

ACUTE PATELLAR LIGAMENT RECONSTRUCTION WITH THE SYNTHETIC LARS LIGAMENT AS AN INTERNAL STABILIZER

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SUMMARY

Background: Acute patellar ligament ruptures present significant surgical challenges due to the essential role of the knee extensor apparatus in gait and postural stability. While direct repair is standard, compromised tissue quality from chronic tendinosis or high functional requirements in athletes may necessitate augmented reconstruction to prevent failure and allow accelerated rehabilitation.

Objective: This article describes a surgical technique for reconstructing the patellar ligament using longitudinal synthetic polyethylene terephthalate (PET) fibers as an internal stabilizer for both acute and chronic injuries.

Key Points: The technique utilizes two LARS PTR 30 ligaments, each providing a tensile strength of 1500 N with 9% elasticity. The procedure involves creating two parallel 4.5 mm longitudinal tunnels in the patella and two tunnels at the tibial tubercle. The synthetic ligaments are anchored proximally via stainless-steel barrettes at the superior patellar pole and secured distally in the tibia using 5.2 x 30 mm metal interference screws. This internal bracing allows for end-to-end suture of the native ligament stumps under reduced tension. Postoperative management includes immediate weightbearing in an extension brace, followed by progressive range-of-motion exercises starting at two weeks. Advantages include the absence of donor site morbidity, high resistance to plastic deformation, and histological evidence of fibroblast ingrowth into the PET mesh.

Conclusion: Internal stabilization with synthetic PET ligaments provides a high-strength alternative for patellar tendon reconstruction. This approach facilitates early mobilization and rapid return to activity, particularly in complex cases or high-demand patients where native tissue quality is suboptimal.

KEYWORDS

Patellar Ligament; Orthopedic Procedures; Reconstructive Surgical Procedures; Polyethylene Terephthalate; Joint Instability

INTRODUCTION

The acute rupture of the patellar ligament represents still an important challenge for the surgeon today. A rapid diagnosis and therapy are essential for an adequate rehabilitation of the patient since the patellar tendon is a key part of the knee extensor apparatus and is essential for walking and maintaining an upright position [1]. Anatomically, the patellar ligament is the continuation of the quadriceps tendon, and mainly composed of the rectus femoris component which passes over the anterior aspect of the patella and inserts itself on the tibial tuberosity. The anteroposterior thickness of the patellar ligament is about 5 - 7 mm and less than that of the quadriceps tendon [2]. The patellar ligament has an average size of 30 mm in width and 50 mm in length [3].

Being an integral part of the knee extensor system, the role of the patellar tendon is to transmit the contraction forces of the quadriceps to the leg. Studies have shown that the distribution of forces during knee flexion are changing. When the knee flexion goes beyond 45 degrees the forces on the patellar ligament are increasing and peak at 60 degrees. Conversely, for knee flexion angles less than 45 degrees, the forces are greater in the quadriceps tendon [4]. This biomechanical concept becomes very interesting when associated with the clinic, where most of the patellar ligament injuries are happening with the knee in flexion [5,6]. The main component of the patellar ligament is type 1 collagen and fibroblasts, distributed parallel in space which gives the ligament a considerable strength [7].

Patellar ligament rupture is the result of a trauma mostly associated with a weakened tendon or chronic tendinosis [7]. Furthermore, many systemic conditions can be associated with an overall weakening of the ligament and tendon structures [8]. All these pathologies correspond histologically to mucoid degeneration, tendon lipomatosis and calcifying tendinopathy. These pathological conditions must be considered when planning surgery. A macroscopically degenerated tendon will make direct repair very difficult but other surgical options, such as internal brace reconstruction, may be a good option, even in acute traumatic injuries.

