

## USE OF POLYPROPYLENE MESH IN ORTHOPEDIC SURGERY – LITERATURE REVIEW AND REPORT OF THREE CASES

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### ABSTRACT

In this article we describe three applications of polypropylene mesh in orthopedic surgery, where the synthetic material was used in challenging scenarios: (1) quadriceps tendon, (2) shoulder and (3) muscle hernia repair. All cases were followed-up for at least two years and there were no complications related to the procedure. Polypropylene mesh is a safe synthetic material widely used in general surgery, however, its use in orthopedic procedures is uncommon. We reported three different applications for polypropylene mesh in complex orthopedic cases. Further studies are necessary to understand the biomechanical behavior of such materials under the tensile load of each tendon; functional results and long term complications associated to this material.

**Keywords:** Polypropylene mesh, Surgery, Quadriceps tendon, Shoulder, Muscle hernia.

### USO DA TELA DE POLIPROPILENO EM CIRURGIA ORTOPÉDICA - REVISÃO DA LITERATURA E RELATO DE TRÊS CASOS

### RESUMO

Neste artigo descrevemos três aplicações da tela de polipropileno em cirurgia ortopédica, onde o material sintético foi utilizado em cenários desafiadores: (1) tendão do quadríceps, (2) ombro e (3) correção de hérnia muscular. Todos os casos foram acompanhados por pelo menos dois anos e não houve complicações relacionadas ao procedimento. A tela de polipropileno é um material sintético seguro e amplamente utilizado em cirurgia geral, porém seu uso em procedimentos ortopédicos é incomum. Relatamos três aplicações diferentes da tela de polipropileno em casos ortopédicos complexos. Mais estudos são necessários para entender o comportamento biomecânico de tais materiais sob a carga de tração de cada tendão; resultados funcionais e complicações a longo prazo associadas a este material.

**Descritores:** Tela de polipropileno. Cirurgia. Tendão do quadríceps. Ombro. Hérnia muscular

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## USO DE MALLA DE POLIPROPILENO EN CIRUGÍA ORTOPÉDICA: REVISIÓN DE LA LITERATURA E INFORME DE TRES CASOS

### RESUMEN

En este artículo describimos tres aplicaciones de la malla de polipropileno en cirugía ortopédica, donde el material sintético se utilizó en escenarios difíciles: (1) tendón del cuádriceps, (2) hombro y (3) reparación de hernias musculares. Todos los casos fueron seguidos durante al menos dos años y no hubo complicaciones relacionadas con el procedimiento. La malla de polipropileno es un material sintético seguro muy utilizado en cirugía general, sin embargo, su uso en procedimientos ortopédicos es poco común. Reportamos tres aplicaciones diferentes para la malla de polipropileno en casos ortopédicos complejos. Son necesarios más estudios para comprender el comportamiento biomecánico de dichos materiales bajo la carga de tracción de cada tendón; resultados funcionales y complicaciones a largo plazo asociadas a este material.  
malla de polipropileno, cirugía, tendón cuádriceps, hombro, hernia muscular

**Descriptores:** Malla de polipropileno. Cirugía. Tendón cuádriceps. Hombro. Hernia muscular

### INTRODUCTION

Alloplastic materials have been used in medicine since ancient times, when Greek used gold as suture material. Other examples include silver and stainless steel which were used for abdominal wall support after laparotomies (Alexander 2009, Politano et al. 2013, McGavin 1907, Babcook 1952). However, these materials had many disadvantages. In 1954, Karl Ziegler developed polypropylene (Ziegler et al. 1974), thereby beginning a new era in medicine.

Polypropylene mesh (PM) is a non-absorbable, high tensile strength material that resists enzyme degradation and incites an intense fibrotic reaction that will tightly adhere to the surrounding tissues (Brown & Finch 2010). For these reasons it is widely used in general surgery for augmentation repair of abdominal hernias.

