

# Patellar Fixation With Suspensory Fixation Device in Single-Tunnel Medial Patellofemoral Ligament Reconstruction



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**Abstract:** The medial patellofemoral ligament (MPFL) is the primary soft-tissue stabilizer of the patellofemoral joint. Among the patellofemoral instability surgery options, MPFL reconstruction is the most preferred soft-tissue procedure. There is no gold-standard surgical treatment method in MPFL reconstruction, and many surgical methods have been described. We describe our surgical technique for MPFL reconstruction wherein the semitendinosus autograft is fixed to a single tunnel opened in the patella with a suspensory fixation device and only a single interference screw on the femoral side.

Patellofemoral instability is a pathology in which several factors are considered to be responsible for its etiology.<sup>1</sup> Surgical and conservative methods of treatment have been used for its treatment.<sup>2</sup> According to current surgical treatment algorithms, medial patellofemoral ligament (MPFL) reconstruction is the most popular treatment method among soft-tissue surgical procedures.<sup>2-4</sup> This is mainly due to the fact that the MPFL is the primary soft-tissue restraint against lateral patellar translation. In fact, the MPFL was found to be 90% to 100% damaged after acute patellofemoral dislocation.<sup>5-7</sup> The MPFL is a ligament present in the second layer on the medial side of the knee, extending along with the superficial fibers of the medial collateral ligament; there are many studies on the anatomic structure of the MPFL.<sup>8</sup> The MPFL goes from its adhesion site in the femur to the patella with a sail-like shape and has a wider patellar adhesion surface area than that of the femoral adhesion site.<sup>9</sup>

Autografts, allografts, and synthetic grafts are used in MPFL reconstruction.<sup>10,11</sup> In surgical techniques wherein static methods are used, these grafts are fixed to the femur and patella. In MPFL reconstruction, tenodesis screws, interference screws, anchors, and suspension systems are used as primary fixation materials.<sup>12</sup> Owing to the presence of a large insertion site of the MPFL in the patella, the double—patellar tunnel fixation method was introduced in MPFL reconstruction surgery.<sup>13,14</sup> However, both single— and double—patellar tunnel reconstruction methods are often preferred in patellofemoral instability surgery.<sup>15,16</sup> We describe our surgical technique for MPFL reconstruction wherein the semitendinosus autograft is fixed to a single tunnel opened in the patella with a suspensory fixation device.

## Surgical Technique

### Patient Positioning and Diagnostic Arthroscopy

With the patient in the supine position, the operative side is sterilized and a tourniquet is applied. Primarily, the knee is re-examined with the patient under anesthesia. Patellar dislocation or subluxation is evaluated under anesthesia, followed by diagnostic arthroscopy, wherein the articular surface of the patella and the relation of the patella with the trochlear groove are examined. Starting from the patella, the MPFL is arthroscopically examined along the entire trace, followed by the graft-harvesting stage.

### Preparation of Autogenous Semitendinosus Graft

The position of the tibial tuberosity is determined. A 3- to 4-cm mini-oblique incision is made from 2 cm

