Technical Note

Superficial and Deep Medial Collateral Ligament Reconstruction for Chronic Medial Instability of the Knee

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Abstract: There are several surgical techniques for medial collateral ligament reconstruction, including anatomic or nonanatomic medial knee reconstruction. Although the medial collateral ligament consists of the superficial medial collateral ligament (sMCL) and deep medial collateral ligament (dMCL), surgical procedures have only been described for reconstruction of the sMCL alone or reconstruction of the sMCL and posterior oblique ligament. The dMCL assists the knee in rotational stability, primarily in extension, moving into early flexion. We describe sMCL and dMCL reconstruction with semitendinosus and gracilis autografts using adjustable-length loop suspensory fixation devices for tibial fixation. By use of our technique, it is possible to provide good stability and satisfactory results for medial instability of the knee.

The medial collateral ligament (MCL) is the main stabilizing structure against valgus force and a secondary restraint to rotation and posterior translation force of the knee.[1] MCL injuries are very common and can be managed nonoperatively with excellent clinical outcomes because of their robust healing capacity.[2] Surgical treatment is recommended, however, for patients with chronic medial instability and MCL injury, combined with multiligament injury.[3]

There are several surgical techniques for MCL reconstruction, including anatomic or nonanatomic medial knee reconstruction.[1] Although the MCL consists of the superficial medial collateral ligament (sMCL) and deep medial collateral ligament (dMCL), surgical procedures have only been described for reconstruction

of the sMCL alone or for sMCL and posterior oblique ligament repair.[1] The sMCL resists valgus forces applied to the knee through all degrees of flexion, with the dMCL acting as a secondary resistance.[4] The dMCL assists the knee in rotational stability, primarily in extension, moving into early flexion.[5]

We describe our technique of sMCL and dMCL reconstruction with semitendinosus and gracilis autografts using adjustable-length loop suspensory fixation devices for tibial fixation (Video 1, Table 1).

MCL Reconstruction Technique

The patient is placed supine on the operating table with an appropriate tourniquet applied over the cast

Table 1. Pearls and Pitfalls

1. It is important to identify the posterior border of the tibia for the tibial insertion of the sMCL and dMCL.
2. The surgeon must ensure that the ends of the whipstitch exit the inferior border of the proximal tendon for smooth insertion of the grafts into the tunnel.
3. Fluoroscopy should be used to mark the proximal tibial insertion of the sMCL, which is often more proximal than expected.
4. Placing the dMCL graft first, followed by the sMCL graft, is a way to insert both grafts into the femoral tunnel safely.
5. The surgeon should check the isometry point one more time before creating the femoral tunnel.
6. Femoral fixation using an interference screw should be tensioned at 20° of flexion.
7. Retightening the tibial fixation by pulling the threads of the TightRope RT after femoral fixation allows firm fixation.

dMCL, deep medial collateral ligament; sMCL, superficial medial collateral ligament.
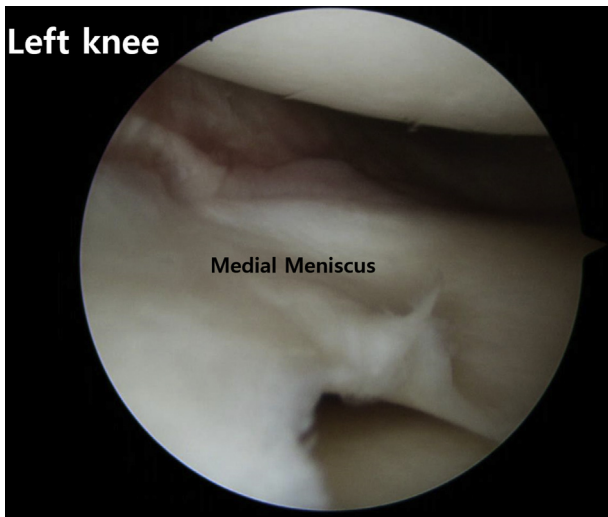
Fig 1. A left knee is shown, viewing from the anterolateral portal. An arthroscopic examination shows a significantly widened medial opening with valgus stress before medial collateral ligament reconstruction.

padding. A standard arthroscopic examination is performed first using the standard anteromedial, anterolateral, and superomedial portals to evaluate medial widening (Fig 1) and to treat the associated lesions, including lesions of the meniscus, cartilage, and so on.