Although there is not a robust evidence for use of PM in human tendon repair, positive results have been reported for Achilles tendons in rabbits (Hosey et al. 1991). The purpose of this article is to review the literature regarding the use of PM in orthopedic surgeries and illustrate three possible indications.

## Literature Review

Browne and Hansen in 2011 described a new technique using synthetic mesh (Marlex®) for the treatment of patellar tendon rupture after total knee arthroplasty (TKA). Patients had successful and durable results, with improved functional scores and range of motion (ROM). The advantages are the maintenance of tensile strength and avoidance of graft elongation, lower costs and disease transmission (Nozdo & Rachala 2016).

PM has been used for augmentation of complete quadriceps rupture after TKA, as reported by Nodzo and Rachala in 2016. They reviewed 7 cases where the tendon was repaired with direct suture and PM augmentation. Mean follow-up was 34 months and patients waited, on average, 3 months between failure of primary repair and revision with synthetic mesh. Four patients had a successful outcome (extensor lag less than 30°) and three failed. Among the failures, two had re-ruptures and the remaining had extensor lag of 40°, but were functional. Of the five functioning knees, significant improvement was noted for the extensor lag, the Insall–Salvati ratio, and mean Knee Society Score for function and pain. This study lacked a control group and sample size was small. Functional results were modest, but postoperative pain improved.

Prosthetic mesh is also an option for iliac crest graft site hernia. Bone graft harvesting is a common procedure and iliac crest is one of the most frequently used sites. Therefore, orthopedic surgeons should be familiar with complications and available treatments. Herniation of gastrointestinal contents through a bony defect in the ilium is a complication with previous reports suggesting an incidence varying between 5 and 9% (Auleda et al 1995). It is more common in females and risk factors include age over 65 years, obesity, hypertension, increased abdominal pressure and full-thickness graft. The mainstay of treatment is reduction of the hernia and obliteration of the defect, which can be accomplished with PM, especially if the defect is greater than 4cm (Politano et al 2013, Danikas et al 2003).

In 1998, Muermans and Coenen compared three materials used in interpositional arthroplasty for osteoarthritis of the trapeziometacarpal joint. The study allocated patients into three groups: ten patients treated with expanded polytetrafluoroethylene (ePTFE) (Gore-Tex®), nine patients with PM (Marlex®) and seven patients with a strip of extensor carpi radialis longus (ECRL) tendon. The groups did not differ regarding pain or strength. Gore-Tex® was discontinued due to significant complications rate. The authors found

PM to be attractive and practical alternative to tendon interposition in the treatment of the trapeziometacarpal osteoarthritis.

Despite the large scale use of PM in general surgery, for abdominal hernias and pelvic organ prolapse, there are some risks. Recurrence, infection, postoperative chronic pain are some of the more common complications described (Brown and Finch 2010, Leber et al 1998, Bellon 2009) and are probably related to mechanical and structural properties of the synthetic material (Leber et al 1998).

In 2014, Li et al performed a study to better understand the mechanical properties of PM, which provided insight into mesh behavior under abdominal pressure. No similar mechanical studies are known in the orthopedic area. Thus, the behavior of such materials for repair or augmentation of tendon ruptures is still unknown. According to Li et al 2010, PM presents a nonlinear and anisotropic behavior. The anisotropy is clinically relevant because “the orientation at which the mesh is implanted will affect the mechanical behavior of the repaired abdominal wall or pelvic viscera” (Saberski et al 2011).

The most relevant study until today is the one by Ciampi et al from 2014. In that article the authors retrospectively selected 152 patients with symptomatic massive posterolateral rotator cuff tear (RCT), confirmed by MRI. They included only patients with fatty infiltration grade 1 or 2 according to Goutallier, failure of conservative treatment. The patients were divided into 3 groups according to the additional procedure performed to repair the RCT with suture anchors: collagen patch, polypropylene patch or control group. The augmentation patch of either collagen or polypropylene was placed on top of the repaired tendon. All patients underwent the same rehabilitation program. During follow up clinical evaluations and scores were performed, and ultrasound was made after 1 year in all patients. This study has limitations such as the retrospective design, no second-look arthroscopic surgery or biopsy was performed and the use of ultrasound, instead of the gold standard MRI. Interesting findings are the low retear rate; increased University of California, Los Angeles (UCLA) score, strength and elevation at three years postoperatively for the polypropylene group; negative influence of age and retears on results. The authors recommend that PM augmentation should be considered for the treatment of massive RCT especially in older patients.

