SUBSPECIALTY PROCEDURES

EXTENSOR MECHANISM RECONSTRUCTION WITH USE OF MARLEX MESH

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Abstract

Background: Marlex mesh reconstruction of the extensor mechanism via a stepwise surgical approach is a viable option to treat disruption of the extensor mechanism after total knee arthroplasty (TKA).

Description: Extensor mechanism reconstruction with mesh involves a stepwise surgical approach with a particular monofilament polypropylene mesh (Marlex; C.R. Bard). Prior to incision, the 10 × 14-in (25 × 36-cm) sheet of Marlex mesh is rolled onto itself 8 to 10 times and sewn together. If the tibia is not being revised, a burr is utilized to create a trough in the tibia. Five centimeters of the tapered portion of the mesh are predipped in bone cement. The remaining cement is inserted into the trough. The tapered portion of the mesh is inserted into the tibial trough, ensuring that the mesh is fully seated. After the cement has cured, a lag screw is placed across the mesh and cement and into host bone. If the tibia is being revised at the time of the Marlex mesh reconstruction, the 5 cm of predipped mesh is placed anteriorly in the medullary canal in line with the tibial crest. The remaining procedure is similar regardless of whether the components are revised. At the level of the joint, it is essential to ensure that the mesh is covered with host tissue. Next, the proximal reconstruction, which involves mobilizing the vastus lateralis and vastus medialis obliquus (VMO) distally by releasing all ventral and dorsal soft-tissue adhesions off the muscle bellies, is completed. Finally, the mesh is unitized to the vastus lateralis. With the limb maintained in full extension, the mesh is pulled directly proximally while another assistant pulls the vastus lateralis distally and medially. The vastus lateralis is deep, and the mesh is directly on top of it. Multiple nonabsorbable sutures are placed through the mesh and vastus lateralis. The VMO is then pulled distally and laterally over the mesh (which is now unitized to the vastus lateralis) by an assistant. Multiple nonabsorbable sutures (usually 8) are placed through the VMO, through the mesh, and through the vastus lateralis, unitizing the entire construct.

Alternatives: Nonoperative treatments include a drop-lock hinge brace or knee immobilizer. Operative treatments include whole extensor mechanism allograft reconstruction or Achilles tendon allograft reconstruction.

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Rationale: The procedure avoids the limitations of allograft with regard to availability, cost, and risk of disease transmission. The technique is reproducible and cost-effective, and it has excellent functional and survivorship outcomes.

Introductory Statement

Extensor mechanism reconstruction with Marlex mesh using a stepwise surgical approach, which is performed in a similar manner for both quadriceps tendon and patellar tendon rupture, has resulted in excellent functional outcomes, with a mean improvement in extensor lag of 26° and 84% of the mesh reconstructions remaining in place at a mean of 4 years¹.

Indications & Contraindications

Indications

- Quadriceps tendon rupture during or after total knee arthroplasty (TKA) leading to extensor lag (either partial or complete), including aseptic and septic etiologies¹⁻⁴.
- Patellar tendon rupture during or after TKA leading to extensor lag (either partial or complete)⁴.
- Catastrophic fracture of the patella (either resurfaced or unresurfaced) during or after TKA leading to extensor lag¹.
- Native quadriceps tendon or patellar tendon rupture leading to extensor lag³.

Contraindications

- Active infection.

Step-by-Step Description of Procedure

Step 1: Preparation of Marlex Mesh

Prepare the Marlex mesh prior to the incision.

- Prior to incision, fold the 10 × 14-in (25 × 36-cm) sheet of Marlex mesh onto itself 8 to 10 times and sew it together with a single nonabsorbable suture in a running locked fashion (Fig. 1).
- If the tibial component will be maintained at the time of the Marlex mesh reconstruction, then taper 1 side of the mesh to allow easier delivery in the tibial trough (described below).
- If the tibial component will be revised, then the mesh does not need to be tapered.

Fig. 1

Fig. 1 Intraoperative photograph of the 10 × 14-in (25 × 36-cm) sheet of knitted monofilament polypropylene mesh folded onto itself 8 to 10 times and then unitized with a running locked suture. (Reproduced from: Abdel MP, Salib CG, Mara KC, Pagnano MW, Perry KI, Hanssen AD. Extensor mechanism reconstruction with use of Marlex mesh: a series study of 77 total knee arthroplasties. *J Bone Joint Surg Am*. 2018 Aug 1;100[15]:1309-18.)