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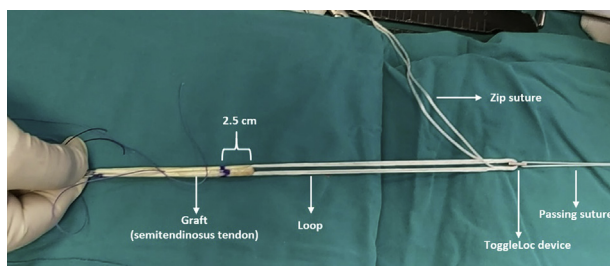
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medial and 1 cm inferior to the tibial tuberosity toward the proximal side. The sartorius fascia is exposed, and the tendons present below it, forming the pes anserinus, are palpated. An inverted-L incision is then made in the sartorius fascia, and the semitendinosus is identified. A Krackow stitch is placed on the end of the semitendinosus tendon with absorbable No. 2 Vicryl suture (Ethicon, Somerville, NJ). Then, the semitendinosus graft is harvested using a tendon stripper, and the fascia incised in the reverse-L shape is repaired. After the graft is harvested, the muscular part of the tendon on the proximal side is removed, and a Krackow stitch is placed on the other end of the tendon with absorbable No. 2 Vicryl suture. The graft is then folded in two, and the semitendinosus is passed through the loop of the ToggleLoc fixation device with ZipLoop technology (Zimmer Biomet, Warsaw, IN) by adjusting the lengths of the semitendinosus at the 2 ends of the loop to be the same. A 2.5-cm part of the graft is marked using a surgical pen so that the patella remains in the tunnel. Because the patellar tunnel is to be opened with a 4.5-mm-diameter drill, the diameter of the graft folded in half is adjusted to not exceed 4.5 mm, and the graft is thinned if necessary (Fig 1).

### Preparation of Patellar Region

A 3- to 4-cm mini-incision is made, which includes the proximal half of the patella. Soft-tissue dissection is then taken down to the bone. The junction between the proximal and middle thirds of the patella is determined by fluoroscopy. In this area, a guidewire is applied medial to lateral through the patella in the middle of its anteroposterior width by fluoroscopy. The bone is drilled over the guidewire using a 4.5-mm ToggleLoc-ZipLoop drill bit through the patella. When the surgeon is opening the tunnel, the patella should be checked by fluoroscopy in both the anteroposterior and lateral positions. It should be confirmed that the drill does not perforate the articular cartilage or anterior



**Fig 1.** ToggleLoc-ZipLoop fixation device. The graft is folded in two, and the semitendinosus is passed through the loop of the ToggleLoc-ZipLoop fixation device by adjusting the lengths of the semitendinosus at the 2 ends of the loop to be the same. A 2.5-cm part of the graft is marked using a surgical pen so that the patella remains in the tunnel.

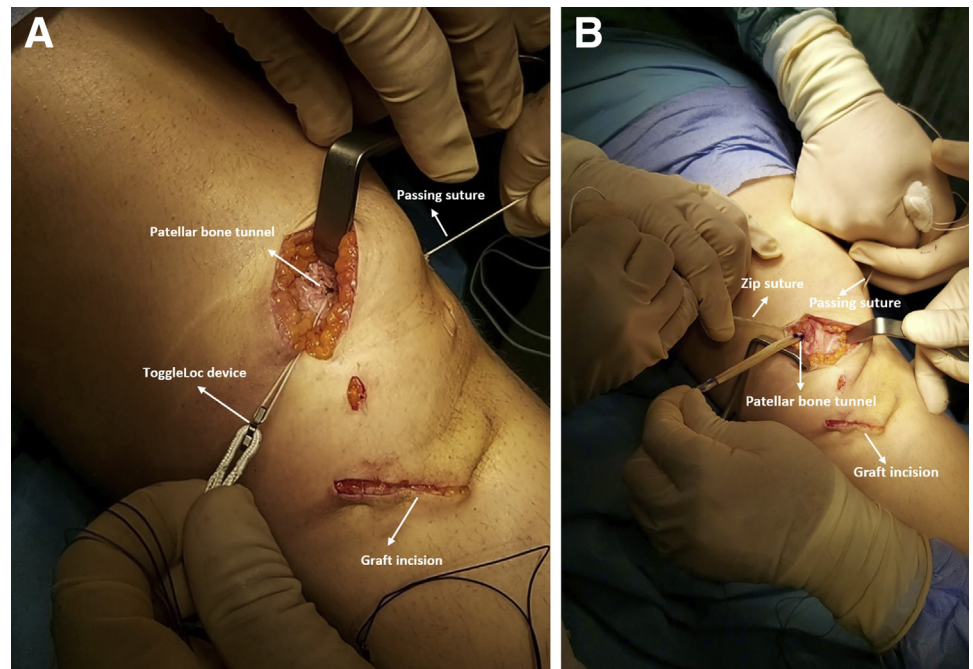
cortex of the patella. Then, a Vicryl suture is looped to the eyelet of the guidewire, and the guidewire is pulled out of the patellar tunnel so that the passing suture of the ToggleLoc-ZipLoop is passed via this loop to the patellar tunnel. The passing suture is pulled, and the ToggleLoc-ZipLoop device is passed through the patellar bone tunnel and hung on the lateral cortex of the patella. The zip suture is then pulled. By pulling the zip suture, the loop size of the ToggleLoc-ZipLoop system is reduced. The zip suture continues to be pulled until 2.5 cm of the graft enters the patellar tunnel (Fig 2). Thus, the fixation of the graft into the patellar tunnel is completed.

