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Case Report

Case Report: Histologic Study of Marlex Mesh Used in the Reconstruction of the Extensor Mechanism of the Knee at 4 Months After Implantation

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Abstract

Disruption of the extensor mechanism of the knee is a rare but potentially disastrous complication of total knee arthroplasty (TKA) with few reliable options for repair or reconstruction. Of growing interest is the use of synthetic mesh to reconstruct a ruptured extensor mechanism. To our knowledge, crystalline polypropylene (Marlex) mesh used to reconstruct the extensor mechanism of the knee has not been described histologically. We describe a 56 year old male with multiple comorbidities who, after a right TKA, suffered a quadriceps tendon rupture which was addressed by primary repair. Subsequently, the tendon ruptured and was again repaired. Unfortunately, he suffered from a significant extensor lag. He was treated with a revision TKA with reconstruction of his chronic quadriceps tendon disruption using Marlex mesh. Four months later the extensor mechanism repair and all implanted components were removed from the right knee secondary to persistent infection. The mesh was obtained for histologic evaluation. Histopathologic examination of the retrieved mesh revealed new connective tissue infiltration with infiltrating fibroblasts and inflammatory cells as well as neovascularization. The sample of mesh most proximal to the host tissue revealed a recognizable transition in collagen density, but nearly seamless integration with the host. Our report confirms findings previously reported in animal models that Marlex mesh used to reconstruct ligaments about the knee can serve as a scaffold for new tissue growth. Barring major infection, this report provides optimism for this techniques' potential use in multiple soft tissue reconstruction procedures.

Introduction

Disruption of the extensor mechanism of the knee is a rare but potentially disastrous complication of total knee arthroplasty (TKA) with a reported incidence of 0.17%- 0.96% of patients undergoing TKA [1,2]. Multiple management options exist including a nonoperative approach, allograft reconstruction, reconstruction using autograft tissues, pateollotibial fusion, arthrodesis, and primary repair [1,3-5]. Nonoperative treatment generally leads to unacceptable results [1], and even primary repair has shown mixed and often unsatisfactory outcomes [1,6]. Allograft reconstruction has been described with the use of both the Achilles tendon [3,7] and the quadriceps tendon-patellar tendon-tibial tubercle allografts [3,8,9] with a significant associated cost[10]. Concerns exist regarding their strength and longevity [4,8] and these reconstructions have shown mixed results [11,12]. In addition, there exists the potential for autoimmune reaction [7] as well as disease transmission [10,13]. Of growing interest is the use of synthetic mesh to reconstruct a ruptured extensor mechanism, owing

to many possible benefits including: lower cost than allograft, elimination of the risks of autoimmune reaction and disease transmission [10]. These potential benefits have been considered in recent reports utilizing these materials and Browne et al, have proposed a new strategy using Marlex mesh in a linear superior-inferior orientation to reconstruct a ruptured extensor mechanism at the patellar tendon [10]. To our knowledge, the histologic evaluation of Marlex mesh used in extremity surgery/ reconstruction around the knee has not been evaluated. We describe a 56 year old male with multiple co-morbidities who suffered from a chronic quadriceps rupture after TKA which was reconstructed with Marlex mesh and subsequently removed four months later due to infection. Histopathologic specimens included new connective tissue consisting of infiltrating fibroblasts as well as inflammatory cells; the histological evaluation suggests graft incorporation was present even in the early postoperative period. These findings are encouraging and we look to this technique with future optimism for the incorporation into the host extensor mechanism even under adverse conditions.