Mersilene® has also been used for treatment of massive, irreparable RCT, as reported by Audenaert et al in 2006 (Audenaert et al 2006). In their study, 41 patients with massive RCT, were treated with Mersilene® mesh and subacromial decompression.

After a mean follow-up of 43 months, they noticed significant improvement ( $p < 0.001$ ) in the Constant and Murley scores, pain and ROM of these patients.

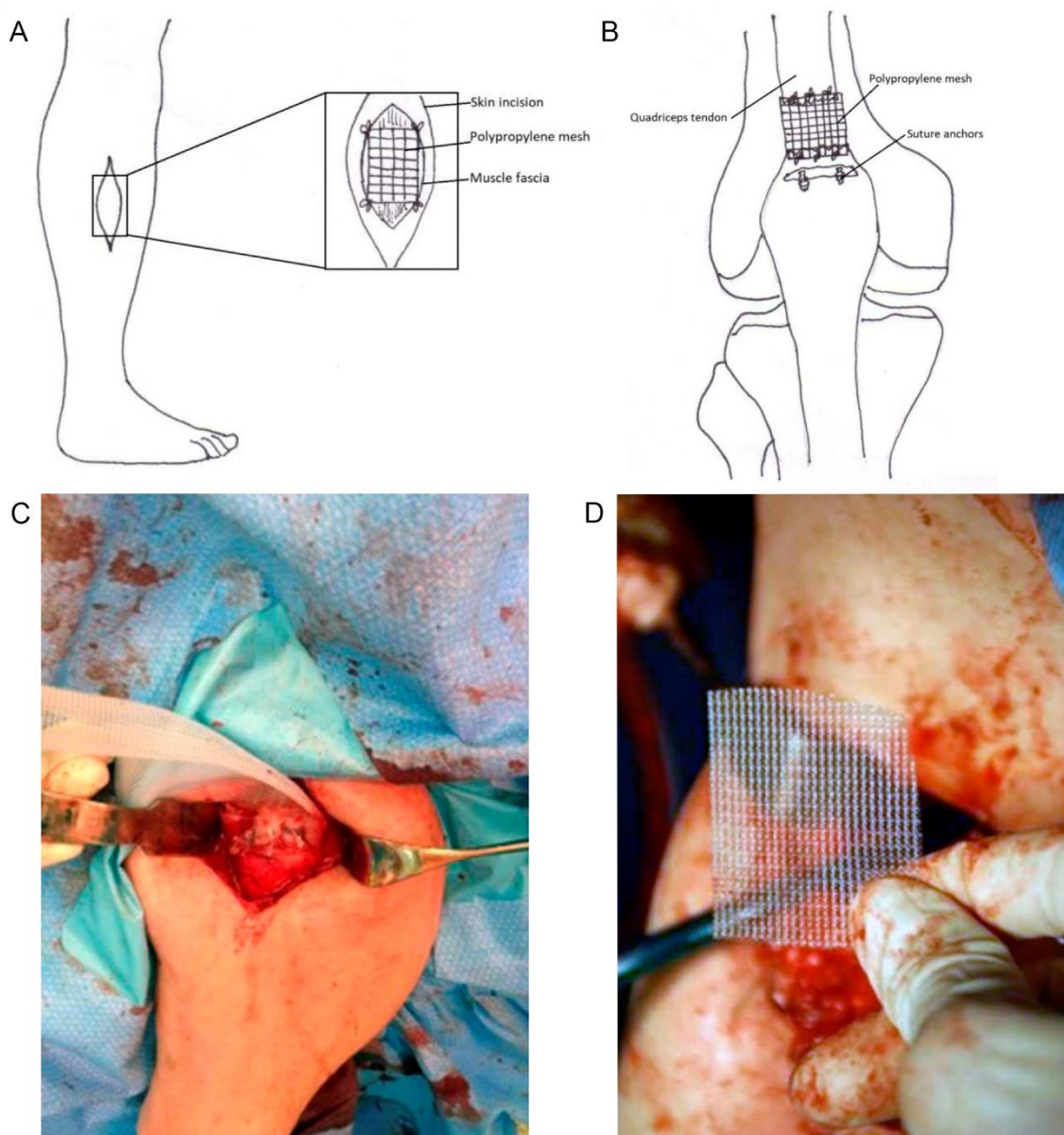
## CASE REPORTS

All patients included in this manuscript have given consent regarding data reporting and publication for scientific purposes. Approval by an ethics committee is waived for case report and literature review.

CASE 1 – A 38-year-old woman with muscular hernia on the lateral compartment of her leg, complained of pain during physical activity, without improvement after one year of conservative measures. We performed a 6 cm incision on the middle third of the leg, dissection was carried down to the superficial muscular fascia and the herniated fibularis longus muscle was identified. A tensionless edge-to-edge suture of the fascia was unable to achieve, therefore a PM was used to close the fascial defect. The mesh was sutured to the fascia edges, using an absorbable suture (polypropylene) reducing the tension between the tissues (figure 1A). Complete closure of the layers was made and no immobilizations were required. The patient had a good recovery and no complications were identified at follow-up. She has completed ten years of surgery and is able to practice non-competitive physical activity (jogging and weight lifting) without any complains.

CASE 2 – A male patient, 70 years old, underwent a TKA and after 6 weeks had a quadriceps tendon rupture during rehabilitation. Examination revealed localized pain, palpable gap and extension lag. The patient was unable to stand upright from a sitting position and couldn't go up and down stairs. Ultrasound demonstrated a 5cm retraction of the quadriceps tendon, which was surgically repaired using two absorbable 4,5mm suture anchors inserted at the superior pole of the patella. A PM was placed for augmentation of the primary repair (figure 1B). The patient was immobilized for 3 weeks allowing only passive ROM during physical therapy and, after this period, he progressed through strengthening and stretching of the quadriceps. The Oxford knee score was 25 and 43, preoperative and postoperatively, respectively and the patient presented with complete extension and function of the leg at 6 months follow-up.

