



Case report

Retrieval analysis of a failed synthetic mesh extensor mechanism reconstruction after total knee arthroplasty

Anna Cohen-Rosenblum, MD ^{a,*}, Ashley Volaric, MD ^b, James A. Browne, MD ^a

^a Department of Orthopaedic Surgery, University of Virginia, Charlottesville, VA, USA

^b Department of Pathology, University of Virginia, Charlottesville, VA, USA

ARTICLE INFO

Article history:

Received 15 June 2018

Received in revised form

20 July 2018

Accepted 25 July 2018

Available online 31 August 2018

Keywords:

Extensor mechanism disruption

Total knee arthroplasty

Synthetic mesh

ABSTRACT

Extensor mechanism disruption after total knee arthroplasty is a relatively rare but potentially devastating complication. One technique to address this problem involves reconstruction with synthetic mesh. Although there are reports of successful clinical outcomes using this technique, we are not aware of any histological analyses of removed mesh grafts. This case report of a failed mesh reconstruction includes a retrieval analysis demonstrating robust host soft-tissue incorporation into the mesh graft and supports the rationale for continued use of this off-label technique. This case report also highlights the need for careful operative technique when performing these procedures to increase the chance of a successful outcome.

© 2018 The Authors. Published by Elsevier Inc. on behalf of The American Association of Hip and Knee Surgeons. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

Extensor mechanism rupture after total knee arthroplasty (TKA) is a relatively rare but potentially devastating complication. A variety of operative strategies have been developed to address disruption at the level of the quadriceps tendon, patella, and patellar tendon, including primary repair as well as augmentation or reconstruction with autograft, allograft, and synthetic mesh [1–5]. Quadriceps tendon tears present a particular challenge, with operative management leading to worse outcomes when compared to patients without TKA, likely due to altered blood supply to the tendon from the prior arthrotomy [6]. Given their lower prevalence than more distal extensor mechanism ruptures, the epidemiology, management, and outcomes of quadriceps tendon tears after TKA are less often reported in the literature [3]. Strategies for quadriceps tendon repair after TKA include primary repair with suture anchors or transosseous tunnels (usually for acute tears in the immediate

postoperative period); augmentation of the repair with hamstring autograft, allograft, or synthetic mesh; and allograft reconstruction of the entire extensor mechanism, which may be performed with or without revision of TKA components [3,6–9].

We present a case report of a failed quadriceps tendon mesh reconstruction after TKA and include a retrieval analysis of the extracted mesh. Although the effect of polypropylene mesh on surrounding abdominal tissue in the case of hernia repair has long been studied [10–12], we were unable to identify any studies specifically examining explanted mesh used for extensor mechanism reconstruction after TKA. Given that this is a relatively new technique which uses mesh in an off-label fashion, we believe that a retrieval analysis can add important information to either support or refute the use of mesh in this novel manner. We also believe that this case emphasizes the importance of correct technique when performing this procedure.

The patient's permission was obtained to prepare this case report for publication.

Case history

A 77-year-old woman with a history of congestive heart failure, hypertension, chronic bronchitis, fibromyalgia, and osteoporosis was referred to our clinic in 2017 for evaluation of right knee pain after undergoing a TKA in 2014 at an outside institution. In 2015, she reportedly suffered from an atraumatic quadriceps tendon tear

One or more of the authors of this article have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to <https://doi.org/10.1016/j.artd.2018.07.009>.

* Corresponding author. 400 Ray C. Hunt Dr. #300, Charlottesville, VA 22903, USA. Tel.: +1 434 243 0278.

E-mail address: jamesbrowne@virginia.edu

<https://doi.org/10.1016/j.artd.2018.07.009>

2352-3441/© 2018 The Authors. Published by Elsevier Inc. on behalf of The American Association of Hip and Knee Surgeons. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

that was treated by a different surgeon at the same outside institution approximately 8 weeks later, with repair augmented with polypropylene mesh. According to the operative report, the patient had an “obvious disruption of the quadriceps tendon”. The native quadriceps tendon was approximated to the native superior pole of the patella, after which polypropylene mesh was sutured to the medial border of the patella and then attached superiorly to the quadriceps tendon with interrupted number 2 braided nonabsorbable sutures. In addition, a vastus medialis obliquus advancement was performed using a similar suture technique to advance the muscle over the mesh graft.