Case Report

A 56 year old male with multiple comorbidities including, but not limited to, hypertension, history of myocardial infarction, morbid obesity, aortic valve disease and is status post St. Jude valve replacement and congestive heart failure, presented with complaints of pain, swelling, and a giving-away sensation. This was accompanied with falls due to a "wobbly" sensation of the right knee. His job makes it necessary for him to negotiate stairs regularly. He had a history of bilateral total knee replacements (TKA), the left three years prior and the right on two years before presentation. Initially, the right TKA was tolerated well. Two months after his right TKA, he described a popping sensation, associated pain, swelling and shifting of the right patella laterally as well as a limited range of motion; at that time it was determined he had suffered a quadriceps tendon rupture. This was treated with primary repair. Two months later, he re-ruptured his quadriceps tendon. He again underwent primary repair, but suffered from a significant extensor lag. On examination the patient weighed 350 lbs at 6 feet of height with a BMI of 47.5, used a cane to ambulate and ambulated with an antalgic gait with hyperextension thrust at his right knee. The right knee had swelling with effusion as well as a defect in the suprapatellar area. He was unable to straighten the knee with a complete extensor lag. The patella was inferior and laterally subluxated. The knee was stable in extension, but had a significant amount of flexion instability. Radiographic evaluation demonstrated a lateral patellar subluxation, and satisfactory TKA component positioning. The patient was treated with a revision TKA with reconstruction of his chronic quadriceps tendon disruption using Marlex mesh, and four months later the extensor mechanism repair and all implanted components were removed from the right knee due to persistent infection. An antibiotic spacer was placed and intravenous antibiotics were initiated. Histopathologic examination of the retrieved mesh revealed new connective tissue infiltration into the mesh. The tissue contained infiltrating fibroblasts and inflammatory cells as well as new vasculature. The sample in closest proximity to the host tissue revealed a recognizable transition in collagen density, but nearly seamless integration with the host (Figures 1-2).

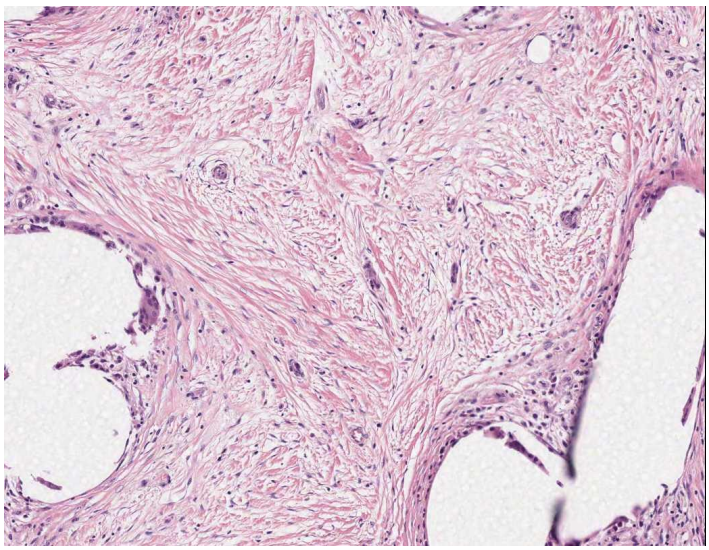

Figure 1. Transverse section of the middle portion of the Marlex mesh four months after implantation demonstrating connective tissue infiltration between the mesh fibers including numerous fibroblasts, also a mild foreign body reaction immediately adjacent to the fibers. Hematoxylin and eosin stain 10 x magnification.

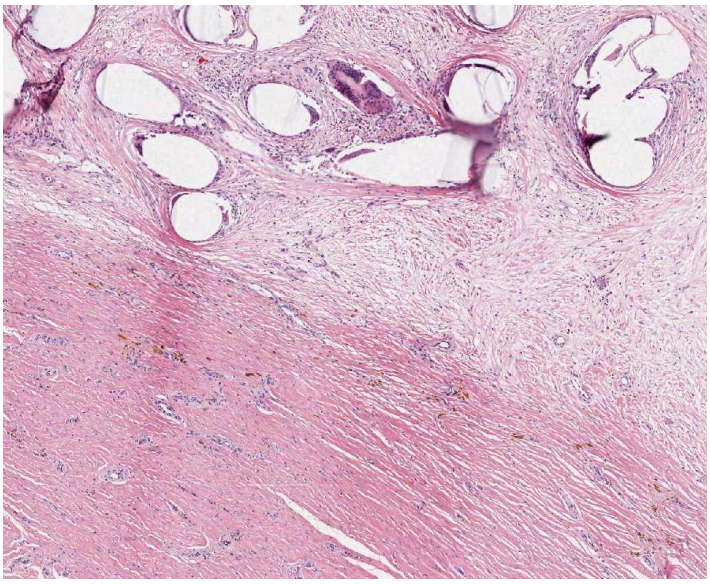

Figure 2. Transverse section of the Marlex mesh-fascia interface four months after implantation demonstrating organized connective tissue infiltration between the mesh fibers including numerous fibroblasts, also a mild foreign body reaction immediately adjacent to the fibers. Hematoxylin and eosin stain 4 x magnification.

