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Patellar dislocation in skeletally immature patients: semitendinosous and gracilis augmentation for combined medial patellofemoral and medial patellotibial ligament reconstruction

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Abstract
Purpose Patellar instability is a frequent condition in children and adolescents. The problem can be associated with malalignment resulting from different anatomical abnormalities. Several surgical procedures have been suggested for recurrent patellar dislocation consequent to failed conservative treatment.
Methods We present an original surgical procedure for reconstructing both the medial patellofemoral (MPFL) and medial patellotibial ligaments (MPTL) by semitendinosus (ST) tendon with gracilis (G) autograft augmentation in skeletally immature patients with recurrent patellar dislocation.
Results This technique is effective and permits satisfactory patellar congruency documented by static and dynamic CT.
Conclusions The operation is associated with optimal functional results and is minimally invasive, causing no growth disturbance.
Level of evidence Expert opinion, Level V.

Keywords Recurrent patellar dislocation · Skeletally immature patients · Semitendinosous augmentation

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Introduction

Dislocation of the patella may be congenital or acquired [4]. Different abnormalities can cause this severe degree of instability: flattened or hypoplasic lateral femoral condyle, hypoplasic or high patella, trochlear groove dysplasia (short and shallow), axial (genu valgum) and sagittal (genu recurvatum) deviations or torsional deformities of the legs (excessive femoral anteversion or external tibial torsion), lateral offset of the tibial tuberosity, generalized ligamentous laxity, and contracture dysfunction of vastus lateralis [4, 16, 21, 22]. These combined anatomic and constitutional factors predispose the patella to lateral dislocation, especially in early flexion.

In 1922, Galeazzi described an effective technique for anatomical physeal-sparing medial patellotibial ligament reconstruction. The purpose of the technique is to direct the pull of the quadriceps in line with the intercondylar notch of the femur. The aim was reached reconstructing MPTL that contributes to establish the height of the patella in relation to the femoral condyle and also transmits the force of the quadriceps contraction to the tibia [15, 20]. Moreover, Panagiotopoulos et al. [23] in a recent cadaveric study on static medial patellar stabilizer has evidenced that MPTL also contributes to medial stability for 13%.

Hall et al. [13] reported a 62% good to excellent results, and Baker et al. [4] reported successful outcomes in 81% of their 53% cases treated with their technique, and Letts et al. [17] reported good to excellent results in 88% of cases treated.

The role of MPFL as guy wire for static stabilizer of the patella in the sulcus [24] was better defined.

In fact, biomechanical researches demonstrate that the MPFL accounts for 50–60% of the medial soft tissue restraining force against lateral patellar subluxation or dislocation [6].

In recent years, increasing interest has been observed in literature for surgical reconstruction of MPFL with good results [7]. The author underlined that the indication for MPFL reconstruction has not completely been clarified. In fact, indications may be different due to various predisposing factors because of severe height patella, and severe Q-angle may have a great influence on MPFL reconstruction [19].

When patellar instability, especially in growing age, is sustained by excessive height of the patella, severe Q-angle, malalignment of the lower limbs, trochlear dysplasia, and iperlaxity, the Galeazzi's procedure lacks of the MPFL reconstruction and the isolated MPFL reconstruction lacks of MPTL to control patellar height.

Therefore, the suggested technique is proposed to combine the reconstruction of both the MPFL and the MPTL and to enhance the strength of the graft to achieve greater stability and thus better results.

The combined use of ST and G, published by Drez et al. [11] for adults, does not add morbidity to the intervention, which provides more strength and durability of the procedure, bearing in mind that adolescent often have a growing patellar instability linked to several factors. Furthermore, the procedure is completely physeal-sparing.

Technical note

All the procedures described in this investigation were approved by the local ethics committee. All the patients and their parents gave written informed consent for inclusion in the present study.

The choice to reconstruct both MPFL and MPTL ligaments is based on the reported importance of MPFL as primary medial patellar stabilizer [1, 8, 10] and of MPTL as accessory stabilizer [14] and patellar height regulator during strong quadriceps contraction [2]. We use combined MPFL/MPTL reconstruction by ST tendon and G autograft augmentation to maintain patellar stability stress occurring during the growth period.

With the patient placed in a supine position on a standard operating table, a pneumatic tourniquet is applied to the proximal thigh. Joint cartilage and menisci conditions are assessed by arthroscopy.

The surgical technique was routinely performed by four mini-incisions, except for the first two cases in which intervention was performed by a longitudinal parapatellar medial incision.