A longitudinal skin incision is made from the medial epicondyle to the pes anserinus level, 7 cm below the joint line. Full-thickness skin flaps are obtained to avoid injury to the saphenous nerve. The pes tendons are identified, and the sartorius fascia is incised. The sartorius fascia is retracted and the semitendinosus tendon is harvested using a hamstring stripper after isolation of the tendon. The gracilis tendon is harvested after semitendinosus tendon harvesting. The semitendinosus and gracilis tendons are prepared on the back table. Both ends of each graft are sutured with a
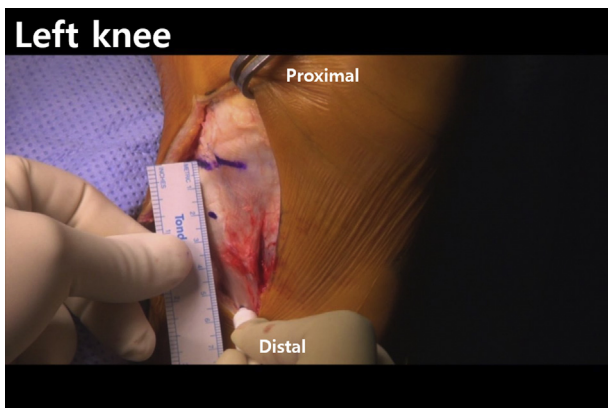

Fig 2. A left knee is shown. The distal tibial attachment sites of the deep and superficial medial collateral ligaments are marked with a ruler; they are 1 cm and 6 cm distal to the medial joint line, respectively.
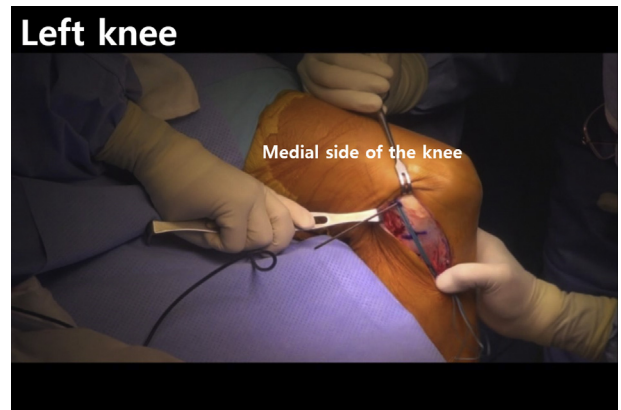

Fig 3. A left knee is shown. The isometric point is checked through a range of knee motion with flexion and extension.

whipstitch using No. 5 Ethibond suture (Ethicon, Somerville, NJ). The 1 free end of the graft is passed through the TightRope RT (Arthrex, Naples, FL), and 2 equal strands are made by folding the graft. The semitendinosus and gracilis grafts are prepared for sMCL reconstruction and dMCL reconstruction, respectively.

The femoral origin of the MCL is identified and marked. The site is just proximal and posterior to the
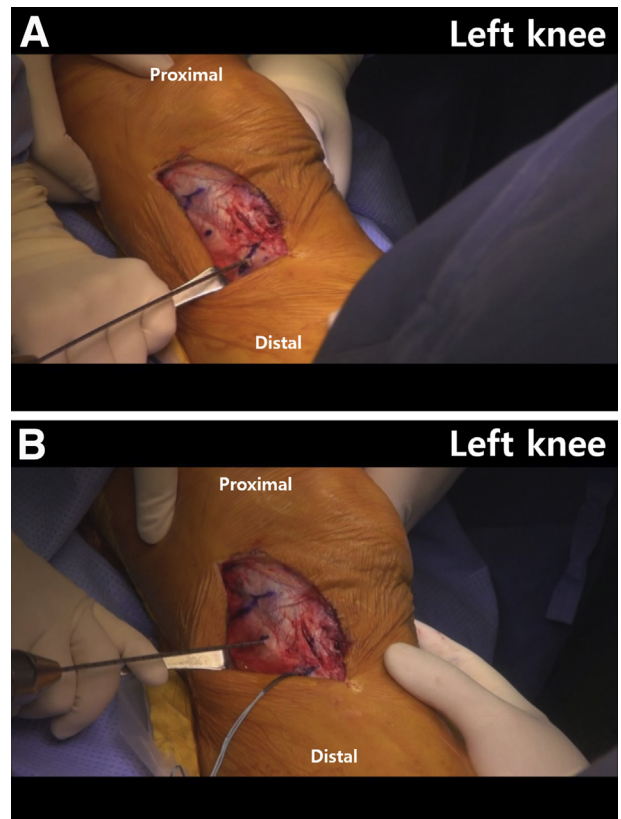