After this procedure, she reported progressive pain on the anterior aspect of the knee which worsened with attempts to rise from a seated position. At the time of her initial consultation with

us, she was ambulating with difficulty with the use of a walker. She denied any fevers, chills, or erythema, swelling, or drainage around her right knee.

Physical examination revealed morbid obesity with a body mass index of 41. She had a well-healed anterior midline incision about the right knee without erythema, drainage, or swelling. Her patella was laterally dislocated. Active right knee range of motion was from 30° to 120° of flexion, and passive range of motion was from 5° to 120° of flexion. When brought passively into full extension with the patella manually reduced, the patient was able to briefly maintain this position until gravity pulled her knee into flexion, and the patella dislocated laterally.

Radiographic imaging revealed a well-fixed posterior-stabilized TKA with femoral and tibial components in reasonable alignment

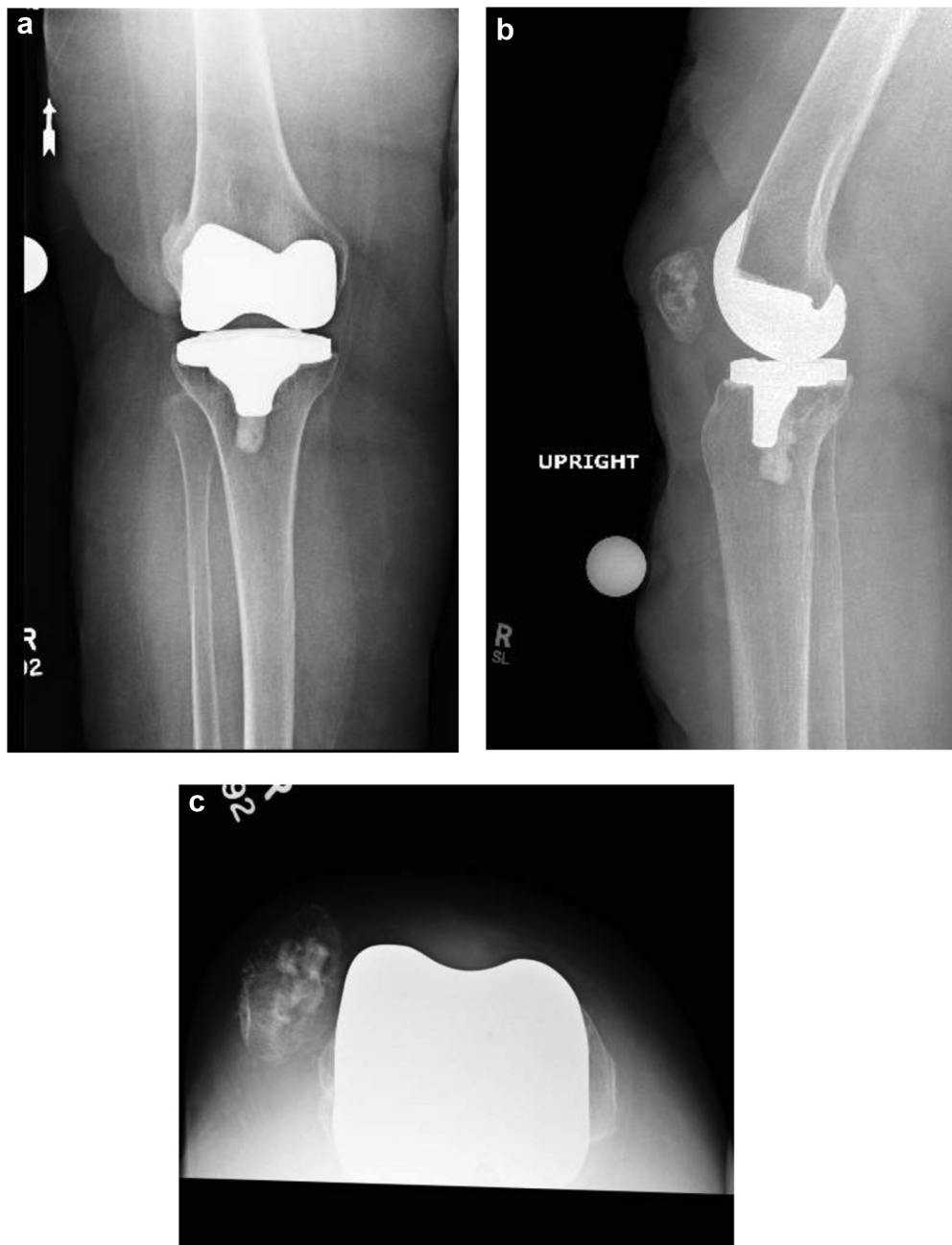


Figure 1. Preoperative anteroposterior (AP) (a), and lateral (b) radiographs demonstrate a well-fixed posterior-stabilized TKA. Sunrise radiograph (c) shows a laterally dislocated patella. A density corresponding to the previously implanted mesh is visible in the trochlear groove of the femoral component.

and a laterally dislocated patella (Fig. 1a-b). A density corresponding to the mesh was visible in the trochlear groove of the femoral component on sunrise view (Fig. 1c). Erythrocyte sedimentation rate and c-reactive protein were normal. A computed tomography scan did not reveal any notable component malrotation. The patient elected to proceed with revision surgery. After