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Technical note

"The Chambat Sardine Can" technique for the treatment of chronic quadriceps tendon rupture

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ABSTRACT

Ruptures of the quadriceps tendon (QT) are rare but serious injuries accounting for less than 2% of all tendon injuries around the knee. These injuries, often occurring in individuals over 40, are leading to a loss of active extension and a significant impact on knee function. While the treatment of acute QT ruptures through various reinsertion techniques has shown excellent outcomes, managing chronic injuries and failed primary repairs remains challenging due to tendon retraction and difficulties in repositioning the tendon stump. This study introduces a novel approach associating direct tendon reinsertion with metal frame reinforcement, aiming to effectively lower the retracted tendon to the proximal pole of the patella. This technique offers a promising alternative that addresses the limitations of traditional methods and potentially improves patient outcomes by providing a safe primary fixation and protection of the repair, enabling early rehabilitation and reducing the need for subsequent interventions.

Level of evidence: IV; case series study.

1. Introduction

Ruptures of the quadriceps tendon (QT) are uncommon injuries of the extensor apparatus, representing less than 2% of all knee tendon injuries. Like all extensor mechanism ruptures, these injuries have serious functional consequences, with loss of active extension. The incidence of QT ruptures is 3 times lower than that of patellar tendon ruptures [1]. They occur preferentially in patients over 40 years old. Nearly three-quarters of patients have predisposing factors such as metabolic and inflammatory diseases or relevant drug (corticoids, quinolones) use [2–4]. Rupture is generally traumatic and is caused by eccentric contraction of the quadriceps in a flexed position [5,6].

Numerous reinsertion techniques have been described in the literature for the treatment of recent quadricipital tendon ruptures and are associated with excellent functional results and a low failure rate [6–8]. On the other hand, there is no consensus on the most suitable method for managing chronic injuries and failed primary repairs due to the complexity of tendon retraction and difficulties in lowering the tendon stump to the proximal pole of the patella [8–11]. The techniques described in the literature require the use of lengthening plasties [6,10–13], or reinforcement with autografts [13–17], allografts [18,19], or synthetic grafts [17].

In this study we describe an original technique involving direct tendon reinsertion with metal frame reinforcement, enabling the retracted tendon to be lowered to the proximal pole of the patella.

2. Technique (video)

The procedure is performed under general or locoregional anesthesia. The patient is placed in a supine position. A pneumatic tourniquet is placed at the base of the limb. A counterbearing is placed on the lateral surface of the thigh, and a distal bar is used to position the knee at

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90° flexion. A second bar can be placed more distally to flex the knee approximately to 20° and facilitate tendon suture at the end of the procedure, without exerting excessive tension on the tendon reinsertion. Indeed, due to tendon retraction, flexion generally increases tension on the sutures at the end of the procedure.

A 10−15 cm anterior, vertical approach is made, starting at the proximal pole of the patella and extending proximally (Fig. 1). The subcutaneous tissue is dissected. Fibrosis is excised to expose the proximal and distal stumps of the quadricipital tendon.

Three 2-mm vertical tunnels are made between the proximal pole and the anterior aspect of the patella. Two or three coarse-gauge wires, such as Fiberwire® n°2 (Arthrex, Naples, FL, Italy) or Mersuture® n°3 (Ethicon, Raritan, NJ, USA), are passed in a frame over the anterior aspect of the patella and left in place. The same procedure is performed on the quadricipital stump (Fig. 2).

Two 2-mm diameter K-wires are placed transversely, one through the patella 2 cm below the proximal pole and the other through the proximal stump of the quadricipital tendon approximately 2 cm from the rupture zone. The two K-wires are then recut, and their extremities are bent. Two 2-mm diameter steel wires are looped through the ends of the K-wires. The knee is placed in extension, and the retracted stump of the quadricipital tendon is progressively lowered to the proximal pole of the patella by tensioning the two wires (Fig. 3).