### Preparation of Femoral Region

Next, the femur is considered. To open the femoral tunnel and to move the graft to the femoral tunnel, the medial epicondyle is palpated, and a 2- to 3-cm mini-incision is made from the medial epicondyle to the adductor tubercle. The free sutures at the end of the semitendinosus graft are passed to the incision on the femoral side. At this stage, the layer through which the graft is passed and carried to the femoral side is quite important. The graft should not pass through the joint or be present directly under the skin. Therefore, a tunnel is created through the soft tissues using a clamp with a blunt tip. This tunnel is superficial to the joint capsule (layer 3) but deep into the medial retinaculum and fascia (layer 2) or is formed in a subsynovial manner. The free sutures at the end of the graft are transported with the passing suture (Vicryl) through this tunnel to the area in which the femoral tunnel will be formed (Fig 3). The graft is moved to the femoral side, followed by the stage of opening the femoral tunnel.

The femoral tunnel should be opened at the Schöttle point. Schöttle et al.<sup>17</sup> described this point as slightly anterior to an elongation of the posterior femoral cortex between the proximal origin of the medial condyle and the most posterior point of the Blumensaat line. To determine the Schöttle point, a fluoroscopically perfect full lateral image of the femur should be obtained. For this, the knee is positioned in 30° of flexion. The first stage of opening the tunnel begins with the application of the guidewire, one end of which is pointed and the other end of which has an eyelet, to the Schöttle point. The guidewire is directed at approximately 30° proximal and anterior to avoid the intercondylar notch and to not cause vascular injury, and it is applied from the Schöttle point laterally and proximally so as to pierce both femoral cortices. The bone is then drilled over the guidewire with a 7-mm interference screw drill bit through the femur. After the tunnel is opened, the free sutures of the graft are passed through the eyelet of the guidewire, and the graft is pulled proximally out of the tunnel so that the sutures at the end of the graft are

**Fig 2.** With the patient supine, the left knee is visualized through a medial incision. (A) The passing suture is applied, and the ToggleLoc device is passed through the tunnel and hung on the lateral cortex of the patella. (B) The zip suture is pulled to ensure that the 25-mm part of the semitendinosus graft is squeezed into the tunnel.



moved outward through the tunnel. Then, the sutures are pulled proximally, and the graft enters the femoral tunnel. This is followed by the stage of interference screw application to fix the graft in the femoral tunnel. This stage is quite critical; the tension of the graft is determined at this stage.

### Graft Fixation

The graft should not be too tight, increasing the patellofemoral pressure, or too slack, causing the risk of recurrent patellar dislocation. The fixation of the graft to the femoral tunnel is performed using a  $7 \times 25$ -mm interference screw (Biomy; Tulpar, Ankara, Turkey) when the knee is at  $30^\circ$  of flexion, and the graft tension is adjusted (Fig 4). While the patella is in the trochlear groove, the patella is pushed from medial to lateral with a finger; the graft tension is provided to allow one-quarter to one-half of the patella to be lateralized, and the graft is fixed with the interference screw. Then, the knee is evaluated with fluoroscopy in the anteroposterior and lateral positions.