THE LARS LIGAMENT AS INTERNAL STABILIZER

In our experience, patellar ligament repair is always a challenge. In our practice, we have used many different techniques including direct repair (by direct suture, anchors or trans osseous fixation) or reconstruction with allo- or autografts. Our clinical results are comparable with those of the literature [9,10]. Sometimes, however, we are faced with cases, where the best-known techniques are not enough. Especially when the tissue conditions of the tendon are not very suitable for repair or if the functional demands of the patient are very high (athletics, elite sports). For these special cases after acute trauma, we use an artificial internal stabilizer for our patellar ligament reconstruction technique. The artificial LARS ligament (LARS company, Arc-sur-Tille) is composed of a woof of longitudinal synthetic fibers and a transversal warp consisting of a thread of textured polyethylene terephthalate (PET).

The synthetic Lars ligament PTR 30 consists of three separate portions (Fig.1):

- superior or proximal portion flattened, whose end contains a small stainless-steel barrette which aids in the primary fixation of the ligament
- middle portion corresponding to the patella tendon of small diameter and made of free fibers

- distal or inferior portion which is cylindrical and intended for tibial fixation

The ligament consists of 30 longitudinal fibers, not braided and therefore less sensitive to plastic deformation. The ligament shows a resistance of 1 500 N and an elasticity of 9 %[11].



Figure 1: Lars ligament

IMPORTANT PREOPERATIVE CONSIDERATIONS

We use this technique for all patients with acute and chronic rupture of the patellar tendon. Obviously, a careful preoperative evaluation must be made, especially about the presence of large wounds or other causes of contamination of the surgical site. A complete assessment of the ligament status of the knee must always be performed, for not to miss the diagnosis of multi-ligament lesions. A preoperative radiograph should be done to exclude patella fractures that could complicate surgery. An ultrasound evaluation will also be necessary to understand the type of the lesion (partial or complete injury, distal or proximal or intermediate lesion).

After the clinical and image evaluations, it will be very important to understand the functional needs of the patient and especially his motivation necessary for postoperative rehabilitation. Young patients, sports or professional athletes represent the type of patients ideal for this surgical technique. In our experience, we have also used this reconstruction technique with the artificial LARS ligament even for more complicated cases like failure of osteosynthesis after tibial tubercle osteotomy. TTO represents a very common surgical procedure for patella instabilities which might have complications that are not always easy to solve. In this specific case we often found a bone fragment which was no longer possible to be fixed for a new osteosynthesis with plates or screws, therefore we approached these cases like an acute avulsion of the patellar tendon from the tibia.

THE SURGICAL TECHNIQUE : TIPS AND TRICKS

We will present our personal technique for the reconstruction of the patellar tendon, using two artificial ligaments (LARS, PRT 30) as internal stabilizers. The patient is in dorsal decubitus position with tourniquet inflated during surgery. As antibiotic prophylaxis two grams of cefazolin is given to the patient intravenously, less than 60 minutes before the start of surgery. The surgical approach is made in flexion medial to the patella, from the superior edge of the patella to the anterior tibial tuberosity (Fig.2).



Figure 2: Medial approach of the knee, between the patella and the anterior tuberosity

Soft tissue dissection is done up to the tendinous plane and the retinaculum and patellar ligament are exposed (Fig. 3).



Figure 3: Exposure of the patellar ligament

Surgical debridement is performed on the distal stump of the patella ligament, to eliminate none viable tissue (Fig. 4).