Once contact between the two tendon stumps has been achieved, the Fiberwire® or Mersuture® wires are passed through the tendon stump and the proximal pole of the patella and then knotted together (Fig. 4). Closure is completed with an edge-to-edge tendon suture using Polysorb® n°2 (Covidien, Le Pont-de-Claix, France). Stability is then assessed by progressively flexing the knee. Finally, the subcutaneous and cutaneous soft tissues are closed.

Pearls and pitfalls of the surgical technique are summarised in Table 1.

The lower limb is immobilized in a removable extension brace for 45 days. Anti-thromboembolic prophylaxis is administered until the splint is removed and full ambulation is resumed. From the first postoperative day, patients are permitted to stand and bear full weight with the aid of the brace. Rehabilitation, focused on isometric quadriceps activation and the progressive recovery of range of motion, begins immediately. Flexion is limited to 30° for the first three weeks, then increases to 60° for the next three weeks, with no restrictions after six weeks.

3. Results

The first 11 patients operated on using this technique between June 2004 and October 2021 were studied. Most of them were men (10/11, 90,9%), aged between 38 and 76 years old. No predisposing factors for rupture were noticed. The time between rupture and surgery ranged from 6 weeks to almost 13 years (median time 26,0 weeks). Rupture occurred in the tendon in 70% of the patients, and a distal avulsion on the patella was noticed in 30% of cases. Only 4 patients (36,4%) showed fatty degeneration of the quadriceps on MRI (Table 2).

All patients had tendon retraction, ranging from 2 to 12 cm, assessed intraoperatively.

At a median FU of 20 months, the median active extension deficit decreased from 40° [min–max: 20–60] to 0° [0–10]. Postoperatively, all patients had a quadriceps strength between 4 and 5/5 according to the MRC classification versus 0–3/5 (5 missing values) preoperatively. No suprapatellar gap was found postoperatively. The median subjective IKDC score increased from 25,9 [16–43,7] preoperatively to 58,6 [49,0–72,4] at the last follow-up.

Seven patients (63.3%) needed hardware removal when the tendon was healed. Three patients had complications:

- One patient presented postoperative stiffness in flexion and needed arthroscopic arthrolysis and the patient had recovered full range of motion at the last FU.
- One patient had a broken K-wire without any functional consequences.
- One patient had an acute infection

4. Discussion

The time between accident and surgery seems to be a determining factor in the quality of functional results of quadricipital tendon reinsertions. Scuderi et al. reported inferior results when the repair was performed more than 72 h post trauma [11]. Similarly, Rougraff et al. reported better functional results and higher satisfaction rates when repairs were performed within 7 days of rupture [20]. For Elattar et al., a maximum lead time of 2–3 weeks was necessary to ensure optimum results [21]. For these reasons, we consider that beyond 3 weeks post trauma, the suture should be considered chronic and secured with a metal frame.

Numerous techniques for the repair of chronic quadriceps tendon ruptures have been described in the literature, but these series were case reports or included small numbers of patients. Some authors [6,22,23] have proposed direct sutures when tendon retraction is not significant, allowing the tendon stump to be lowered onto the patella. Release of the medial and lateral patellar retinaculum may facilitate approximation. In cases where the suture is under tension or when tendon retraction does not allow the tendon stump to be lowered to the proximal pole of the

