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Original article

Quadriceps or patellar ligament reconstruction with artificial ligament after total knee replacement

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Abstract. *Background and aim of the work:* Ruptures of the quadriceps or patellar tendon after TKA implantation are a fearful and disabling complication. Direct reconstructions highlighted various problems, such as the decrease in extensor force, failure, need for prolonged post-operative immobilization. So augmentation techniques have been proposed with autologous tendons, allografts, artificial ligaments. Among these, the LARS seems the most modern and promising. For this reason, we have retrospectively reviewed a case series of patients operated with this artificial ligament, to assess the results and highlight the tips and tricks for this procedure. *Methods:* Ten patients with a mean age of 69.4 years suffered an extensor apparatus lesion after knee replacement. These patients underwent primary reconstruction and augmentation with LARS. They were retrospectively reviewed at a mean follow-up of 3.8 years, by measuring active flexion and extension, and by Lysholm scoring scale. *Results:* We did not observe any problems with healing of the surgical wound, nor phenomena of intolerance to the implanted material, such as inflammation, skin rashes or fistulas. The mean flexion was 117 degrees. Active extension was allowed in all patients, but with a mean extensor lag of 18 degrees. The mean Lysholm score was 74.2. *Conclusions:* LARS offers good results without completely solving the problem of extensor lag, linked to the softness of the tissues in the quadriceps. The major advantages of LARS were in the good tissue ingrowth, the absence of adverse tissue reactions, the ubiquitous availability and the possibility of stable fixation with early rehabilitation. (www.actabiomedica.it)

Key words: LARS, artificial, ligament, knee, arthroplasty, quadriceps, patellar

Introduction

The rupture of the extensor apparatus (patellar or quadriceps tendon, or both) after knee replacement is a fairly rare event, but nevertheless it's not to be underestimated, occurring in 0.1-3% of cases (1-7).

The consequences of this injury are the defect of active extension and the instability when walking, causing frequent falls, thus with the risk of prosthetic mobilization (8).

Primary repair can be considered in the case of acute injury (9,10). However, in the presence of a TKA it is usually a matter of degenerative lesions, with poor quality of residual tissues. Frequently these are not traumatic lesions but spontaneous, that is why the diagnosis and surgical treatment are generally late, when the tendon stumps are atrophic, retracted and adherent to the surrounding tissues. In these cases, a primary repair requires a prolonged period of immobilization and often provides unsatisfactory results (1,7-9,11-15).

An augmentation with autologous semitendinosus was proposed (16-18). However, in the elderly, the quality of autologous tissues may be poor, with the disadvantage of further surgical trauma and prolonged rehabilitation (19).

Reinforcement with allografts or synthetic ligaments was then proposed. The most used allografts are the Achilles tendon (20-24) and the whole extensor apparatus (7,25). These allografts were related with good results (2,20,22,26), with the advantage of

avoiding harvest morbidity (27), and with good tissue integration (28). However, the literature reported a 58% revision rate (29), 38% failure rate (7), progressive loosening with extensor lag (26,30), non-ubiquitous availability, possible transmission of infectious diseases (20,31).

In particular, the Achilles tendon showed failure rates ranging from 5 to 100% (30,24,32,33) and a tendency to secondary elongation with an average extensor lag of 15 degrees (33), which can be prevented by fixing the graft in full extension (34). The whole extensor apparatus was associated with good results (35,36) but with high failure rates (26,30).

Synthetic ligaments, on the other hand, have ubiquitous availability (2,37), they have no possibility of transmitting infectious diseases, serve as scaffolds for tissue ingrowth (38,39), have greater load to failure and stiffness (38,40).

The reported synthetic ligaments were the Leeds-Keio (41), Trevia-Tube (42), meshes (38,43), carbon fibres (44), but the Marlex was considered the gold standard (37, 38,45), which compared to allografts demonstrated to halve complications and failures (46).

The LARS ligament have been studied mainly in ACL reconstruction (47-54) and in extensor apparatus reconstructions, after tumour resection knee replacement (27,55,56). LARS showed the same properties as Marlex in terms of tissue ingrowth and lack of foreign tissue reactions (54), while having superior load to failure and stiffness (40,55). This should mean less secondary elongation and less extension lag (57). Further advantages of LARS are the lack of harvest morbidity, the lack of intolerance reactions, the possibility of revision, the possibility of avoiding additional cerclages (17,18,58). It allows early rehabilitation by splinting the primary repair (59-61), which can be performed with direct suture, with suture anchors or with V-Y plasty in case of quadriceps retraction (11).