Discussion

To our knowledge, the histology of Marlex mesh used in extremity surgery/ reconstruction has not been described to date. Our findings of infiltrating fibroblasts, neovascularity and deposition of collagen provide optimism regarding the prognosis of patients treated with this technique even under less than ideal circumstances. Disruption of the extensor mechanism of the knee is a rare but potentially disastrous complication of total knee arthroplasty (TKA). Rates that have been reported range from 0.17% in a review of 8288 TKAs reviewed by Rand et al. [1], whereas Jackson et al reported patellar tendon avulsions in 0.96% of patients undergoing quadriceps sparing TKAs [2].

Management of extensor mechanism complication have included nonoperative management, allograft reconstruction, reconstruction using autograft tissues, pateollotibial fusion, arthrodesis, and primary repair. Nonoperative treatment often is inadequate [1], and primary repair has given mixed results [1,6]. Allograft reconstruction has been performed using achilles tendon allograft [3,7], and quadriceps tendon-patellar tendon-tibial tubercle allografts [3,8,9]. These allografts can be expensive, as reported by Browne et al with the cost of an Achilles tendon allograft is more than $1200 US dollars and a total extensor allograft costs more than $4400 [10]. Other concerns regarding allografts include graft weakening over time [4,8], autoimmune reaction [7], and rarely disease transmission [10,13]. Attempts to reconstruct a knee extensor mechanism with autogenous grafting has also had mixed results, with a wide range of reported outcomes across various techniques [11,12]. Mesh can also be used to reconstruct the extensor mechanism. Synthetic mesh has been used in orthopaedic surgery extensively in the past; in the case reports by Parrish et al, Marlex mesh has been used in reconstruction surgery after tumor resection for a number of years with acceptable results [14]. The benefit of a mesh material is the versatility of the potential applications. The mesh can be woven through tissue, or sewn into the host tissues with a more broad distribution to cover larger defects. In the case described a combination of techniques were utilized to address the soft tissue defects and bridge the soft tissue gap of the extensor mechanism. The Leeds-Keio ligament, an open-weave polyester ligament, has been used successfully in the past in the reconstruction of ruptured anterior cruciate ligaments (ACL) [15], and also used with high success rates in the repair of Achilles tendon rupture [16]. In a two and four year follow-up of 20 patients treated with Leeds-Keio ACL reconstruction, Macnicol, et al found subjectively improved function of the knee and in ten specimens obtained for histological review, collagen was organized along intact graft fibers. The greatest knee stability was found in a sample that was found to be covered by a thin, hyperaemic synovium. These histologic changes are consistent with neoligamentization, and suggest that when mesh is implanted in extremities it can act as a scaffold for host tissue to form a new ligament [15]. Zaffagnini et al, obtained a biopsy of a Leeds-Keio ACL ligament twenty years after implant and examined it histologically to assess the neoligamentization process. It was found that the implant was completely covered with collagen and synovial tissue, the sample was found to be 95% collagen and only 5% mesh, and had evidence of vascularity mimicking a native ACL [17]. A strategy that has been used with Leeds-Keio ligaments is reconstruction of the knee extensor mechanism with the ligament in a figure-of eight pattern. Results have generally been positive [5]. Marlex mesh is a plastic mesh with high tensile strength that is porous enough to act as a scaffold for tissue growth [14,18,19]. The success of mesh can be partially due to its ability to act as a scaffold for new tissue growth, with the size of the pores proportional to the amount of growth [20]. In a dog model, Marlex mesh was used to replace partial or total collateral ligaments in knees. All of the animals did well clinically by week 4. At 4 weeks, the graft showed early collagen formation around enlarged fibroblasts, numerous capillaries, and a mild inflammatory reaction. At 3 months, the graft had progressed to uniform fibrous infiltration and the inflammatory response had subsided. The mesh-native ligament junction had mature fibrocytes in an orientation similar to normal ligament [18]. To our knowledge, the histology of Marlex mesh used in extremity surgery and reconstruction around the knee has not been described to date. Our findings of infiltrating fibroblasts, neovascularity and collagen deposition provide optimism regarding the prognosis of patients treated with this technique even under less than ideal circumstances. Our report confirms that Marlex mesh used to reconstruct ligaments about the knee can serve as a scaffold for new tissue growth. Barring major infection, this provides optimism for this techniques' use in a variety of patients.

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