After the fixation process is completed, flexion and extension movements of the knee are performed. The tension of the patella is again checked by gliding it toward the medial and lateral regions, followed by diagnostic arthroscopy. The trace of the reconstructed MPFL in the subsynovial region is observed arthroscopically. The areas with incision are repaired. The surgical procedure is terminated by applying a Hemovac drain and a compression bandage is applied. Postoperatively, knee radiographs are taken in the

anteroposterior and lateral positions (Fig 5). Our technique is shown in Video 1; pearls and pitfalls are listed in Table 1.

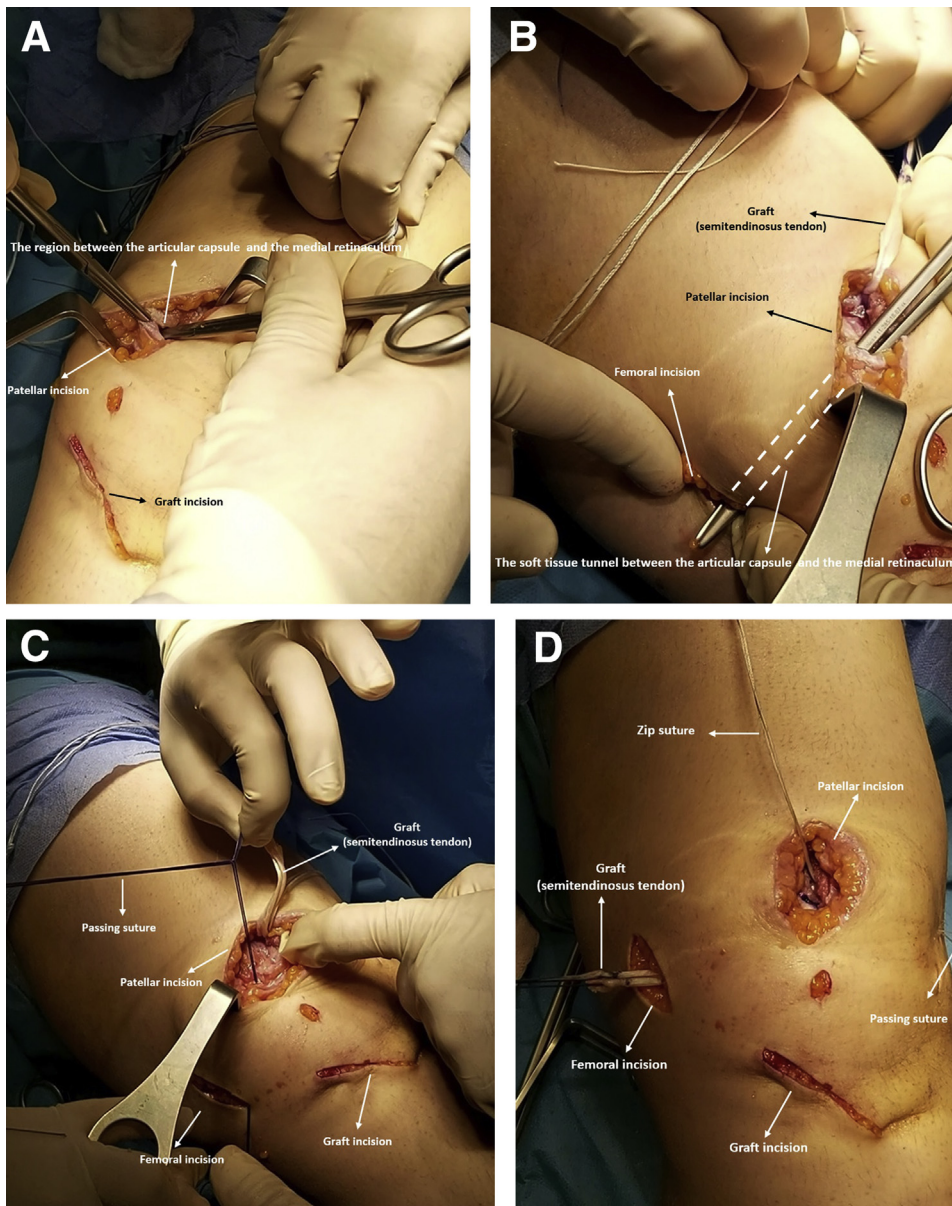
Postoperatively, a hinged knee brace is applied and locked at full extension. The patient is allowed as much loading of the limb as can be tolerated. Straight-leg lifting and isometric quadriceps exercises are immediately started. At the end of the third week, the aim is to achieve  $90^\circ$  of knee flexion. Then, a gradual increase in knee flexion is continued, and at the end of the sixth week, the hinged knee brace is removed.