Fig 4. A left knee is shown. (A) The distal attachment of the superficial medial collateral ligament is rechecked. A 4.5-mm guide pin is inserted in an anterolateral direction. (B) The guide pin is inserted at the distal insertion site of the deep medial collateral ligament.
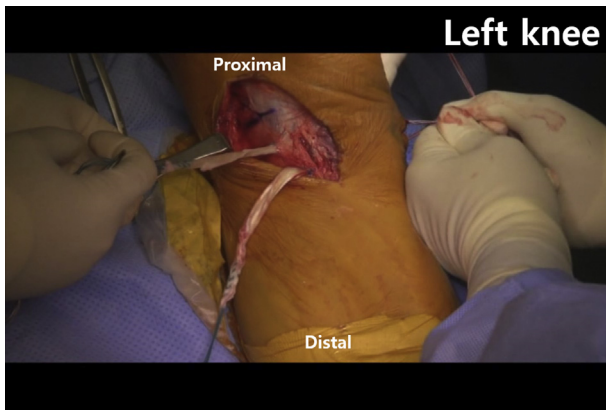
Fig 5. A left knee is shown. The prepared semitendinosus graft with the ACL TightRope (Arthrex) is pulled into the superficial medial collateral ligament tunnel of the tibia. The prepared gracilis graft with the ACL TightRope is pulled into the deep medial collateral ligament tunnel of the tibia.

medial epicondyle.[6,7] The medial joint line is also marked with a needle. The distal tibial attachment sites of the dMCL and sMCL are marked with a ruler and are 10 mm and 60 mm distal to the medial joint line, respectively (Fig 2).[6,7] The guide pin is inserted into the femoral attachment site of the MCL from medially to laterally as a check of the isometric point. The isometric point is checked through a range of knee motion with flexion and extension (Fig 3). Adjustments are necessary when differences in the length of the grafts during flexion and extension of the knee are observed. Lengthening of the grafts during flexion means that they are tight during flexion. Therefore, the position of the femoral pin is moved a few millimeters posteriorly to achieve an isometric point.

The distal attachment of the sMCL is rechecked. A 4.5-mm guide pin is inserted in an anterolateral direction (Fig 4). Overdrilling with a reamer is performed with a
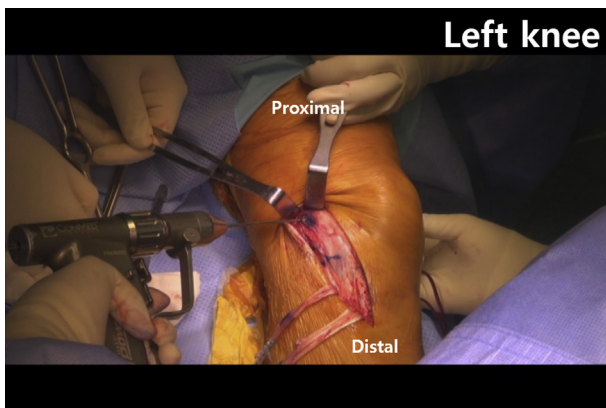

Fig 6. A left knee is shown. The femoral guide pin is inserted into the isometric point of the femoral attachment of the superficial medial collateral ligament found previously. The lateral target point is slightly anterior and proximal.
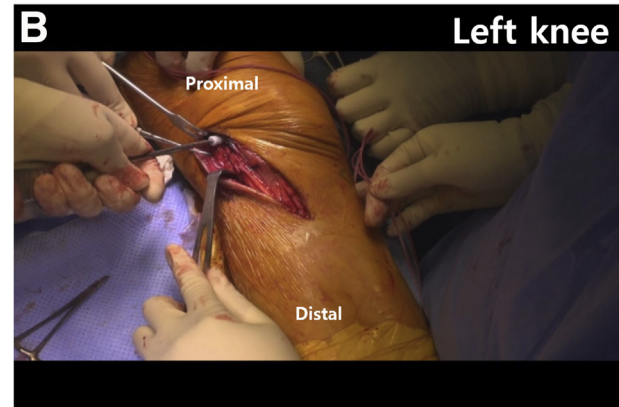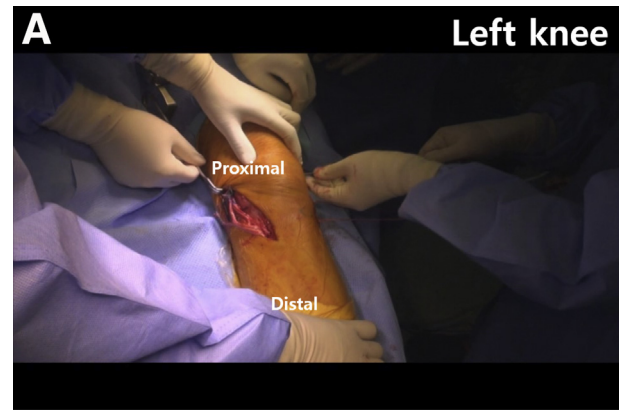