exposure, the mesh graft was noted to be sutured to the medial aspect of the patella, presumably over the closure of the medial parapatellar arthrotomy. The graft had been completely incorporated into the surrounding soft tissue (Fig. 2). When the knee was flexed, the graft caused the patella to dislocate laterally due to mass effect, with the graft displacing the patella out of the trochlear groove. We skeletonized the graft, excised it, and sent it to pathology for evaluation (Fig. 3). We then identified the vastus medialis and vastus lateralis. The lateral aspect of the quadriceps tendon appeared intact, as did the patellar tendon, and no frank extensor mechanism disruption was identified. It was felt that no additional augmentation of host tissues was required, and the vastus medialis obliquus was advanced over the patella and lateral quadriceps tendon in a pants-over-vest fashion. This gave us excellent patellar tracking through a full range of motion.

Histological analysis of the graft revealed the presence of fibrosis (Fig. 4a) and polarizable foreign body material (presumably graft) with associated giant cell reaction (Fig. 4b). There was no evidence of acute or chronic inflammation. The patient's immediate postoperative hospital course was uneventful. The knee was immobilized for 4 weeks, followed by progressive resumption of motion and ambulation. At her 3-month postoperative visit, she was ambulating well with a cane and had minimal pain and a

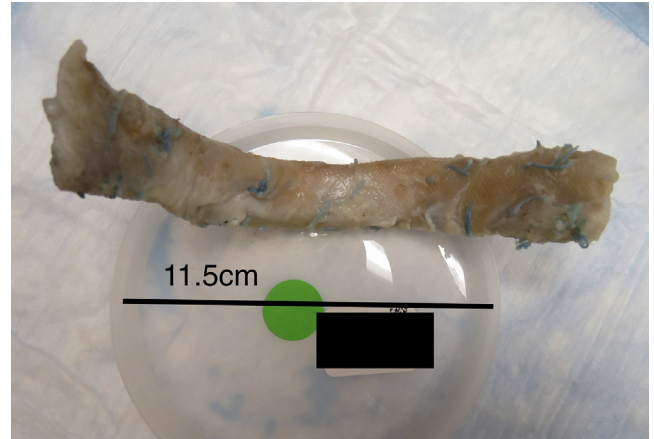


Figure 3. The skeletonized and excised synthetic mesh graft.

well-healed surgical scar. Active range of motion was noted from 0° to 85° of flexion without extensor lag. Radiographic imaging from this visit revealed a located patella (Fig. 5).