Literature is lacking to evaluate LARS for extensor apparatus reconstruction following total knee replacement. So the aim of the present study was to investigate the results from a case series of patients operated for extensor apparatus reconstruction following total knee replacement, to asses the results compared to the literature from other procedures, to highlight the technical tips, tricks and pitfalls. Since the main problem with extensor reconstructions was secondary elongation loss with extensor lag, we debated about the best fixation method for the LARS ligament.

Methods

Patient population

In the hospitals of Riccione, Cattolica and then at the ISS of San Marino, 712 bicompartment knee prostheses, 146 tricompartment prostheses, 67 prosthetic revision surgeries were performed from 2009 to 2020. Cemented and uncemented prostheses, PS or mobile plate were used.

Ten of these patients suffered a lesion of the extensor apparatus on the operated knee, in five cases involving the quadriceps tendon, in four cases involving the patellar tendon, one of which at the lower pole of the patella, three due to detachment of the tibial tuberosity for previous osteotomy in revision surgery. One case suffered complete injury to the patellar and partial quadriceps tendon following hyperflexion trauma.

The injuries were atraumatic in seven cases, occurring 2-6 weeks after surgery. In one case it was a cut injury, in two cases a hyperflexion trauma. Traumatic cases occurred further away from the prosthesis surgery.

Two cases were recurrent lesions after previous allograft reconstruction. Three cases resulted from prosthetic revision performed by osteotomy of the tibial tuberosity, with its subsequent detachment.

Surgical technique

Primary repair of the extensor apparatus was performed with direct suture and with trans-osseous sutures placed through two parallel trans-patellar longitudinal holes. In four cases, tendon re-insertion to the patella was performed using suture anchors (Fig. 1). The tibial tuberosity was reinserted with screws when detached. The repair was reinforced with LARS. This was passed transversely into the quadriceps tendon at the superior pole of the patella for patellar tendon injuries. For quadriceps tendon injuries it was passed proximal to the quadriceps tear on healthy tissue. The

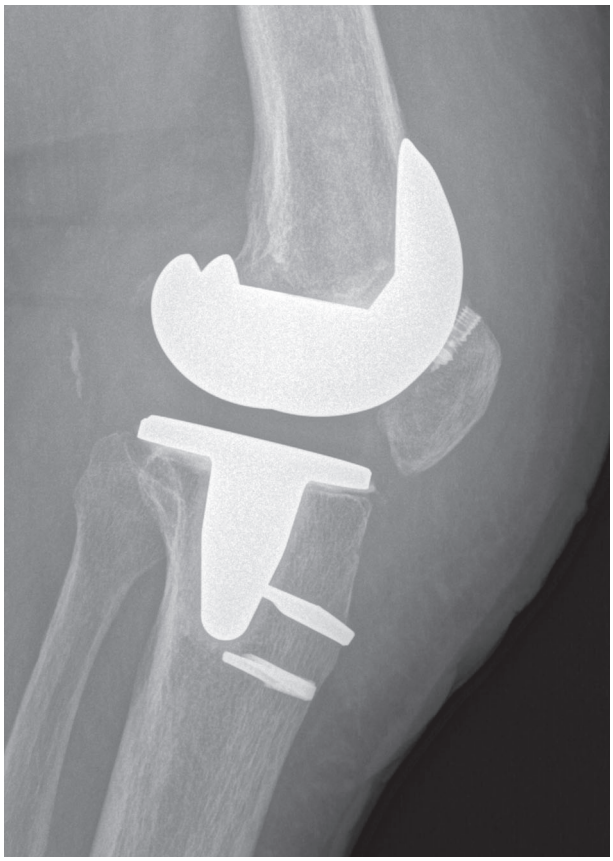

Figure 1. X-Rays showing primary quadriceps reconstruction with suture anchors at the superior pole of the patella, and tibial fixation of the LARS ligament with two staples

LARS was passed distally under the alar ligaments and fixed distal to the tibial tuberosity with interference screws or titanium staples avoiding the tibial prosthetic component, in some cases using a trans-tibial tunnel (Fig. 2). In the first three cases, fixation of the LARS was performed at 15 degrees of flexion. In the following seven cases, the LARS was fixed with the knee fully extended.

Post-operative treatment

Immobilization with a rigid extension brace for 15 days was advised. Passive knee flexion was then allowed, and then active mobilization after 3 weeks. The weight-bearing was allowed with a knee brace after 4 weeks, and without the knee brace after 6 weeks. The crutches were finally abandoned after two months.