Fig 7. A left knee is shown. (A) The tunnel depth is prepared sufficiently, to about 25 mm. The semitendinosus and gracilis grafts are passed through the femoral tunnel. (B) The bioabsorbable interference screw (BioComposite screw) is used to fix the graft in the femoral tunnel.

depth of 20 mm. The No. 5 Ethibond suture is penetrated to the far cortex. The guide pin is inserted at the distal insertion site of the dMCL (Fig 4). Reaming is performed using a reamer with a depth of 20 mm. The No. 5 Ethibond suture is also penetrated to the far cortex. The prepared semitendinosus graft with the TightRope RT is pulled into the sMCL tunnel of the tibia (Fig 5). The

Fig 8. A left knee is shown. The reconstructed graft is checked finally by applying valgus force.
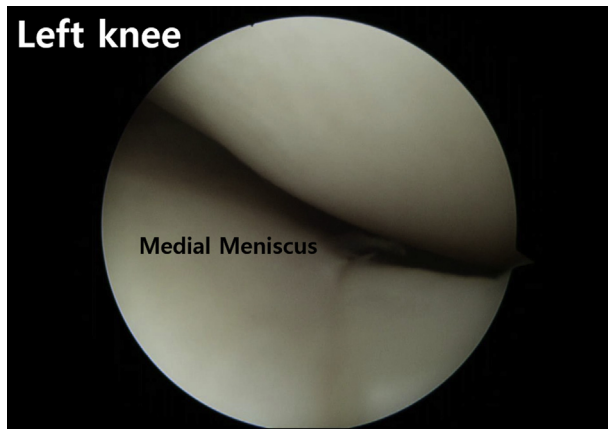
Fig 9. A left knee is shown, viewing from the anterolateral portal. After medial collateral ligament reconstruction, the medial opening is reduced with the same valgus stress.

noted, the pin is repositioned appropriately. The femoral tunnel is drilled to the same size as the 2-graft bundle. The tunnel depth is prepared sufficiently, to about 25 mm. The semitendinosus and gracilis grafts are passed through the femoral tunnel (Fig 7). It is important to make sure that all grafts completely pass through the tunnel. The dMCL graft is tightened first; the sMCL graft is then tightened. Thereafter, the stability of the graft is evaluated with valgus stress. A bioabsorbable interference screw (BioComposite screw; Arthrex) is used to fix the graft in the femoral tunnel (Fig 7). The TightRope RT of the sMCL graft is tensioned using 20° of knee flexion and varus force. The TightRope RT of the dMCL graft is also re-tensioned in the same position. Finally, the reconstructed graft is checked by applying valgus force (Fig 8). A metal anchor is inserted in the proximal tibial insertion of the sMCL, 14 mm distal to the joint line.[6,7] The suture of the anchor is tied after passing through the graft. After MCL reconstruction, the medial opening is reduced and normal with the same valgus stress (Fig 9). Postoperative radiographs are also checked (Fig 10). The medial opening width is reduced from 15 mm before the operation to 7 mm during valgus stress radiography at 8 weeks postoperatively (Fig 11).

After the operation, a hinged brace is applied with a slight varus mold for the first 6 weeks postoperatively.