Figure 2. Intraoperative photo of the failed mesh augmentation.

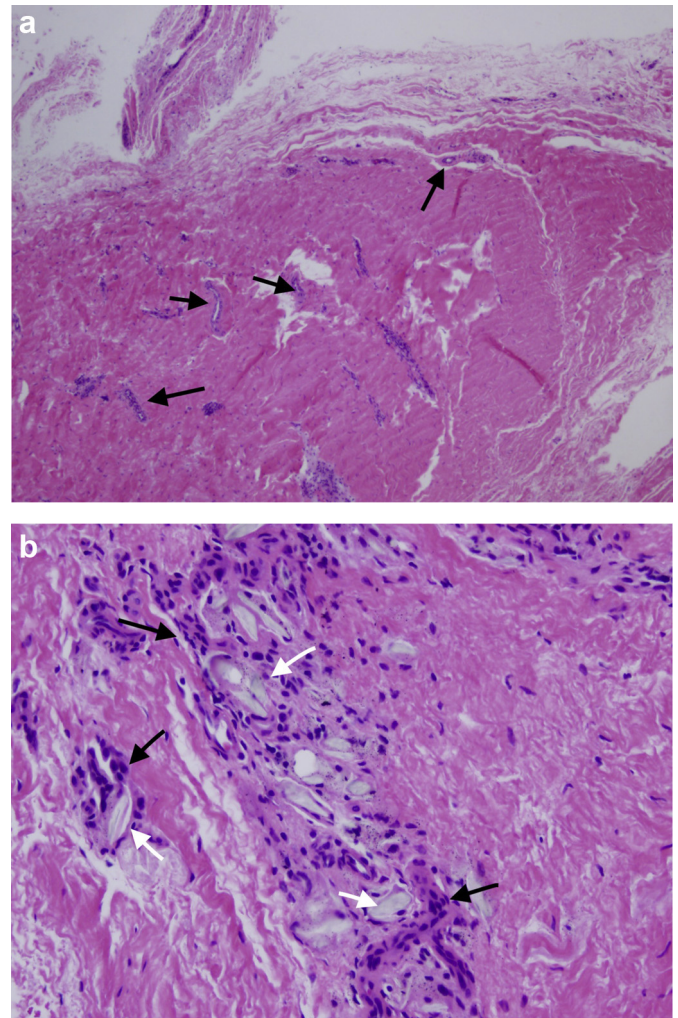


Figure 4. Histologic specimens of the excised mesh show (a) pink fibrous tissue with infiltrating vessels (black arrows) and (b) foreign body giant cell reaction (black arrows) around graft material (white arrows).

Discussion

To our knowledge, this is the first retrieval analysis of a failed polypropylene mesh graft used for extensor mechanism reconstruction after TKA. Gross analysis of the graft demonstrated excellent incorporation into host soft tissues. Histologic analysis revealed surrounding fibrosis with foreign body giant cell reaction and without significant acute or chronic inflammation, consistent with other studies examining explanted polypropylene mesh from abdominal walls in animal studies [11,13]. The abundant and robust fibrous tissue infiltration with soft-tissue incorporation confirms the theoretical basis for this technique and supports the continued off-label use of this procedure.

This case also illustrates the importance of surgical technique. Successful mesh augmentation of quadriceps tendon repair after TKA has been described in various reports in the literature with slightly varying methodology (Table 1). Dobbs et al. [6] described resecting any degenerated or frayed tendon, mobilizing the remaining tendon and attaching it to the patella via drill holes, and reinforcing this with tubularized polypropylene mesh incorporated into the repair through a tunnel over the patellar tendon. Ndozo and Rachala [8] described quadriceps repair, followed by cementation and screw fixation of tubularized polypropylene mesh to a burr hole lateral to the tibial tubercle, passing the mesh up the lateral aspect of the patellar tendon, and then weaving it through the quadriceps tendon repair site for reinforcement. Ormaza et al. described reinforcement of the quadriceps tendon repair with a polyethylene terephthalate mesh tube, which is then passed from proximal to distal through the patellar tendon sheath and distally secured with sutures [14].

