Synthetic Mesh Augmentation of Acute and Subacute Quadriceps Tendon Repair

Matthew C. Morrey, MD; Jonathan D. Barlow, MD; Matthew P. Abdel, MD; Arlen D. Hanssen, MD

Abstract

Quadriceps tendon rupture is an uncommon injury. To date, surgical results have been less than favorable. A novel repair technique that uses Marlex mesh (C R Bard, Murray Hill, New Jersey) has been developed. Use of this repair may allow earlier range of motion and functional restoration of extension. The authors sought to evaluate the technical feasibility, durability, and postoperative function of this repair. This study retrospectively analyzed 8 knees (7 patients) operated on with this technique from 1990 to 2011. Mean follow-up was 9 years. Average age at the time of injury was 69 years. Mean operative time was 130 minutes. No perioperative complications occurred, no patients had clinical evidence of failure, and no patients required subsequent reoperation. Mean flexion at final follow-up was 100°. Of the 8 knees, 7 knees had no extensor lag at final follow-up. Marlex mesh augmentation for quadriceps tendon ruptures has promising clinical results, despite significant comorbidities. The results showed that the technique was feasible, with low cost and reasonable operative time. The clinical results were durable, with no intraoperative complications, no re-ruptures, rare extension lag, and good range of motion. Therefore, synthetic mesh augmentation is a feasible option in acute quadriceps tendon ruptures. [Orthopedics. 2016; 39(1):e9-e13.]

In obese patients and those with systemic disease and lower-quality tissue, there is often concern about whether this type of repair can withstand the forces generated through the extensor mechanism. This concern increases the need for prolonged immobilization postoperatively. A novel repair technique with a synthetic knitted monofilament polypropylene heavyweight mesh (Marlex mesh; C R Bard, Murray Hill, New Jersey) has been developed by the senior surgeon (A.D.H.). This has been documented to be effective in augmentation of patellar tendon reconstruction in total knee arthroplasty. Using this repair may allow earlier range of motion and functional restoration of extension, especially in patients with dimin-

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The authors evaluated the following factors: (1) technical feasibility of this technique, as indicated by operative time and intraoperative and postoperative complications; (2) durability of this repair, as indicated by clinical failures and reoperation rate; and (3) patient function obtained after repair, as indicated by final range of motion and extensor lag in those who underwent repair of quadriceps tendon rupture with Marlex mesh.

**Materials and Methods**

The authors retrospectively analyzed 8 knees in 7 consecutive patients operated on by the senior author (A.D.H.) using this technique from January 1, 1990, to January 1, 2011 (Table). In all cases, the diagnosis was made by clinical evaluation, with a palpable quadriceps defect and an extensor lag. Patients were included if they had clinical follow-up until they were discharged by the surgeon or until failure of the repair or death occurred. Mean follow-up for all patients was 9 years (range, 1-19 years). Average patient age at the time of injury was 69 years (range, 53-85 years). Average body mass index was 31 kg/m² (range, 29-35 kg/m²). All patients in the study had significant medical comorbidities. The average number of relevant comorbidities (diabetes mellitus, coronary artery disease, hyperlipidemia, chronic obstructive pulmonary disease) in the group was 2 (range, 0-4). All patients were men. All ruptures were the result of ground-level falls or falls that occurred while navigating stairs. Seven patients were treated within 1 week of injury. One patient was treated 3 months after injury.

**Surgical Technique**

Patients were positioned supine in the operating room. A tourniquet was applied. In all patients, a midline incision was made and carried down to the extensor mechanism. The tear was evaluated, and in all cases, there was a direct tear of the quadriceps off of the superior border of the patella (Figure 1). The medial and lateral retinacula were frequently disrupted. Hematoma was evacuated from the knee, and the edge of the tendon and the superior patella were debrided of fibrous tissue. In 3 patients, drill holes were made through the patella with a Krakow suture in the quadriceps tendon (Video).

A mesh consisting of a synthetic knitted monofilament polypropylene heavyweight mesh (Marlex mesh) was used as

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Body Mass Index, kg/m²</th>
<th>Comorbidities</th>
<th>No. of Comorbidities</th>
<th>Extension</th>
<th>Flexion</th>
<th>Range of Motion</th>
<th>Quadriceps Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>29.6</td>
<td>None</td>
<td>0</td>
<td>0º</td>
<td>120º</td>
<td>0º-120º</td>
<td>5/5</td>
</tr>
<tr>
<td>2</td>
<td>30.9</td>
<td>Diabetes mellitus type 2, hypertension, neuropathy</td>
<td>3</td>
<td>0º</td>
<td>125º</td>
<td>0º-125º</td>
<td>5/5</td>
</tr>
<tr>
<td>3</td>
<td>35.3</td>
<td>Tobacco abuse, peptic ulcer disease, coronary artery disease</td>
<td>3</td>
<td>0º</td>
<td>70º</td>
<td>0º-70º</td>
<td>5/5</td>
</tr>
<tr>
<td>4</td>
<td>30.5</td>
<td>Previous left leg deep venous thrombosis, tobacco abuse, diabetes mellitus type 2</td>
<td>3</td>
<td>0º</td>
<td>125º</td>
<td>0º-125º</td>
<td>5/5</td>
</tr>
<tr>
<td>5</td>
<td>29.0</td>
<td>Hypertension, depression, prostate cancer, parkinsonism, diabetes mellitus type 2</td>
<td>4</td>
<td>10º</td>
<td>110º</td>
<td>10º-110º</td>
<td>4+/5</td>
</tr>
<tr>
<td>6</td>
<td>32.2</td>
<td>Severe (steroid-dependent) chronic obstructive pulmonary disease</td>
<td>1</td>
<td>0º</td>
<td>100º</td>
<td>0º-100º</td>
<td>5/5</td>
</tr>
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<td>7</td>
<td>31.5</td>
<td>Hyperlipidemia on simvastatin, hypertension (2 drugs)</td>
<td>2</td>
<td>0º</td>
<td>110º</td>
<td>0º-110º</td>
<td>5/5</td>
</tr>
</tbody>
</table>