CASE 3 – An eighty-year-old man who had a total shoulder replacement, due to glenohumeral arthrosis, pushed himself up from a chair, resulting in dislocation of the prosthesis 4 weeks after surgery. Examination, x-rays and ultrasound confirmed an anterior prosthesis dislocation and associated complete subscapularis tendon tear. During revision surgery, we were unable to suture the torn edge of the subscapularis tendon to the bony trough because it was retracted even after mobilization. In this case, we used a PM which was sutured to the edge of the tendon and to the bone with 2 bioabsorbable 4,5mm anchors inserted in the lesser tubercle of the humerus (figure 1C). A standard rehabilitation protocol was adopted and six months after surgery the patient had significant improvement in function and UCLA score of 27 (preoperative score was 8).



**Figure 1.** (A) Illustration for case 1 - polypropylene mesh was used to close a fascial defect on the lateral compartment of the leg, due to a herniation of the fibularis longus muscle. (B) Illustration for case 2 – polypropylene mesh used for augmentation of quadriceps tendon repair after a rupture following TKA. (C) Case 3 – polypropylene mesh used for subscapularis tear repair, after total shoulder arthroplasty dislocation. (D) Polypropylene mesh in detail.

## CONCLUSION

All three cases were followed-up for at least two years and there were no complications related to the procedure, infection or adverse reactions related to the synthetic material used.

PM is a safe synthetic material frequently used in general surgery, however, its use in orthopedic procedures is uncommon. We describe three applications of PM (figure 1D) in orthopedic surgery, where the synthetic material was used in difficult scenarios and may represent a surgical option. Further studies are necessary to understand the biomechanical behavior of such materials under the tensile load of each tendon, as well as appropriately designed clinical studies to evaluate functional results and long term complications associated with the use of PM in orthopedic surgeries.