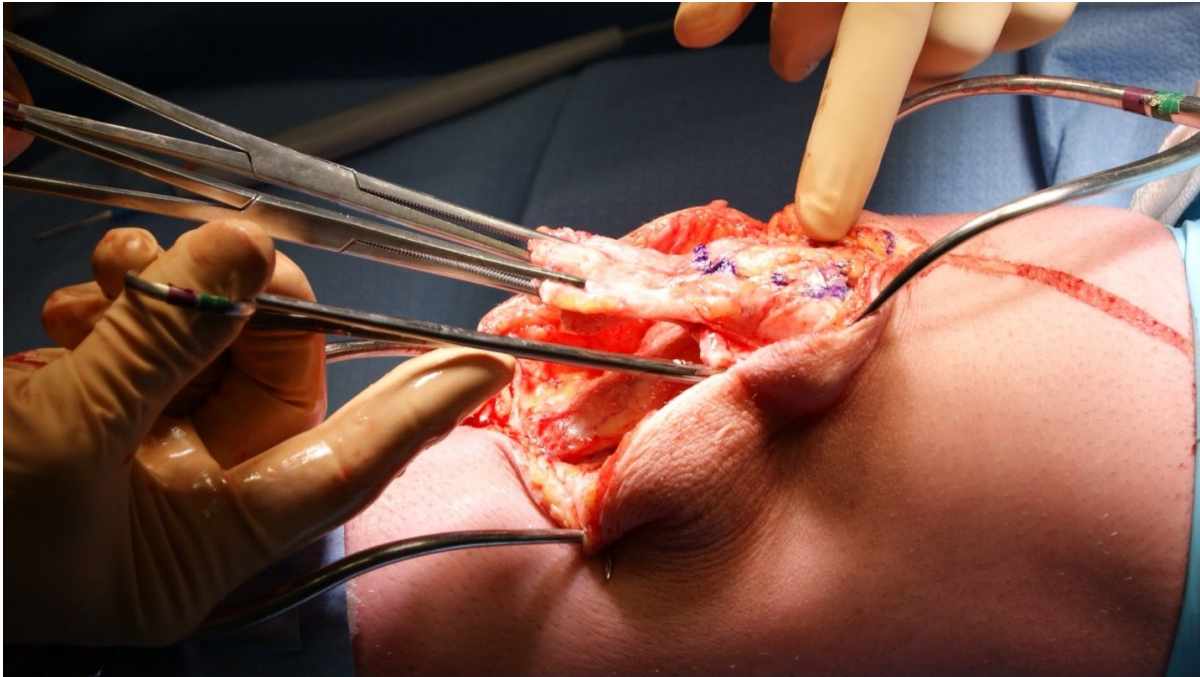


Figure 4: The preparation of distal ligament stump

Two tunnels are prepared in the patella, to allow a 4.5mm mesh to be passed from distal to proximal. The tunnels are parallel and must be fully in the bony structure. Two Lars ligaments are then passed from distal to proximal. The steel rod is flipped to the upper pole of the patella to act as an anchoring system (Fig. 5, 6).

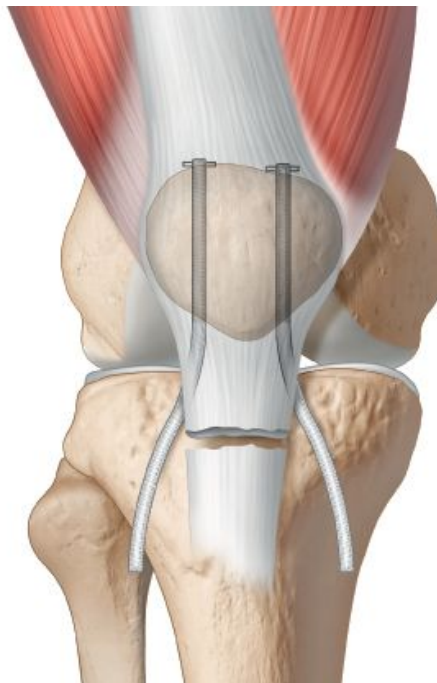


Figure 5: two artificial Lars ligaments within the bony tunnel in the patella. The stainless-steel bar ensures a firm anchorage to the bone.