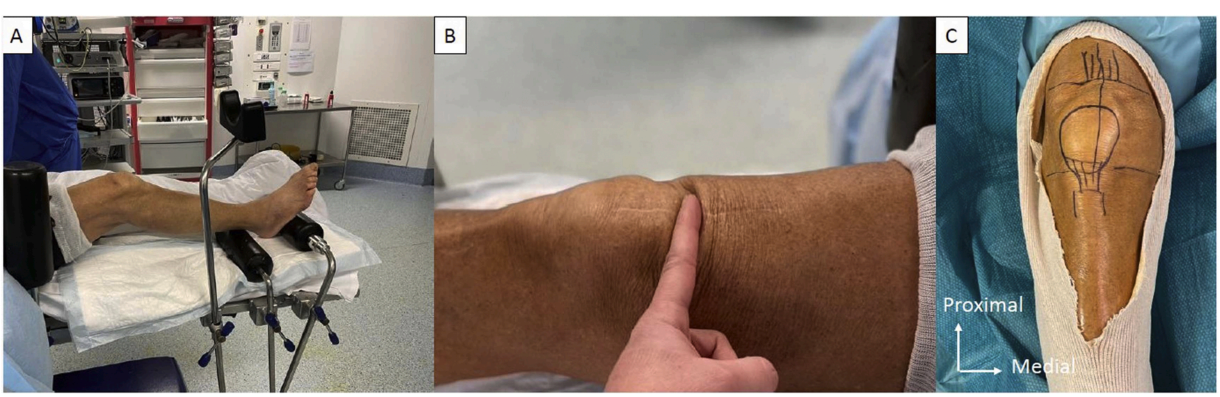

Fig. 1. Preoperative patient positioning.
A. A pneumatic tourniquet is placed at the base of the limb. A counterbearing is placed on the lateral surface of the thigh, and two distal bars are used to position the knee at 90° flexion and at approximately 30°.
B. Clinical assessment of tendon gap localization.
C. Marking for the median incision.

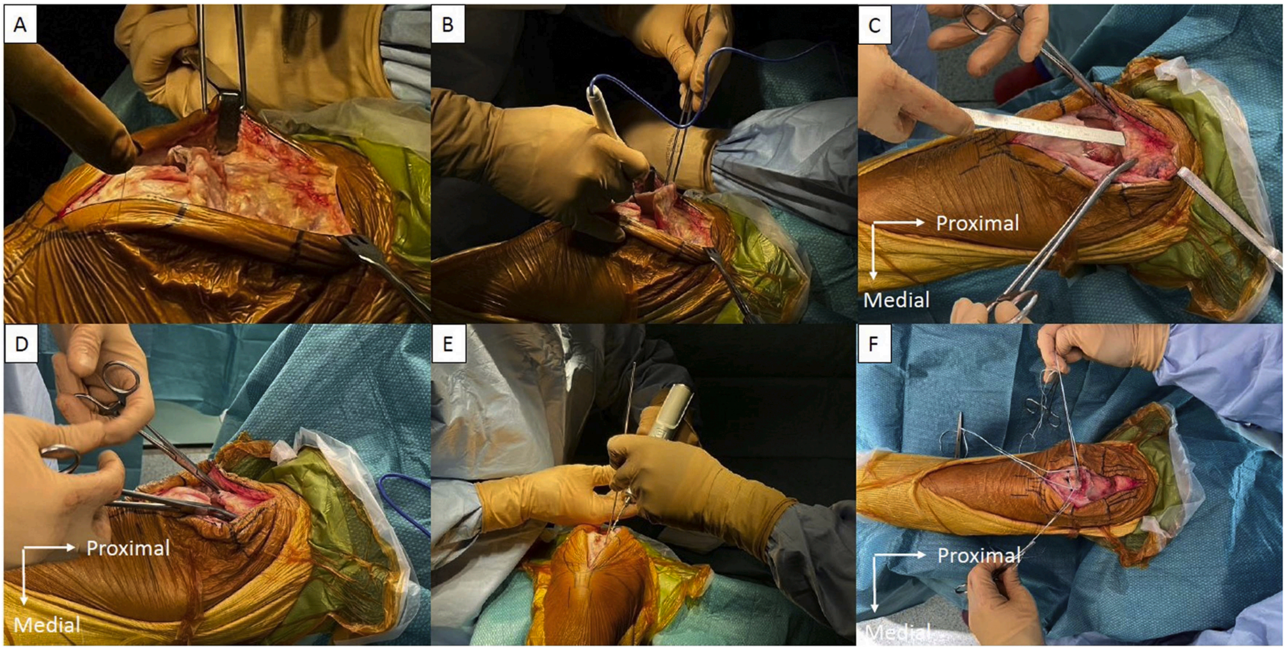

Fig. 2. First part of the surgical procedure.
A. Median approach and exposure of surgical site.
B. Removal of fibrosis from the cicatricial tendon and sub-quadricipital area.
C. Assessment of tendon gap between patella and proximal stump.
D. Assessment of the feasibility of tendon reduction after sub-quadricipital release.
E. Preparation of transosseous tunnels in the patella.
F. Surgical aspect prior to sardine cannulation.