First, a transversal skin incision is made medial to the anterior tibial apophysis to identify the insertion of the pes anserinus tendons. The ST and G tendons are identified and divided from the musculo-tendinous junction, preserving the distal insertion site. The tendons must be at least 12–13 cm long. A second mini-incision is made just medial to the inferior patellar apex. An additional 2 cm incision is made at the supero-medial border of the patella. A longitudinal 2-mm Kirschner nail is driven into the medial third of the patella (Fig. 1). A distal to proximal intraosseus longitudinal tunnel is made with a 4-mm drill and is then expanded to a diameter of 4,5 mm. After division, the tendon grafts are passed through the soft tissue from their distal insertion to the beginning of the patellar tunnel (Fig. 2). ST and G tendons are brought distal to proximal into the tunnel, exiting through the upper tunnel opening. By traction of the proximal portion of the autografts, the distal portion of ST and G tendons is tensioned in full knee extension, drawing the patella medially and downwards to obtain its correct centering in the trochlear. Using a bioabsorbable suture, the distal ST and G autografts are immediately sutured under tension to the periosteum of the distal pole of the patella (Fig. 2). The femoral adductor tubercle is exposed by a 3 cm skin incision made at the middle of its medial aspect, and the proximal portions of the ST and G tendons are tunnelled into the medial parapatellar subfascial soft tissue.

With the patella well situated in the trochlea, the proximal parts of the ST and G tendons are tensioned maximally

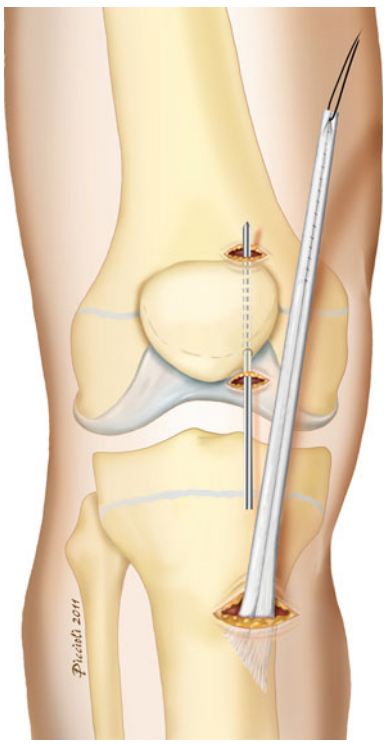

Fig. 1 After dissection, the harvested semitendinosus and gracilis tendons are sutured, preserving the distal insertion site. A second mini-incision is made just medial to the inferior patellar apex. An additional 2 cm incision is made at the supero-medial border of the patella. A longitudinal 2-mm Kirschner nail is driven into the medial third of the patella

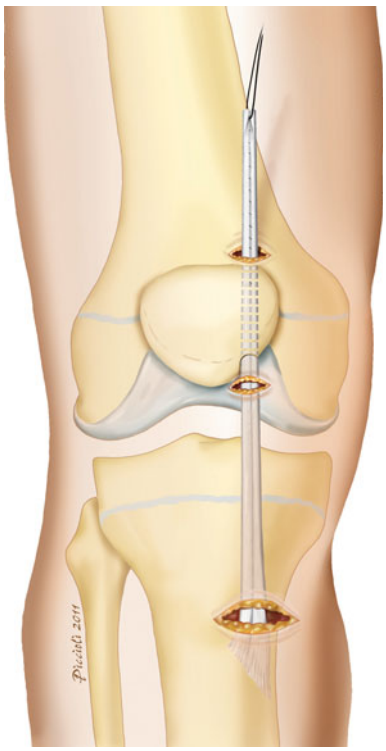

Fig. 2 A distal to proximal intraosseus longitudinal tunnel, 4 mm diameter, is performed. Once the tunnel is expanded to a diameter of 4.5 mm, ST and G tendons are passed over the tibial growth plate through the soft tissue and then are brought distal to proximal into the patellar tunnel

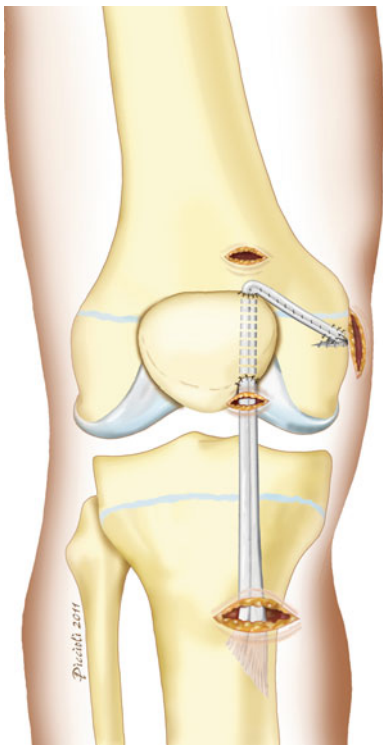

Fig. 3 A fouth skin incision is made to expose the femoral adductor tubercle. The proximal portions of the ST and G tendons are tunnelled into the medial parapatellar subfascial soft tissue. The ST and G tendons are tensioned at 30°–45° of flexion and fixed at the middle of the edge of adductor tubercle of the medial femoral condyle by a titanium suture anchor