There are few published results of mesh augmentation of quadriceps tears in the setting of TKA. Dobbs et al. [6] reported 4 of 10 repairs functioning well at a mean follow-up of 34 months with 6 of 10 reruptures and/or infections. Ndozo and Rachala [8] reported 4 of 7 repairs doing well at a mean follow-up of 34 months with 2 reruptures that were subsequently infected and 1 extensor lag of 40° that did not require further operative intervention. Ormaza et al. [14] reported 3 repairs with satisfactory range of motion and function outcome at a mean follow-up of 19 months. Cumulatively, these studies report a 55% success rate (11/20) using mesh augmentation of quadriceps repair after TKA. Of note, a systematic review by Shau et al. [15] comparing synthetic

Table 1

Described techniques for mesh augmentation of quadriceps tendon repair after total knee arthroplasty.

| | Technique | Results |
|--------------------------------------|--|---|
| Dobbs et al., 2005 ⁶ | Attach remaining quad tendon to patella via drill holes and reinforce with tubularized mesh tunneled over patellar tendon | 4/10 are doing well and 6/10 had reruptures/infections (mean 34 months) |
| Ndozo and Rachala, 2016 ⁸ | Screw fixation of tubularized mesh into burr hole lateral to tibial tubercle, which is passed up in lateral aspect of patellar tendon to reinforce quadriceps repair | 4/7 are doing well and 2/7 had reruptures (mean 34 months) |
| Ormaza et al., 2017 ¹⁴ | Mesh tube reinforcing repair performed and then passed from proximal to distal through patellar tendon sheath, which is secure distally with sutures | 3/3 are doing well (mean 19 months) |

mesh and allograft extensor mechanism reconstruction (not exclusively quadriceps tendon rupture) found both groups to have a failure rate of approximately 25%.

The initial mesh-augmented quadriceps tendon repair performed in the aforementioned case did not use any of these published techniques, with the mesh graft having been attached medial to the patella over the parapatellar arthrotomy closure. We propose that this led to the graft displacing the patella and resulting in patellar dislocation and need for further revision surgery. It is also possible that a prior medial retinacular disruption was not addressed during the initial procedure, and the unbalanced pull of the vastus lateralis pulled the patella laterally. When performing mesh-augmented extensor mechanism repairs, it is important to advance the vastus medialis to cover the mesh with host tissue both proximally and distally. The advancement of the vastus medialis over the mesh in a so-called “pants-over-vest” fashion was described by Browne and Hanssen [5]. We also recommend securing the mesh distally into an intramedullary trough in the tibia using cement, which has been previously described for mesh extensor mechanism reconstruction [4,5,8]. This method has been shown to result in robust fixation of the graft, and failure at this interface has not been reported. In our opinion, suturing the graft into the soft tissues or securing it to the tibia in an extramedullary position may increase the chance of failure.

Although chronic quadriceps tendon tears in the setting of TKA are difficult to manage as discussed previously, we continue to use mesh extensor mechanism reconstruction for complete tears. As seen in this case, surgical technique is important, and failure of the reconstruction may be due to technical aspects and not the mesh itself.

Summary

Rupture of the quadriceps tendon after TKA presents a unique challenge to the orthopedic surgeon. Mesh reconstruction has been used recently with increasing frequency to address this problem. This retrieval analysis revealed robust host soft-tissue incorporation into the mesh graft and supports continued use of this off-label technique. This case report also highlights the need for careful operative technique when performing these procedures to increase the chance of a successful outcome. As an increasing number of TKAs are performed in the coming years, orthopedic surgeons should be prepared to address extensor mechanism ruptures using all available methods, including mesh augmentation.