### Discussion

There are surgical steps with technical difficulties and challenges regarding MPFL reconstruction. These steps mainly concern determining the correct location of femoral graft insertion, adjusting the graft tension, and determining what the angle of flexion in the knee should be during femoral fixation of the graft.<sup>18,19</sup> Failure to determine the location of the femoral tunnel directly affects the clinical results of MPFL reconstruction. This condition is closely related to the recurrence of patellar instability. There are defined zones for the anatomic insertion of the MPFL.<sup>17,20</sup> These defined zones are based on the adductor tubercle and medial epicondyle. Among these, the most widely accepted is the Schöttle point.<sup>17</sup> In our surgical technique, we considered the Schöttle point as a reference to the femoral insertion site.

One of the important stages in MPFL reconstruction is determining what angle the knee will be at while

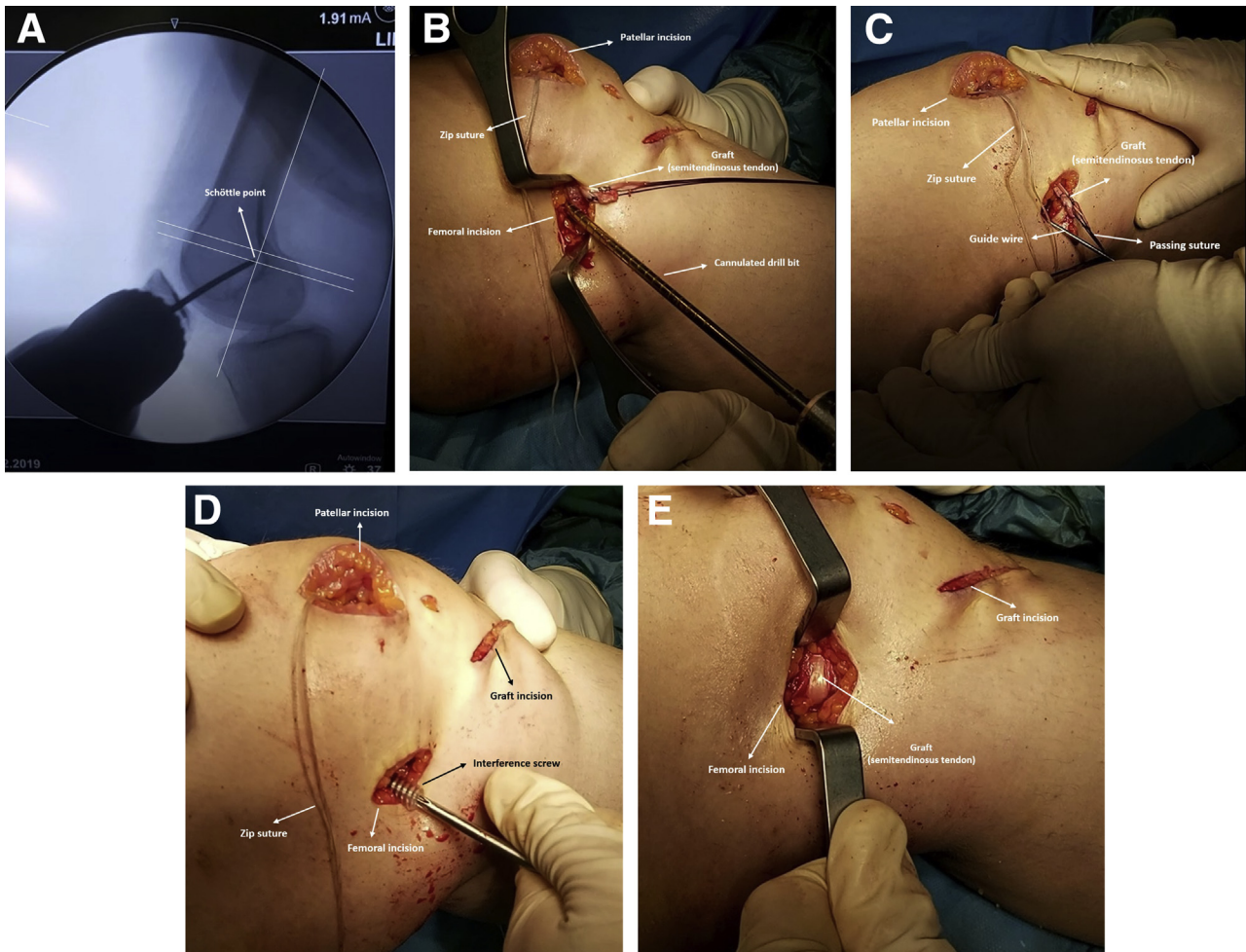




**Fig 3.** With the patient supine, the left knee is visualized through a medial incision. The layer through which the graft is passed and carried to the femoral side is quite important. The graft should not pass through the joint or be present directly under the skin. (A) From medially to the patella, the region between the articular capsule (layer 3) and the medial retinaculum is determined (layer 2). (B) A soft-tissue tunnel is formed by blunt dissection between the articular capsule and the medial retinaculum. The blunt dissection is terminated so that the tunnel outlet opens to the femoral incision zone. (C) The free sutures at the end of the semitendinosus are transported with the passing suture through the tunnel to the femoral incision zone. (D) The graft transfer through the soft-tissue tunnel to the femoral incision zone is completed by pulling the passing sutures.