at 30°–45° of flexion [18] and fixed at the middle of the edge of adductor tubercle of the medial femoral condyle by a titanium suture anchor (Fig. 3) (Arthrex Corkscrew suture anchor with needles: 5 mm × 12.1 mm with two size 0 fiberwire). The ST and G autografts are secured to the periosteum of the proximal pole of the patella with a bioabsorbable suture. The final stability of the patella is checked in full extension of the knee allowing congruent smooth tracking of the patella. The free movement of the knee is carefully verified, testing the motion in flexion up to 90°. The surgical technique was performed by one senior surgeon (GV). The knee is then positioned in a 20° flexion brace for 3 weeks. CT scan was performed postop to verify that there was no overcorrection, which could lead to a medial patellar subluxation. Isometric quadriceps muscle exercises are started in brace the day after surgery. Once immobilization is stopped, control passive motion of the knee and volitional exercises combined with neuromuscular electrical stimulation are begun, as well as quadriceps and hamstring muscles strengthening exercises. One month after surgery, knee flexion of more than 90° and progressive weight bearing until complete are allowed. Sports activities are restricted for 4–6 months.

Preoperative assessment includes study of axial and sagittal deviations and torsional deformities of the lower limb. Physical examination determines joint stability, patellar tracking, Q-angle, knee range of motion, and muscular tension.

The knee was routinely submitted to radiograph anteroposterior and lateral view at 30° of flexion, and MRI as well as static and dynamic CT scan [12] to assess the patellofemoral relationship (Fig. 4). In the initial stages of an acute phase of recurrent dislocation all clinical evaluations and dynamic CT examination may be difficult to perform.

In case of recurrent patellar dislocation with excessive patella alta, severe Q-angle (>15°), trochlear dysplasia, TAGT (distance between anterior tuberosity and the deeper part of the groove) >1.2 cm at CT examination, and hyperlaxity the proposed technique is indicated.

Discussion

The most important finding of this technique is that it allows the immediate correction of patellofemoral malalignment followed by clinical stability confirmed by static and dynamic CT examination at 24 months in the first patients operated.

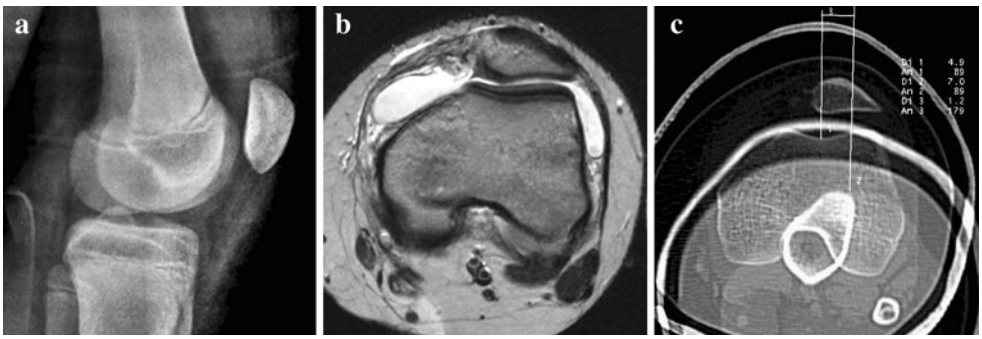

Fig. 4 Female athlete, 12 years old, with severe patellar instability (recurrent dislocation) and generalized ligament laxity. New acute patellar dislocation (third episode). **a** Preoperative standard X-Ray, lateral view showing a high patella. **b** The MPFL tear with a minimal osteochondral fragment avulsed from patellar insertion at MRI study. **c** The TAGT was 1.2 cm on CT scan

Various procedures have been described for the treatment for recurrent dislocation of the patella [11]. In growing patients, physeal-sparing procedures are recommended [4, 9]. The reconstruction of medial structures is an important factor in stabilization of the knee during flexion and extension. The importance of MPFL in controlling lateral patellar dislocation has been well documented in different biomechanical studies [8, 10]. MPTL also plays an important role, not so much as a secondary medial patellar stabilizer [14] as helping the patellar tendon to limit upward displacement of the patella during strong quadriceps contraction [2]. In case of recurrent patellar dislocation with excessive patella alta, severe Q-angle (>15°), trochlear dysplasia, TAGT > 1.2 cm at CT examination, and iperlaxity, the Galeazzi's procedure, or its modifications, lacks of the MPFL reconstruction, and the isolated MPFL reconstruction lacks of MPTL to control patellar height.