## REFERENCES

Alexander JW. History of the medical use of silver. *Surg Infect (Larchmt)*. 2009 Jun;10(3):289-92.

Audenaert E, Van Nuffel J, Schepens A, Verhelst M, Verdonk R. Reconstruction of massive rotator cuff lesions with a synthetic interposition graft: a prospective study of 41 patients. *Knee Surg Sports Traumatol Arthrosc*. 2006;14:360-4.

Auleda J, Bianchi A, Tibau R, Rodriguez-Cano O. Hernia through iliac crest defects. A report of four cases. *Int Orthop*. 1995;19:367–9.

Babcock WW. The range of usefulness of commercial stainless steel clothes in general and special forms of surgical practice. *Ann West Med Surg*. 1952;6:15-23.

Bellon JM. Role of the new light weight prostheses in improving hernia repair. *Cir Esp*. 2009 May;85(5):268-73.

Brown C, Finch J. Which mesh for hernia repair? *Ann R Coll Surg Engl*. 2010;92(4):272–8.

Browne JA, Hanssen AD. Reconstruction of patellar tendon disruption after total knee arthroplasty. *J Bone Joint Surg Am*. 2011;93(12):1137-43.

Ciampi P, Scotti C, Nonis A, Vitali M, Di Serio C, Peretti GM, et al. The Benefit of Synthetic Versus Biological Patch Augmentation in the Repair of Posterosuperior Massive Rotator Cuff Tears: a 3-Year Follow-up Study. *Am J Sports Med*. 2014;42(5):1169-75.

Danikas D, Theodorou SJ, Stratoulas C, Constantinopoulos G, Ginalis EM. Hernia through an iliac crest bone-graft donor site. *Plast Reconstr Surg*. 2003;110:161–3.

Hosey G, Kowalchick E, Tesoro D, Balazsy J, Klocek J, Pederson B et al. Comparison of the mechanical and histologic properties of Achilles tendons in New Zealand white rabbits secondarily repaired with Marlex mesh. *J Foot Surg*. 1991;30(3):214–33.

Leber GE, Garb JL, Alexander AI, Reed WP. Long-term complications associated with prosthetic repair of incisional hernias. *Arch Surg*. 1998;133(4):378–82.

Li X, Kruger JA, Jor JW, Wong V, Dietz HP, Nash MP, et al. Characterizing the ex vivo mechanical properties of synthetic polypropylene surgical mesh. *J Mech Behav Biomed Mater*. 2014 Sep;37:48-55.

McGavin L. An Address on the Use of Filigrees Of Silver Wire in the Cure of Herniae Usually Considered Inoperable: Read before the Norwood Division of the British Medical Association. *Br Med J*. 1907;2:1395-8.

McGavin L. The results of filigree implantation. *Proc R Soc Med*. 1913;6:103-20.

Muermans S, Coenen L. Interpositional arthroplasty with Gore-Tex, Marlex or Tendon for osteoarthritis of the trapeziometarcarpal joint: a retrospective comparative study. *J Hand Surg Br*. 1998;23(1):64-8.



Nozdo SR, Rachala SR. Polypropylene mesh augmentation for complete quadriceps rupture after total knee arthroplasty. *Knee*. 2016;23(1):177-80.

Politano AD, Campbell KT, Rosenberger LH, Sawyer RG. Use of silver in the prevention and treatment of infections: silver review. *Surg Infect (Larchmt)*. 2013;14:8-20.

Saberski E, Orenstein S, Novitsky Y. Anisotropic evaluation of synthetic surgical meshes. *Hernia*. 2011;15(1):47–52.

Ziegler K, Breil H, Martin H, Holzkamp E. Verfahren zur Homopolymerisation von Propylen und  $\alpha$ -Butylen. DBP 1257430, 1974.