femoral fixation is performed. There are different opinions on this topic.<sup>21</sup> The general trend is the completion of the fixation process when the knee is at 30° to 60° flexion.<sup>18,19</sup> Schöttle et al.<sup>22</sup> argued that the primary structure showing resistance to lateral patellar translation when the knee is at 30° of flexion is the MPFL. Thus, they argued that the knee should be at 30° of flexion while the graft is fixated to the femoral tunnel. In a review of the flexion angles in the knee during femoral tunnel fixation, no significant difference was observed between fixations performed at 20° and 90° of flexion in terms of clinical results and recurrent dislocations.<sup>21</sup> Similarly to Schöttle et al., we believe that femoral tunnel fixation performed at 30° of flexion is more appropriate.

Another important stage of MPFL reconstruction is the adjustment of graft tension. The graft tension determines the pressure formed in the patellofemoral joint, which directly affects the success of surgery. Beck et al.<sup>23</sup> have shown that 2 N of graft tension restores normal patellar translation. In a biomechanical study, Lorbach et al.<sup>24</sup> reported that femoral fixation performed after providing 2 N of graft tension when knee flexion was at 60° provided successful results. In another study, Stephen et al.<sup>25</sup> reported that femoral tunnel fixation performed after 2 N of graft tension while knee flexion was at 30° or 60° provided successful results. Feller et al.<sup>26</sup> argued that when the knee is at 20° of flexion, the graft tension is sufficient to allow translation of a quarter of the