**Figure 1:** Typical direct tear of the quadriceps tendon from the superior pole of the patella.
a stent to reinforce the repair. A 10×14-in piece of mesh was rolled into a tube approximately 8 to 10 layers thick. This was tunneled through the midsubstance of the quadriceps tendon (Figures 2-3) and secured with multiple No. 5 and No. 1 nonabsorbable sutures (Figure 4). A tunnel was prepared distally over the patella (Figure 5), covering the graft in host tissue. The mesh was drawn distally to the insertion of the patellar tendon (Figures 6-7) and secured distally with multiple No. 5 and No. 1 sutures. The medial and lateral retinacula were closed with interrupted No. 1 nonabsorbable sutures. Intraoperatively, the quality of the repair and range of motion before undue tension was placed on the construct were noted. Postoperatively, the patient was placed into a bulky, posterior slab Robert Jones dressing.

**Postoperative Rehabilitation**

Patients were maintained in a bulky postoperative dressing for 24 to 48 hours after surgery. They were then transitioned to a hinged knee brace, with flexion set according to intraoperative findings. Partial weight bearing with gait aids was recommended for 6 weeks. After 6 weeks, patients were allowed to return to weight bearing as tolerated. Patients were instructed in isometric quadriceps strengthening and range of motion exercises.

**RESULTS**

The technique was technically feasible, with a mean operative time of 2 hours and 10 minutes. Operative time for this technique decreased over time, with the last 3 repairs taking slightly longer than 90 minutes (1:31, 1:34, and 1:32 hours, respectively). There were no intraoperative or immediate postoperative surgical complications, such as acute re-rupture, wound dehiscence, or infection. In a patient who had a history of contralateral deep venous thrombosis, a deep venous thrombosis developed in the operative leg 1 month after surgery. He had been on a prolonged flight. He was transitioned to warfarin for prophylaxis and had no further complications.

This technique provided durable results. No patients in the cohort had clinical evidence of failure at final follow-up or required subsequent reoperation for any reason.

Final clinical outcomes after repair were excellent. Average flexion at final follow-up was 100° (±28°). Seven patients had no extensor lag at final follow-up. One patient had a 10° extensor lag. He was seen 6 months postoperatively and had full range of motion, no extensor lag, 5/5 quadriceps strength, and no functional limitations. He returned 9 years later with limited ambulation as a result of progressive Parkinson’s disease and a contralateral quadriceps tear. This tear was repaired with Krakow suture and bone tunnels by another surgeon. On final examination, the patient had extensor lag of 10° on the Marlex mesh repair side and 30° on the contralateral side.

**DISCUSSION**

Although quadriceps tendon rupture is rare, it has profound functional implications. Traditional transosseous suture repair of rupture has a long track record of success. 1-4 A period of immobilization is
advocated to ensure adequate healing.\(^2,5\)

Additional stress is placed on the repair as a result of lower tissue quality because of chronic disease and elevated body mass index. The senior author developed a technique for augmentation of quadriceps tendon repair that may allow early range of motion and increased resistance to failure in these patients.

In this series, Marlex mesh augmentation of quadriceps ruptures was technically feasible. No intraoperative or postoperative surgical complications occurred. Operative time for the last 3 procedures in the series was approximately 90 minutes. The use of synthetic mesh avoids donor site morbidity, which is associated with autograft augmentation of repair.\(^14\) The mesh used is cost-effective and nearly universally available. At the authors’ institution, 1 sheet of mesh costs approximately $122.00.\(^15\)

This technique provided durable results as well. No patients had clinical failure or subsequent re-rupture. This finding is in agreement with previous literature that documented very few re-ruptures.\(^2,3\)

In contrast, the current study allowed early range of motion. Previous studies used 6 weeks of immobilization to protect the repaired tissue.\(^1,7\)

Final clinical outcomes were excellent. Only 1 patient had extension lag, which was likely a late sequel of Parkinson’s disease because the patient had earlier follow-up with full, strong extension. Previous studies showed that early range of motion may predispose to suboptimal clinical results.\(^6\) A previous study included 31 patients who were immobilized postoperatively and 3 patients who had early range of motion. Of the 3 patients with early motion, 2 (66%) had extensor lag compared with only 6 of 31 (20%) with postoperative immobilization.\(^6\) In this series, early range of motion was allowed, without evidence of extension lag.

**Limitations**

This study had some limitations. First, it was a small, retrospective series. The patients had elevated body mass index and increased comorbidities, which represents an inclusion bias. However, it is likely that this group of patients may gain the most benefit from this augmentation of repair. Future studies could include healthier patients with a lower body mass index. Second, this study included only clinically evident outcome measures. Previous studies documented biomechanical testing and functional outcome scores in addition to clinical data. These could be further evaluated in subsequent studies.

**Conclusion**

Marlex mesh augmentation of quadriceps tendon ruptures showed promising clinical results in this group of patients, despite increased mean body mass index and significant comorbidities. The technique was feasible, with low cost and reasonable operative time. The clinical results were durable, with no intraoperative complications, no re-ruptures, rare extension lag, and good range of motion. Therefore, Marlex mesh augmentation is a feasible option in acute quadriceps tendon ruptures.

**References**

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