Recently, various surgical procedures have been proposed for the reconstruction of both MPFL and MPTL using the semitendinosus tendon alone [5, 6, 18]. To our knowledge, to date no surgical procedures have been published, which combine ST autograft with G tendon augmentation in skeletally immature patients. The G tendon augmentation can improve the opposition of the patella to quadriceps contraction and favor patellofemoral stability. This neo-ligament consisting of two tendons is more resistant to ligamentous laxity and to high patella and/or abnormal TAGT that often characterize the recurrent patellar dislocation in skeletally immature patients.

The technique does not require a lateral release and/or medial retinaculum reefing and can be carried out using mini-incisions (Fig. 3), thus reducing the morbidity connected with medial longitudinal parapatellar incision. For female patients, the cosmetic aspect is significant [4].

A wise surgical approach is required for treatment for recurrent lateral patellar dislocation in young patients.

The described technique is a good compromise for restoring a more complete medial patellar restraint with minimal

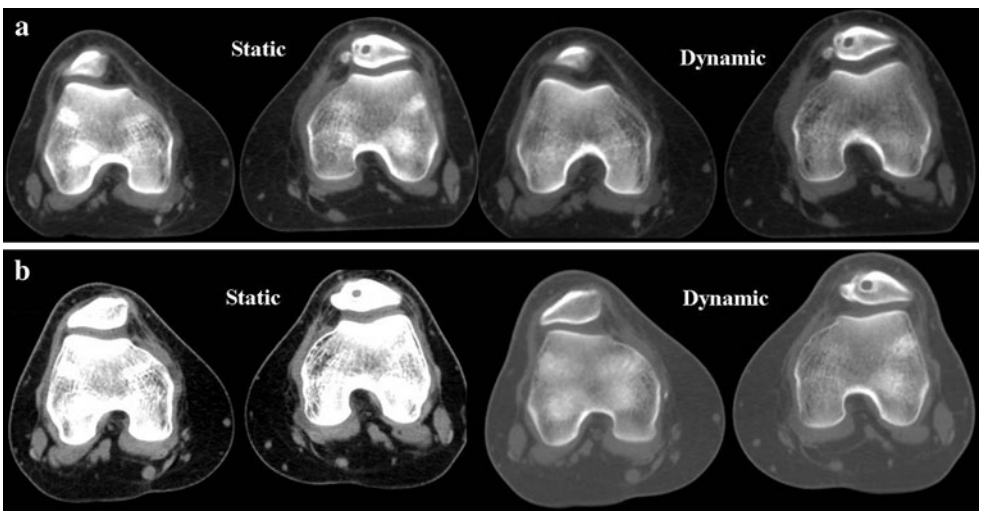

Fig. 5 Static and dynamic CT showing the patellafemoral congruency at 6 months (**a**) and 24 months (**b**) follow-up. The parapatellar medial hole of semitendinosus and gracilis autografts appears in the medial third of the patella. At 24 months follow-up, (**b**) the osteochondral avulsed fragment appears to be fused to patellar bone

soft tissue exposure. The question of isometry in MPFL and MPTL reconstruction remains open and debatable [3].

The technique should be considered on a large number of cases. It is also indispensable that the results should be reviewed when patients have reached full skeletal maturity. However, the clinical results as well as the static and dynamic CT evaluation at 24-months postsurgery are satisfactory (Fig. 5).

Another limitation is that the technique could not be definitive because patellar instability in children and adolescent is often supported by different predisposing factors that may require additional procedures if they worsen during growth.

Various techniques were proposed for the treatment for patellar instability with good but not completely satisfactory results. The suggested technique is based on the reinforced reconstruction of two major components for the stability of the patella in the sagittal and coronal views. The clinical relevance of this technique is that it allows patellar stability and has the potential to keep it longer to reach a better functional outcome than other surgical options already proposed in case of recurrent patellar dislocation with excessive patella alta, severe Q-angle (>15°), trochlear dysplasia, TAGT > 1.2 cm at CT examination, and iperlaxity.

Conclusion

The procedure described is original because, to our knowledge, the combined reconstruction of MPFL and MPTL by ST and G tendon augmentation in adolescents has not been reported in literature. This technique is effective and avoids recurrent patellar dislocation, restores patellofemoral congruency in both static and dynamic CT conditions, and can be carried out in a minimally invasive fashion. The procedure is totally physeal-sparing.

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