Patients were retrospectively re-evaluated by measuring the degree of active knee flexion and extension, and by the Lysholm scoring scale.

Figure 2. X-Rays showing LARS fixation with a single staple and trans-tibial passage through a 4.5 mm tunnel

All participants provided written informed consent to participate in this study. This study was conducted under the principles of the Declaration of Helsinki.

Results

We retrospectively reviewed patients after a mean follow-up of 3.8 years (range 3 months – 11 years). They were 6 females and 4 males with an average age of 69.4 years (range 54-77).

In all patients we observed perfect healing of the surgical wound. The artificial ligament has always been well tolerated, and has never caused intolerance phenomena such as inflammation of the soft tissues, skin rashes or fistulas.

All patients had excellent flexion, averaging 117 degrees. Active extension was allowed in all patients, but with a mean extensor lag of 18 degrees (range 0-30 degrees) (Fig. 3). The mean Lysholm score was 74.2 (fair result).

Figure 3. Active extension allowed with extensor lag.

Discussion

The lesion of the extensor apparatus after knee arthroplasty cannot be considered as traumatic, being often atraumatic upon tissues affected by degenerative phenomena. In these cases, an augmentation technique must be considered. Among these, autologous semitendinosus is an option, but with the disadvantage of causing further surgical trauma and slowing down rehabilitation. In addition, in the elderly, the quality of the autologous tendons may not be suitable. Allografts have a cost, a possibility of immune reaction and transmission of infectious diseases, and a non-ubiquitous availability. For these reasons, various artificial tissues have been proposed over time. Among these LARS demonstrated good tissue ingrowth capabilities, did not present adverse tissue reactions, has a ubiquitous availability and high load to failure and stiffness values. This in theory should help solve the problem of extensor lag, which is present with all the techniques mentioned above.

This type of injury is quite rare, occurring in 1.1% of our cases. Therefore, our case series is rather limited. However, the results were good, having allowed good flexion and also the restoration of active extension in all patients. The problem of extensor lag remained (mean 18 degrees) despite the superior mechanical properties of the synthetic ligament, in line with the values obtained with allografts, for which an extensor lag of 15 degrees was reported (33), in some cases reaching 59 degrees (30). This phenomenon was not due to the mechanical failure of the LARS, nor to its fixation to the bone, since radiographically we did not observe any signs of mobilization or patella alta. We believe that the extensor lag was due to the collapse of the tissues at the level of the proximal passage, which is why we have decided in the course of our experience not to fix the ligament in flexion, but with the knee completely extended. Also with this method we observed an excellent recovery of flexion, indicating the softness of the tissues in the quadriceps. This data was confirmed by previous experiences from other authors who have found better results by fixing the ligament in full extension (26,34), although other authors do not specify at how many degrees of flexion to perform fixation (11,19), while some fix it in flexion (62). The recommended fixation devices for LARS are non-absorbable interference screws, but in the presence of knee prosthesis in our opinion it is easier to fix the ligament with one or two staples, with or without a tibial tunnel.

The fair results obtained with the Lysholm score were related to the presence of knee primary or revision replacement, and therefore to the multiple surgery already undergone. Moreover, two cases were recurrent lesions after a previous allograft reconstruction. Three patients had undergone osteotomy of the tibial tuberosity with subsequent detachment. This experience could indicate that the osteotomy of the tibial tuberosity during revision surgery may require augmentation with LARS in the first instance, to allow early mobilization without risking the detachment of the tuberosity.

The limitation of this study was the small case series of patients, justified by the fact that it is a rare lesion, and by its retrospective uncontrolled nature. However, this study can provide useful indications about the use of LARS in ruptures of the extensor apparatus after knee prosthesis, as studies on the subject have not yet been published, given that LARS has been studied particularly in ACL injuries and in tumour resection prosthesis.

Conclusions

In conclusion, LARS offered good results without completely solving the problem of extensor lag, linked to the softness of the tissues in the quadriceps. The major advantages of LARS reside in good tissue ingrowth, in the absence of adverse tissue reactions, in the ubiquitous availability and in the possibility of stable fixation with early rehabilitation.

Conflict of interest statement: Each author declares that he has no commercial associations (e.g. consultancies, stock ownership, equity interest, pa-tent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article. The present study was not submitted to an ethic committee, being a retrospective case series of patients operated with a non-experimental device.

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