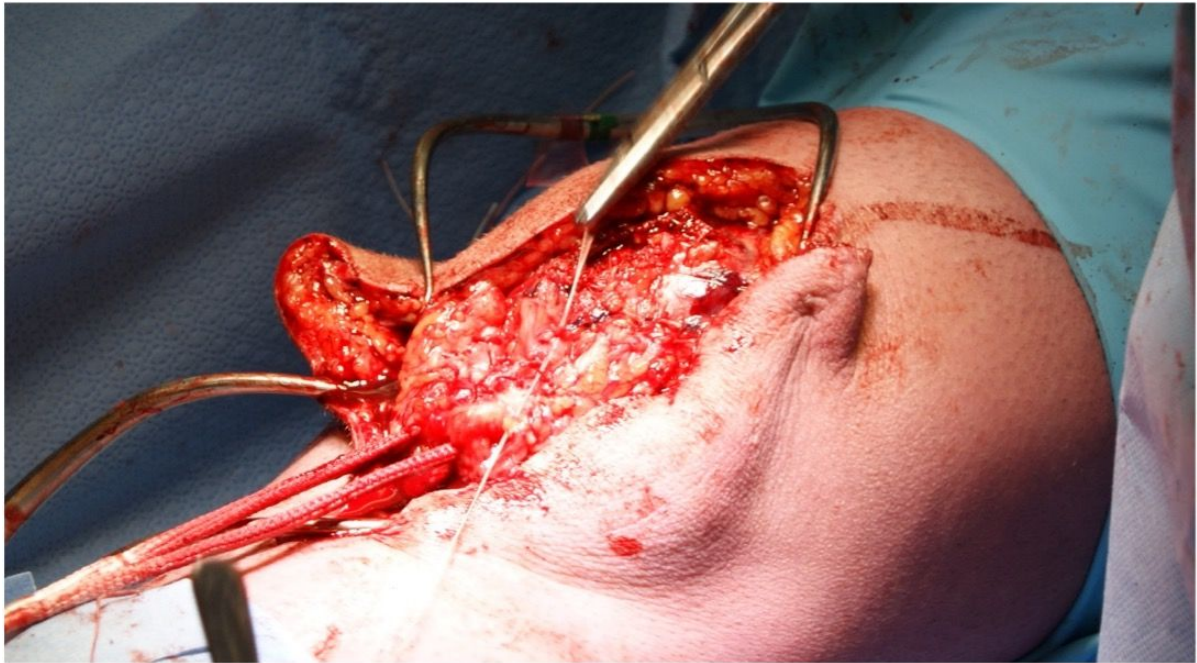


Figure 6: The passage of 2 artificial ligaments from the patellar inferior pole towards the distal part.

Subsequently, two further tunnels are performed at the root of the anterior tibia tubercle. They should be on different levels in the anteroposterior plane. The distal part of each ligament is passed through the tunnel, so that it comes out on the opposite side (Fig. 7).

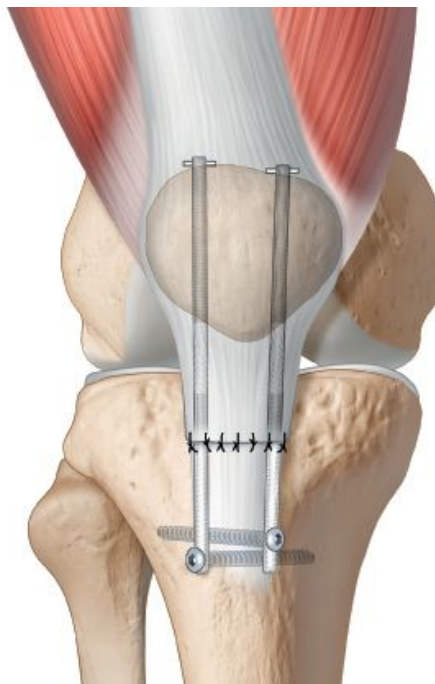


Figure 7: The passage of the distal part of the LARS artificial ligament into the tibial tunnels.

The stump of the distal patellar ligament is sutured end to end, to create a solid distal part which is strongly supported by the artificial ligaments.

The ligaments are finally fixed with 2 full threaded metal interference screws (5.2 x 30 mm) and excess ligament is cut (Fig. 8 A & B). The extensor system of the knee is now restored. Flexion and extension are tested intraoperatively. The subcutis and skin are closed with sutures and staples.