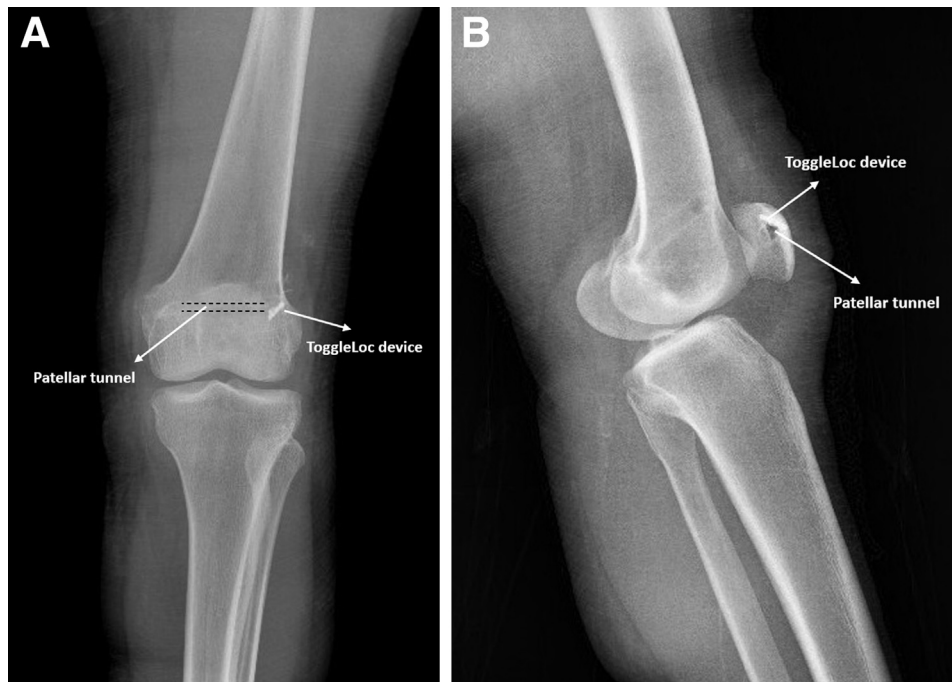
**Fig 4.** With the patient supine, the left knee is visualized through a medial incision. The Schöttle point is determined fluoroscopically. (A) To determine the Schöttle point, a fluoroscopically perfect full lateral image of the femur should be obtained. The Schöttle point is slightly anterior to an elongation of the posterior femoral cortex between the proximal origin of the medial condyle and the most posterior point of the Blumensaat line. (B) From the Schöttle point to 30° proximal and anterior, the bone tunnel is drilled over the guidewire with a 7-mm interference screw drill bit through the femur, which passes both the medial and lateral femoral cortices. (C) From the eyelet at the end of the guidewire, the free sutures of the graft are passed, and the guidewire is pulled through the tunnel so that the free sutures are moved from the lateral femoral cortex out of the tunnel. (D, E) At 30° of knee flexion, the graft is fixed in the femoral tunnel using an interference screw.

patella from the boundary of the lateral femoral condyle. With the knee at 30° of flexion, Schöttle et al.<sup>17</sup> recommended a degree of graft tension that would allow a patellar translation, in which the patellar lateral edge is aligned with the lateral femur condyle. When we adjusted the graft tension, we bent the knee at 30° of flexion, and we performed a patellar glide test while the patella was in the trochlear groove. While the patella was pushed from medial to lateral, we aimed to provide graft tension that would allow one-quarter to one-half of the patella to be lateralized. Recurrence is inevitable in a slack graft, which does not have sufficient tension. In contrast, a graft with too much tension can cause a restriction in the range of motion and an increase in patellofemoral joint

pressure. An appropriate approach on how to adjust graft tension has not yet been fully described.

