients. They proposed that the proximal migration of the femoral fixation materials and the graft due to growth resulted in failure. In contrast, Aoki et al. [7] reported a case of metaphyseal screw migration in an 11-year-old patient following MPFLR. Despite the screw migrating proximally, the MPFL graft remained at its original insertion site near the medial epicondyle. This case

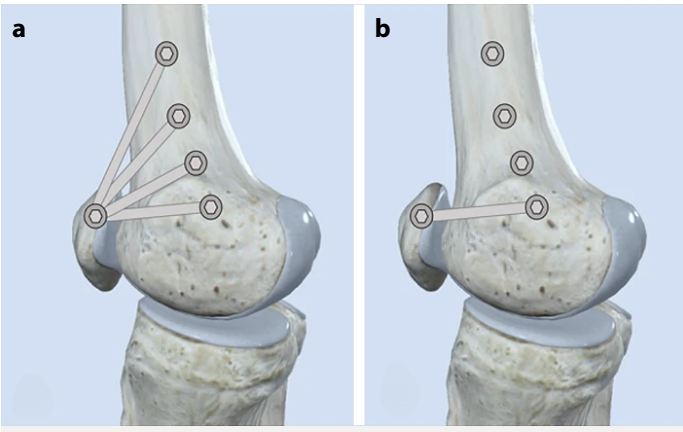

Figure 4. (a) Metal anchor and associated graft migration and failure scenario proposed by Kupczik et al. [6] **(b)** Anchor migration and graft status proposed by Aoki et al. The findings in this case support this suggestion.

suggests that while fixation materials may migrate due to skeletal growth, the graft itself remains stable, potentially due to soft tissue and periosteal healing. This observation aligns with the findings in this study, where the graft stayed in place despite the migration of the anchor (Fig. 4).

Other than two case studies that report proximal migration of fixation materials, two other studies investigated femoral tunnel enlargement and migration following MPFLR. Kita et al. [8] conducted a study using 3D computed tomography to evaluate morphological changes in the femoral tunnel after MPFLR with a hamstring tendon graft for recurrent patellar dislocation. They found that the femoral tunnel aperture showed significant anterior migration at a one-year follow-up, although the greatest distance in the distal-proximal direction was negligible (approximately 2 mm). The mean age of the patients was 24, but the age range included individuals as young as 14, some of whom might not have completed skeletal growth. This study suggests that while femoral tunnel changes can occur, they are generally minimal in the distal-proximal direction, particularly in skeletally immature patients. Ewald et al. [9] studied femoral tunnel widening and migration post-MPFLR in a large cohort. They found that tunnel changes, such as widening and migration of the tunnel center, were related to the initial malpositioning of the tunnel and correlated with poorer clinical and functional outcomes. Specifically, they noted that malpositioned tunnels often migrated anteroproximally, anteriorly, or anterodistally. In both of these studies, the tunnel migration did not exceed 4 mm in any direction. In contrast, the anchor was migrated approximately 8 cm superiorly in our case.

A recent meta-analysis summarizing data from six studies reported that in 82 cases, the medial patellofemoral ligament (MPFL) attachment site was, on average, located 7 mm distal to the femoral physis [5]. The MPFL attaches to the saddle sulcus, situated between the adductor tubercle and the medial epicondyle. It is crucial to acknowledge that anatomical variations can occur in this region. An examination of 1,094 knees indicated that these variations can influence the MPFL attachment site [10]. Despite these variations, in skeletally immature patients, the MPFL femoral tunnel should be placed distal to the femoral epiphysis to prevent superior migration of the tunnel or fixation anchor, which could compromise the graft's isometry. While the findings of this study show the graft in the expected anatomical location, we did not quantify minor positional changes. Generally, tendons and ligaments attach to bones and maintain their anatomical locations during growth. For instance, despite the distal attachment of the medial collateral ligament to the proximal tibial physis, it does not migrate distally with growth. Similarly, it can be assumed that the graft will not migrate proximally. Although the anatomical MPFL attachment site is located distal to the femoral physis, the fixation was placed proximal to the physis in our case. This placement error highlights the challenge of using intraoperative fluoroscopy, which can sometimes lead to inaccurate positioning. This misplacement underscores the importance of using both lateral and AP fluoroscopic views intraoperatively to ensure accurate positioning and avoid errors associated with relying solely on lateral images.

Among alternative surgical approaches, methods that do not require a femoral tunnel have also been proposed. In particular, techniques such as adductor sling reconstruction and adductor transfer reconstruction may eliminate the need for femoral fixation while preserving the growth plate. However, in the study by Black et al. [11], the adductor sling and adductor transfer techniques were significantly more anisometric from 40 to 110 degree of knee flexion. In this case, grafts became tighter in flexion, resulting in potential loss of motion, pain, graft stretching, and failure.

In conclusion, the findings of this study demonstrate that metallic anchors can migrate proximally with skeletal growth while the graft remains stable, likely due to periosteal-level healing. Although this case specifically involved a metallic anchor, similar anchor migration may occur with other materials, such as Polyether Ether Ketone (PEEK), given their susceptibility to growth-related forces. Differences in material properties, such as elasticity and bone integration, could affect the degree of migration and clinical outcomes. Therefore, careful consideration of anchor placement and material selection is crucial in skeletally immature patients, and further research is needed to explore the behavior of various anchor types and optimize surgical strategies.

DECLARATIONS

Ethical Approval: Not applicable.

Data Avaliability Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of Interest: The authors declared no conflict of interest.

Informed Consent: Informed consent was provided by the parents of the patient.

Use of AI for Writing Assistance: The author declared that no generative artificial intelligence was used for the writing of this manuscript, nor for the creation of images, graphics, tables, or their corresponding captions.

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ABBREVIATIONS

ED - Emergency Department

MPFL - Medial Patellofemoral Ligament

MPFLR - Medial Patellofemoral Ligament Reconstruction

MRI - Magnetic Resonance Imaging

PEEK - Polyether Ether Ketone

TTO - Tibial Tubercle Osteotomy

TT-TG - Tibial Tuberosity-Trochlear Groove

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