Step 2: Incision and Exposure

For a Marlex mesh reconstruction, prepare and drape the entire limb, use a sterile tourniquet, and extend the proximal incision as needed until the vastus lateralis and vastus medialis obliquus (VMO) muscles are appropriately mobilized.

- Prepare and drape the patient in the usual sterile fashion and include the entire involved extremity up to the anterior superior iliac spine (ASIS), given the need for a proximal exposure.
- A sterile tourniquet is preferred.
- Thereafter, expose the knee utilizing the same midline incision through which the TKA was performed.
- If multiple incisions are present, use the most laterally based appropriate incision.
- Extend the incision from distal to the tubercle to 10 cm proximal to the superior aspect of the patella.
- After that, evaluate the extensor mechanism disruption.
- For both quadriceps tendon and patellar tendon disruptions, perform a standard medial parapatellar arthrotomy, taking care to maintain an equal amount of robust soft tissue on the sides of both the vastus lateralis and VMO muscles.
- Mobilize the medial and lateral gutters and release adhesions; however, avoid removing scar tissue as this tissue can be utilized to incorporate the mesh later in the procedure.

Step 3: Creation of the Tibial Trough and Fixation of the Marlex Mesh

If maintaining the tibial component, create a tibial trough with a high-speed burr that will accept the Marlex mesh as well as cement.

- If the tibia is not being revised at the time of the reconstruction, use a 6.5-mm round burr to create a trough in the tibia (Video 1).
- Ensure that this trough is ≥ 3 cm in the medial to lateral plane by 3 cm in the anterior to posterior plane by 5 cm in the superior to inferior plane (Figs. 2-A through 2-D).
- Moreover, place the trough at a similar location to the existing tibial tubercle and inferior to the tibial baseplate by approximately 2 cm (but anterior to the tibial keel or metaphyseal fixation device if present).
- Use a 19-mm-wide curved osteotome to ensure the tapered side of the mesh fits into the prepared trough with adequate room for a cement mantle.
- If the trough appears tight, it will be too tight. In that case, use the burr to remove additional bone.
- At this point, mark and predip 5 cm of the tapered portion of the mesh in unheated bone cement that contains 1 g of vancomycin per 40-g bag of cement. Place the remaining cement in a syringe and insert into the trough.
- Thereafter, insert the tapered portion of the mesh into the tibial trough, ensuring the marked line (indicating 5 cm) is fully seated (Video 2).
- Use of the 19-mm-wide curved osteotome allows impaction of the mesh deep into the tibial trough and ensures stability while the cement cures.
- Reflect the mesh proximally as the cement cures and remove additional cement.
- After the cement has cured, place a lag screw across the mesh and cement and into the host bone.
- Typically, it is necessary to angle the screw either medially or laterally to avoid the tibial keel and preexisting cement. The usual screw length is 40 to 60 mm.

Fig. 2

Fig. 2 When the components are maintained, a tibial trough is created with a high-speed burr, as depicted in the illustration (**Fig. 2-A**) and as seen in the intraoperative photograph (**Fig. 2-B**). Intraoperative photographs show the cementation of the mesh into the trough, with the mesh reflected proximally (**Fig. 2-C**) and distally (**Fig. 2-D**). (Reproduced from: Abdel MP, Salib CG, Mara KC, Pagnano MW, Perry KI, Hanssen AD. Extensor mechanism reconstruction with use of Marlex mesh: a series study of 77 total knee arthroplasties. J Bone Joint Surg Am. 2018 Aug 1;100[15]:1309-18. Figure 2-A used with permission of the Mayo Foundation for Medical Education and Research. All rights reserved.)

Video 1 The tibial trough is being prepared with a 6.5-mm round burr.

Video 2 Mesh insertion and placement of lag screw if tibial component is not being revised at the time of the extensor mechanism reconstruction.

Step 4: Alternative: Placement of Marlex Mesh in the Medullary Canal During Revision TKA

If the tibial component is being revised at the time of a Marlex mesh reconstruction, a tibial trough does not need to be created as the Marlex mesh is cemented with the tibial component and stem in the medullary canal.