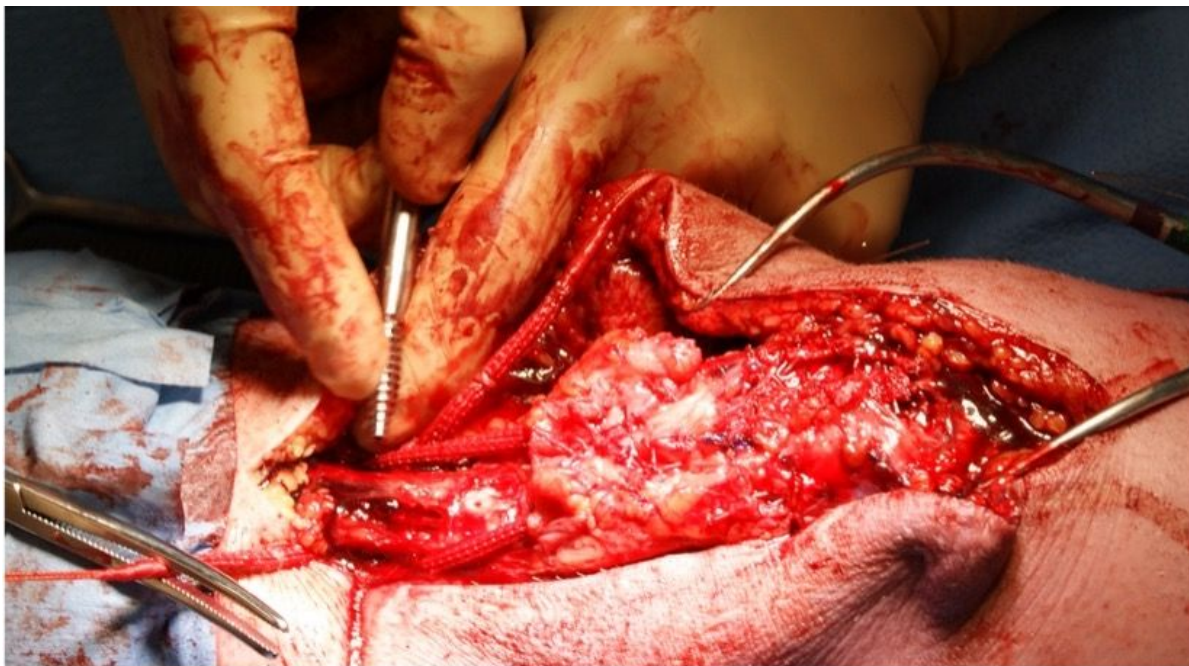


Figure 8 A, B: Final fixation of the ligament to the bone with metal screws and the final result after cutting the excess.