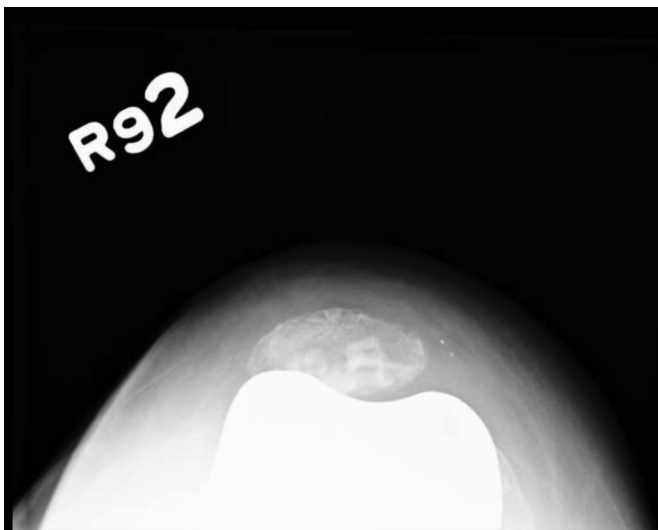


Figure 5. Postoperative sunrise radiograph.

References

- [1] Bates M, Springer B. Extensor mechanism disruption after total knee arthroplasty. *J Am Acad Orthop Surg* 2015;23:95.
- [2] Rosenberg AG. Management of extensor mechanism rupture after TKA. *J Bone Joint Surg Br* 2012;94-B(Suppl A):116.
- [3] Papalia R, Vasta S, D'Adamio, et al. Complications involving the extensor mechanism after total knee arthroplasty. *Knee Surg Sports Traumatol Arthrosc* 2015;23:3501.
- [4] Springer B, Della Valle C. Extensor mechanism allograft reconstruction in total knee arthroplasty. *J Arthroplasty* 2008;23(7):35.
- [5] Browne J, Hanssen A. Reconstruction of patellar tendon disruption after total knee arthroplasty: results of a new technique utilizing synthetic mesh. *J Bone Joint Surg Am* 2011;93:1137.
- [6] Dobbs R, Hanssen A, Lewallen D, Pagnano M. Quadriceps tendon rupture after total knee arthroplasty. *J Bone Joint Surg Am* 2005;87-A(1):37.
- [7] Ricciardi B, Oi K, Trivellas M, et al. Survivorship of extensor mechanism allograft reconstruction after total knee arthroplasty. *J Arthroplasty* 2017;32:183.
- [8] Ndozo S, Rachala S. Polypropylene mesh augmentation for complete quadriceps rupture after total knee arthroplasty. *Knee* 2016;23(1):177.
- [9] Courtney PM, Edmiston TA, Pflederer CT, Levine BR, Gerlinger TL. Is there any role for direct repair of extensor mechanism disruption following total knee arthroplasty? *J Arthroplasty* 2018;33:S244.
- [10] Dabrowiecki S, Svanes K, Lekven J, Grong K. Tissue reaction to polypropylene mesh: a study of oedema, blood flow and inflammation in the abdominal wall. *Eur Surg Res* 1991;23:240.
- [11] Hodde J, Suckow M, Johnson C, Rodenberg E, Ritchie R. Histological and adhesiogenic characterization of the Zenapro hybrid hernia repair device. *Int J Surg Open* 2016;5:27.
- [12] Klosterhalfen B, Klinge U. Retrieval study at 623 human mesh explants made of polypropylene—impact of mesh class and indication for mesh removal on tissue reaction. *J Biomed Mater Res B Appl Biomater* 2013;101B(8):1393.
- [13] Orenstein S, Saberski E, Kreutzer D, Novitsky Y. Comparative analysis of histopathologic effects of synthetic mesh based on material, weight, and pore size in mice. *J Surg Res* 2012;176:423.
- [14] Ormaza A, Moreta J, Mosquera J, Saez de Ugarte O, Martinez-de los Mozos J. Chronic quadriceps tendon rupture after total knee arthroplasty augmented with synthetic mesh. *Orthopedics* 2017;40(1):38.
- [15] Shau D, Patton R, Patel S, Ward L, Guild G. Synthetic mesh vs. allograft extensor mechanism reconstruction in total knee arthroplasty—a systematic review of the literature and meta-analysis. *Knee* 2018;25:2.