- If the tibia is being revised at the time of the Marlex mesh reconstruction, place the 5 cm of predipped mesh anteriorly in the medullary canal in line with the tibial crest, ensuring that it is fully surrounded by cement (Video 3).
- Immediately thereafter, place the tibial component with a tibial stem in the canal posterior to the mesh, locking the mesh into place (Figs. 3-A and 3-B).

Fig. 3

Fig. 3 When the components are revised, the mesh can be cemented in an intramedullary position with the tibial component and stem, as noted in these intraoperative photographs with the mesh reflected proximally (**Fig. 3-A**) and distally (**Fig. 3-B**). (Reproduced from: Abdel MP, Salib CG, Mara KC, Pagnano MW, Perry KI, Hanssen AD. Extensor mechanism reconstruction with use of Marlex mesh: a series study of 77 total knee arthroplasties. J Bone Joint Surg Am. 2018 Aug 1;100[15]:1309-18.)

Video 3 During revision TKA, the mesh simply can be inserted into the medullary canal before the revision tibial component and its respective stem are cemented into place.

Step 5: Distal Incorporation of Marlex Mesh

After the Marlex mesh is secured in the tibia, ensure that the distally placed end of the mesh is covered with host tissue both ventrally and dorsally.

- The remaining procedure is similar regardless of whether the components are revised.
- At the level of the joint, it is essential to ensure that the mesh is covered with host tissue both ventrally and dorsally using nonabsorbable sutures as this will avoid wound compromise and abrasion of the mesh against the implant (Video 4).
- Complete this step typically with the remnant patellar tendon if a patellar tendon disruption is present or with the intact patellar tendon if the procedure is being completed for a quadriceps tendon disruption (Figs. 4-A and 4-B).
- Occasionally, free tissue from the iliotibial (IT) band can be brought down to cover the mesh.
- Thereafter, pass the mesh proximally.
- If substantial soft tissue is present superficial to the actual patella, create a tunnel and pass the mesh with a curved Kocher clamp.
- If the tissue superficial to the patella is thin, then elevate the tissue directly off the ventral surface of the patella, pass the mesh, and close the soft tissue right back to an anatomic location over the mesh.

Fig. 4

Fig. 4 The mesh is incorporated into remaining host tissue distally as noted in this illustration (**Fig. 4-A**) and intraoperative photograph (**Fig. 4-B**). The goal is to have the mesh pass through the host tissue via a tunnel, but to have host tissue ventral and dorsal to the mesh to avoid any portion of the mesh rubbing on the prosthesis. (Reproduced from: Abdel MP, Salib CG, Mara KC, Pagnano MW, Perry KI, Hanssen AD. Extensor mechanism reconstruction with use of Marlex mesh: a series study of 77 total knee arthroplasties. *J Bone Joint Surg Am*. 2018 Aug 1;100[15]:1309-18. Figure 4-A used with permission of the Mayo Foundation for Medical Education and Research. All rights reserved.)

Video 4 Distal incorporation of the Marlex mesh into host tissue is essential.

Step 6: Mobilization of Vastus Lateralis and VMO

Next, complete the proximal reconstruction by mobilizing the vastus lateralis and VMO distally.

- Mobilize the vastus lateralis and VMO distally by releasing all ventral and dorsal soft-tissue adhesions off the muscle bellies (Videos 5 and 6).
- An essential portion of the procedure, the mobilization requires a substantial soft-tissue dissection proximally.
- Often, it is helpful to place 2 nonabsorbable sutures into the vastus lateralis and another 2 nonabsorbable sutures into the VMO.
- This allows the surgeon to identify adhesive bands, while also assessing the amount of excursion gained both distally and medially (for the vastus lateralis) and distally and laterally (for the VMO).
- The goal is to have the VMO overlap the vastus lateralis by approximately 5 cm.

Video 5 Proximally, the vastus lateralis must be mobilized distally and medially.

Video 6 The VMO must be mobilized distally and laterally.

Step 7: Unitize Marlex Mesh (Middle) and Vastus Lateralis (Deep), and Then VMO (Superficial)

In the final major portion of the reconstruction, perform the so-called pants-over-vest reconstruction in which the vastus lateralis is deep, the Marlex mesh is in the middle, and the VMO is on top (all unitized with nonabsorbable sutures).