Tunnels that open to the patella can be formed along the width of the patella or to include part of the patella.<sup>12</sup> In our surgical technique, although a 4.5-mm-diameter tunnel was opened along the patella, only 25 mm of the graft remained in the tunnel. Because there are no implants between the graft and the bone, a favorable environment for bone-tendon healing is created. In the rest of the tunnel, there are passing sutures of the suspension system, which remain very thin compared with the graft diameter. Therefore, in part of the tunnel outside the graft, extensive bone healing can occur. The risk of patellar fracture may also be reduced in this way. We prefer a single-tunnel





**Fig 5.** Postoperative radiographs of left knee taken in anteroposterior (A) and lateral (B) positions.

fixation method in the patella. The literature includes biomechanical and clinical studies comparing single- and double-tunnel fixation methods.<sup>15,27</sup> Kang et al.,<sup>15</sup> in a review, reported no significant difference between the techniques in terms of clinical scores and complications.

Our technique has several advantages. It can be applied with a minimally invasive method. An early rehabilitation program can be applied to patients because stable fixation is obtained by a suspension system used for patellar fixation. The graft can be applied by pulling the zip suture with a press-fit fixation technique to each patellar tunnel of different lengths. In addition, because there are no bioabsorbable screws along the tunnel where the graft enters, straight bone-tendon healing is possible. We used the ToggleLoc-ZipLoop fixation device only for stable fixation purposes. Therefore, knee rehabilitation can be started at an early stage. In our technique, this system does not

have a determinative role in the adjustment of graft tension. However, there are surgical methods wherein an adjustable-loop cortical suspensory device system is used in femoral tunnel fixation, and in these studies, it is emphasized that the graft tension can be adjusted by this method of fixation.<sup>28-30</sup> However, in our opinion, this may not always be possible, and these methods are risky choices in MPFL reconstruction. An overly tight graft fixation performed by accident might lead to irreversible results. An overly tightened system will lead to an increase in the pressure in the patellofemoral joint. In such a situation, the graft tension cannot be loosened by the same system, and it is necessary to completely change the fixation system.<sup>30</sup>

The method we used also has some disadvantages. In cases wherein the patellar tunnel is opened close to the anterior cortex, especially in thin patients with less subcutaneous soft tissue, the ToggleLoc device can be

### Table 1. Pearls and Pitfalls

#### Pearls

The patellar tunnel should be opened in parallel to the joint in the coronal plane, and it should be opened from the middle of the anterior and posterior cortices in the sagittal plane.

To open the femoral and patellar tunnels, it is mandatory to obtain anteroposterior and lateral fluoroscopic images in the correct position. At 30° of knee flexion, after graft tension is provided to allow one-fourth to one-half of the patella to be lateralized, fixation is performed using an interference screw.

When the long axis of the ToggleLoc device is perpendicular to the patella in the coronal plane, it is then made parallel to the patella with the end of a mosquito clamp after blunt dissection. Thus, the risk of irritation in the subcutaneous tissue is minimized.

#### Pitfalls

As a result of incorrect fluoroscopic evaluation, the tunnels may not be opened at the appropriate locations.

A tunnel that is opened close to the anterior cortex can cause patellar fracture and irritation under the skin because of the ToggleLoc device.

An overly tightened graft can cause joint pain and arthrosis postoperatively, whereas slack graft fixation can lead to early recurrent instability.

felt by hand under the skin and can cause irritation. However, we did not encounter such a complication in any of our patients in whom we applied this technique. Similarly to other MPFL reconstruction methods, the difficulties in fluoroscopic assessment of the femoral entry site, as well as the difficulties in the adjustment of graft tension and patellofemoral pressure, constitute the main disadvantages of this technique. There are some risks and limitations in performing this procedure. Improperly adjusted graft tension may lead to patellofemoral joint arthritis and recurrent instability in the postoperative period. One limitation of this technique is the lack of prospective studies evaluating its clinical results. Although we have achieved successful clinical results, we need long-term outcomes.

In conclusion, our minimally invasive method can be easily applied. Early rehabilitation can be started when using the described system, which provides stable patellar fixation. However, further clinical studies are necessary to determine the overall outcomes of this procedure.

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