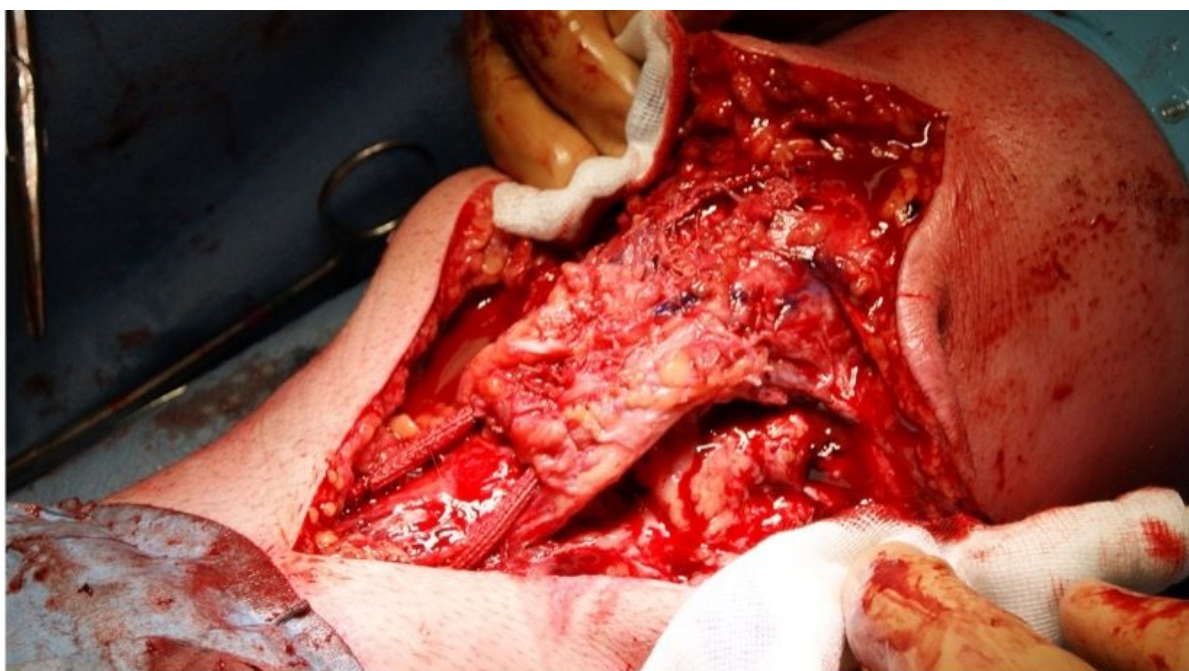


Figure 8 A, B: Final fixation of the ligament to the bone with metal screws and the final result after cutting the excess.

POST-OPERATIVE MANAGEMENT

After surgery the patient wears an extension immobilizer brace for 2 weeks with unrestricted load walking. After two weeks, the first medical follow-up with an radiograph is performed to verify the adequate wound healing and verify the correct position of the implants. Immobilization in extension is changed to an articulated orthosis that allows progressive knee flexion. Flexion is allowed progressively in 2 weeks interval from 30 to 60 and finally 90 degrees at the end of the sixth week. Physiotherapy should be started immediately after the operation. For the first 6 weeks the goal is the recovery of knee mobility and the drainage of edema. Then, protocols for the recovery of

proprioception and muscle strengthening are followed. The complete resumption of sports, even those at risk, starts around the eighth/ninth postoperative month.

CONSIDERATIONS AND CONCLUSION

The use of the LARS artificial ligament for the reconstruction of the patellar ligament seems to ideal from our experience for the cases we have discussed especially to increase resistance, biointegration and failures. The PET fibers used possess a high resistance to traction that increases with the number of longitudinal fibers used. Tests have been undertaken by the Institut Textile de France (ITF) demonstrated a total resistance to rupture equal to 1500 N for the 30 fibers ligament PTR 30, used in our surgery. Also, the rate of residual stretching is very low. A study conducted by the ITF after traction at 2 500 N indicates the same results immediately after testing and 24 hours later. Elongation was less or equal to 1.5 % regardless of fiber quantity in the ligament[12]. Regarding biointegration, a histological study demonstrated a complete cellular and connective tissue in growth in the LARS ligament and in vitro fibroblasts and osteoblast-like cells encapsulated the LARS ligament fibers [13]. Our post-operative results correspond to what was published in the literature, with excellent results for patellar ligament reconstruction [14,15,16]. This technique allowed our patients to initiate retesting early and quickly return to daily activities and favorite sports. In addition to the simple surgical technique, there are several advantages compared to other techniques described in the literature.