- Finally, unitize the mesh to the vastus lateralis (Video 7).
- Keeping the limb in full extension with a bump underneath the calf, have an assistant pull the mesh directly proximal with a Kocher clamp while another assistant pulls the vastus lateralis distally and medially.
- The vastus lateralis is deep, and the mesh is directly on top of that (Figs. 5-A and 5-B).
- Place multiple nonabsorbable sutures (usually 4) through the mesh and vastus lateralis.
- Then have an assistant pull the VMO distally and laterally over the mesh (which is now unitized to the vastus lateralis) (Video 8).
- Place multiple nonabsorbable sutures (usually 8) through the VMO, through the mesh, and through the vastus lateralis, unitizing the entire construct.
- The key is to ensure that the entire mesh is covered by host vastus lateralis and VMO both ventrally and dorsally.
- Close the remaining arthrotomy and retinacular tissues with nonabsorbable sutures.

Fig. 5

Fig. 5 Finally, the mesh is incorporated with the proximal tissue after aggressive ventral and dorsal mobilization of the VMO and vastus lateralis. The vastus lateralis is dorsal with the mesh incorporated ventral to that, and then the VMO ventral to the mesh, sandwiching the mesh between the vastus lateralis and VMO (**Fig. 5-A**). Thereafter, the remaining proximal mesh is excised and the arthrotomy is closed (**Fig. 5-B**). (Reproduced from: Abdel MP, Salib CG, Mara KC, Pagnano MW, Perry KI, Hanssen AD. Extensor mechanism reconstruction with use of Marlex mesh: a series study of 77 total knee arthroplasties. J Bone Joint Surg Am. 2018 Aug 1;100[15]:1309-18. Figure 5-A used with permission of the Mayo Foundation for Medical Education and Research. All rights reserved.)

Video 7 The Marlex mesh is then unitized to the vastus lateralis with multiple nonabsorbable sutures and with the mesh being superficial to the vastus lateralis.

Video 8 The VMO is brought over the mesh that is now unitized to the vastus lateralis, creating a true pants-over-vest closure.

Step 8: Postoperative Protocol

Ensure that the patient maintains postoperative immobilization and follows subsequent prescriptive rehabilitation protocols, which are essential.

- At 48 hours, evaluate the wound and place the leg in a long leg cast incorporating the foot, with the knee flexed to 5°.
- In patients with extreme obesity, use a custom bivalved thigh-leg-foot orthosis, which has been fitted preoperatively.
- Change the cast and remove the sutures at 2 to 3 weeks. Total time of cast immobilization is 12 weeks.
- At 3 months, remove the cast and place the limb in a hinged knee brace full-time for an additional 3 months. Allow the patient to do only active gravity flexion exercises in the brace, which is adjusted monthly at 45° for the first month, 60° for the second month, and 90° for the third month. Allow the patient to bear weight during this time, with the brace locked at 0°.
- During this time, and after brace removal, it is recommended that the patient use an ambulatory aid such as a cane or walking stick to help to prevent a fall that hyperflexes the knee and disrupts the extensor mechanism reconstruction.

Results

At the most recent follow-up (mean, 4 years), 65 of 77 mesh reconstructions were in place¹. Of the 12 patients who had a mesh failure, 5 had revision because of patellar tendon rupture; 5, for quadriceps tendon disruption; and 2, for symptomatic lengthening of the mesh. There were 4 additional patients who had mesh failures, but they did not undergo revision mesh reconstructions. The mean improvement in extensor lag was 26°, with a mean extensor lag of 9° at the most recent follow-up ($p < 0.001$). Moreover, the Knee Society scores significantly improved ($p < 0.001$).

Pitfalls & Challenges

- Be certain that the mesh is not overly wide when folding it over on itself and unitizing it. Otherwise, it will be difficult to insert the mesh into the tibial trough or through the medullary canal.
- It is essential that a good portion (approximately 5 cm) of the mesh be cemented into the tibia (regardless of whether the tibial component is being revised simultaneously).
- Distally, the mesh must be covered with host tissue both ventrally and dorsally to avoid wound compromise and mesh abrasion (and thus tearing) against the implant, respectively. Occasionally, this requires free soft tissue from the IT band.
- The vastus lateralis and VMO must be mobilized distally by releasing any adhesions to the muscle bellies both ventrally and dorsally. Importantly, this often requires a very proximal dissection. This tissue also must fully cover the mesh both ventrally and dorsally to avoid the above noted complications.

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