gracilis graft prepared with the TightRope RT is inserted into the dMCL tunnel of the tibia (Fig 5). The femoral guide pin is inserted into the isometric point of the femoral attachment site of the sMCL found previously (Fig 6). The lateral target point where the guide pin exited is slightly anterior and proximal. The isometric point is rechecked with the semitendinosus and gracilis grafts. If a minimal length change within 2 mm is not
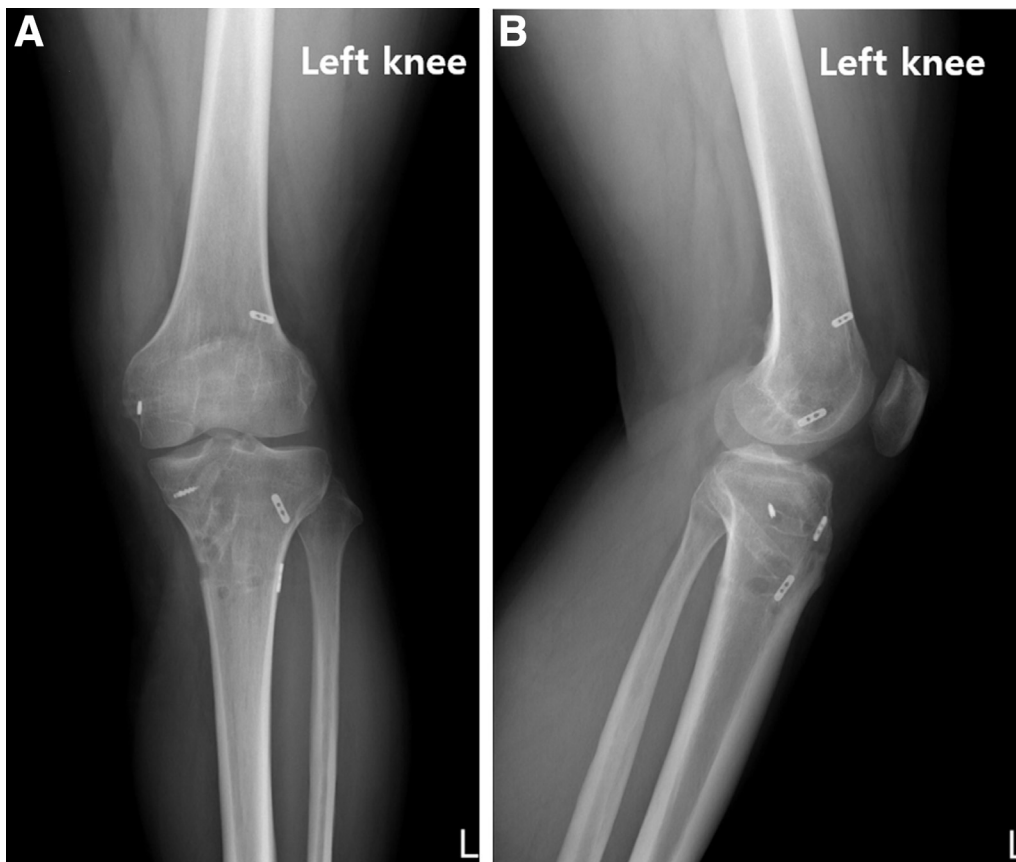

Fig 10. A left knee (L) is shown. Postoperative anteroposterior (A) and lateral (B) radiographs show a well-seated TightRope RT button in the proximal tibia.
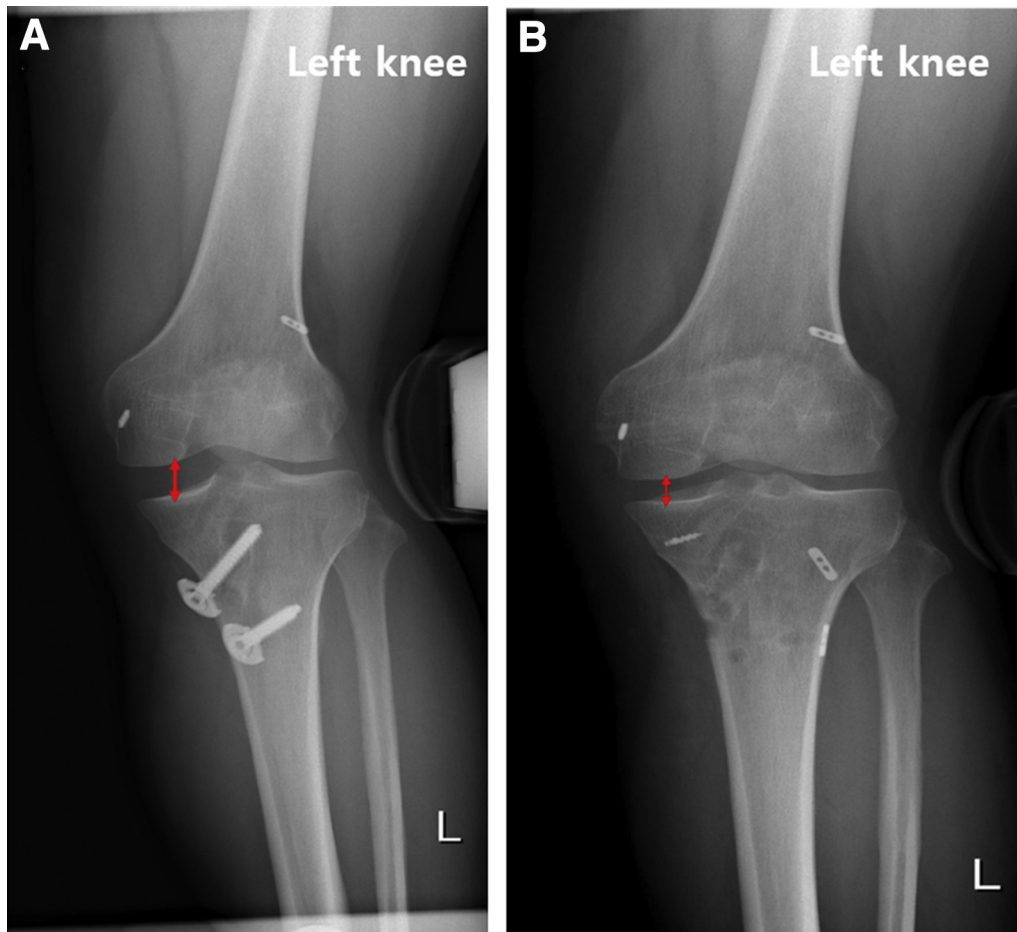
Fig 11. A left knee (L) is shown. Compared with the preoperative radiograph (A), the postoperative valgus stress radiograph (B) shows that the medial opening width (red lines) was reduced.