Main advantages of the LARS technique

- no donor site morbidity
- no presence of rejection or intolerance of the implant
- growth of fibroblasts around artificial ligaments[17]
- rapid mobilization and immediate weightbearing for walking
- possibility of repeating the reconstruction surgery if necessary [18, 19]
- no need for cerclage wiring

REFERENCES

- 1. Dwek JR, Chung CB.** The patellar extensor apparatus of the knee. *Pediatr Radiol.* 2008 Sep;38(9):925-35. doi: 10.1007/s00247-008-0746-8. Epub 2008 Feb 12. PMID: 18265971.
- 2. Miller TT.** The patellar tendon. *Semin Musculoskelet Radiol.* 2013 Feb;17(1):56-9. doi: 10.1055/s-0033-1333915. Epub 2013 Mar 13. PMID: 23487335.
- 3. Matava MJ.** Patellar Tendon Ruptures. *J Am Acad Orthop Surg.* 1996 Nov;4(6):287-296. doi: 10.5435/00124635-199611000-00001. PMID: 10797196.
- 4. Huberti HH, Hayes WC, Stone JL, Shybut GT.** Force ratios in the quadriceps tendon and ligamentum patellae. *J Orthop Res* 1984; 2(1):49-54
- 5. Garrett WE Jr.** Injuries to the muscle-tendon unit. *Instr Course Lect* 1988;37:275-282
- 6. Zernicke RF, Garhammer J, Jobe FW.** Human patellar-tendon rupture. *J Bone Joint Surg Am* 1977;59(2):179-183
- 7. Rauh M, Parker R.** Patellar and quadriceps tendinopathies and ruptures. In: DeLee JC, ed. *DeLee and Drez's Orthopaedic Sports Medicine.* Philadelphia, PA: Saunders; 2009:1513-1577
- 8. Pope JD, El Bitar Y, Plexousakis MP.** StatPearls [Internet]. StatPearls Publishing; Treasure Island (FL): Sep 14, 2021. Quadriceps Tendon Rupture.
- 9. Kannus P, Józsa L.** Histopathological changes preceding spontaneous rupture of a tendon. A controlled study of 891 patients. *J Bone Joint Surg Am* 1991;73(10):1507-1525
- 10. Larsen E, Lund PM.** Ruptures of the extensor mechanism of the knee joint. Clinical results and patellofemoral articulation. *Clin Orthop Relat Res* 1986;(213):150-153
- 11. Institi Textile de France,** Rapport d'Essai B2-278, Contrôle dynamométriques sur ligaments, 22 mai 1992.
- 12. Sarcovam,** Test Report RES 90258 C Rev2, Implants for Surgery – Artificial Ligaments – Part 3: Fatigue Test – Determination of resistance to abrasion (method A), June 2012.
- 13. Trieb K, Blahovec H, Brand G, Sabeti M, Dominkus M, Kotz R.** In vivo and in vitro cellular ingrowth into a new generation of artificial ligaments. *Eur Surg Res.* 2004 May-Jun;36(3):148-51. doi: 10.1159/000077256. PMID: 15178903.
- 14. Dominkus M, Sabeti M, Toma C, Abdolvahab F, Trieb K, Kotz RI.** Reconstructing the extensor apparatus with a new polyester ligament. *Clin Orthop Relat Res.* 2006;453:328-334.
- 15. Adrian James Talia and Phong Tran.** Bilateral patellar tendon reconstruction using LARS ligaments: case report and review of the literature. *Talia and Tran BMC Musculoskeletal Disorders* (2016) 17:302
- 16. Naim S, Gougoulas N, Griffiths D.** Patellar tendon reconstruction using LARS ligament: surgical technique and case report. *Strat Traum Limb Recon* (2011) 6:39-41.
- 17. Trieb K, Blahovec H, Brand G, Sabeti M, Dominkus M, Kotz R (2004)** In vivo and in vitro cellular ingrowth into a new generation of artificial ligaments. *Eur Surg Res* 36(3):148-151
- 18. Ecker ML, Lotke PA, Glazer RM (1979)** Late reconstruction of the patellar tendon. *J Bone Joint Surg Am* 81A:884-886
- 19. McNally PD, Marcelli EA (1998)** Achilles tendon allograft of a chronic patellar tendon rupture. *Arthroscopy* 14:340-344