The brace is locked in the extension position with non−weight bearing and unlocked to provide range of motion of the knee joint. Progressive weight bearing with the unlocked brace is started 6 weeks after surgery. At postoperative week 8, daily activities and full weight bearing without the brace are permitted.

Discussion

There are several methods for surgical treatment of chronic medial instability of the knee joint.[2] MCL reconstruction has mainly focused on reconstruction of the sMCL.[1] To accomplish this with our technique, the femoral attachment site of the sMCL is placed in a depression, 3.2 mm proximal and 4.8 mm posterior to the medial epicondyle.[6,7] There are 2 attachments of the tibial portions, 14 mm and 60 mm distal to the joint line.[6,7] The dMCL consists of a meniscofemoral ligament and meniscotibial ligament, relatively thinner than the sMCL.[6,7] The femoral insertion of the dMCL is made 20.5 mm proximal to the joint line and located below the insertion of the sMCL.[6,7] The tibial insertion of the dMCL is made 6.5 mm from the joint line.[6,7] The dMCL functions as a secondary restraint to valgus

loads.[8,9] A previous study reported that the mean failure load of the sMCL was 557 N and that of the dMCL was 100 N.[9] The dMCL also assists the knee in rotational stability, primarily in extension, moving into early flexion.[5] Therefore, we tried to reproduce the anatomy and function of a normal knee when reconstructing the dMCL, as well as the sMCL, in an MCL reconstruction for chronic medial instability of the knee.

Our technique has several pearls and pitfalls. It is important to identify the posterior border of the tibia for tibial insertion of the sMCL and dMCL. It must be confirmed that the ends of the whipstitch exit the inferior border of the proximal tendon for smooth insertion of the grafts into the tunnel. The proximal tibial insertion of the sMCL is marked with the aid of fluoroscopy, which may yield a location more proximal than expected. Placing the dMCL graft first, followed by the sMCL graft, is a way to insert both grafts into the femoral tunnel safely. We recommend checking the isometric point one more time before creating the femoral tunnel. Femoral fixation using an interference screw should be tensioned at 20° of flexion (Table 1). A limitation of our technique is that although it seeks to

reproduce both the sMCL and dMCL, it is not really a complete representation of the femoral attachment site of the 2 ligaments. Although there is a difference in the femoral attachment sites of the sMCL and dMCL, in our technique, we try to reproduce the femoral attachment sites of the 2 ligaments at the femoral attachment site of the sMCL. Thus, although the 2 ligaments are reproduced, they may function differently from the sMCL and dMCL. This will be confirmed later in a biomechanical study. Our technique of anatomic reconstruction of both the sMCL and dMCL concomitantly using autogenous hamstring tendons with adjustable-length loop suspensory fixation devices provides good stability and satisfactory results for medial instability by restoring the anatomy and function of the knee.

References

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