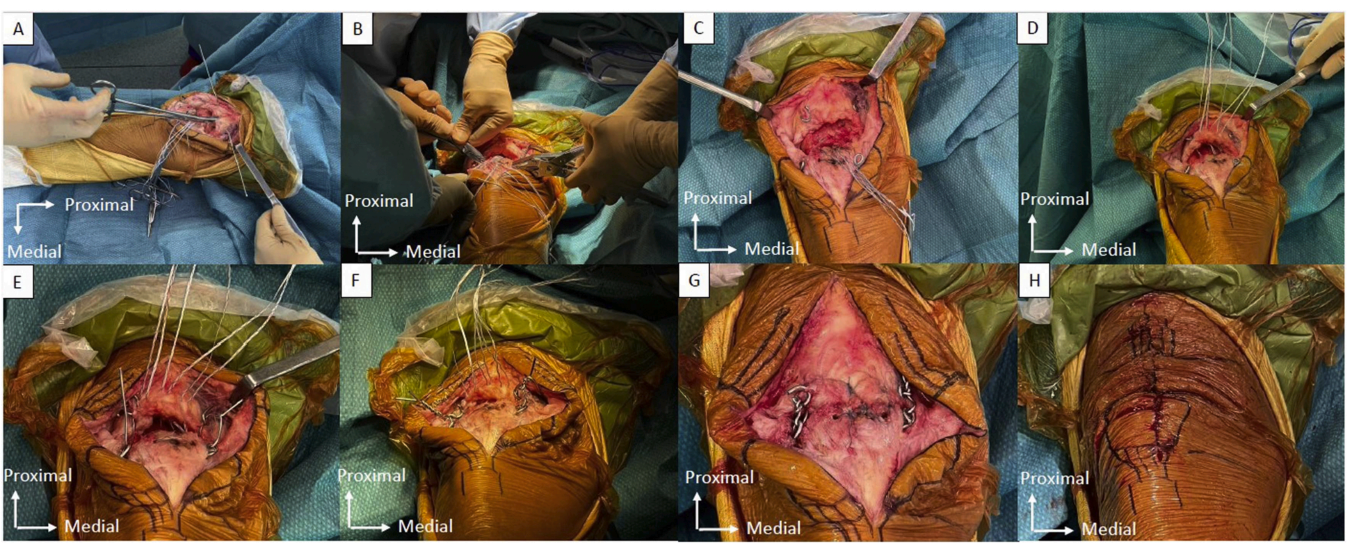

Fig. 3. Second part of the surgical procedure.
A. Placement of two 2-mm transverse K wires in the patella and tendon stump.
B. The ends of the wires are recut and bent.
C. Appearance before placement of cerclage wires.
D. Passage of transpatellar reinsertion threads through proximal tendon stump.
E. Placement of 2-mm cerclage wires between the two K wires.
F. Gradual repositioning of the tendon stump by tightening the cerclage wires.
G. Appearance once the tendon has been reduced.
H. Appearance when skin is closed without tension.

patella, other authors have proposed a V-advancement plasty or a V–Y lengthening of the quadriceps [6,24]. However, Siwek et al. reported only 50 % good results with Codivilla's V–Y lengthening technique [6]. Owing to the K-wire placed in the tendon stump and in the proximal pole of the patella, the technique we have described enables gradual, easy lowering of the tendon stump to the patella, as well as solid primary fixation to protect tendon reinsertion until healing. All patients in our series presented tendon retraction ranging between 2 and 12 cm. In all

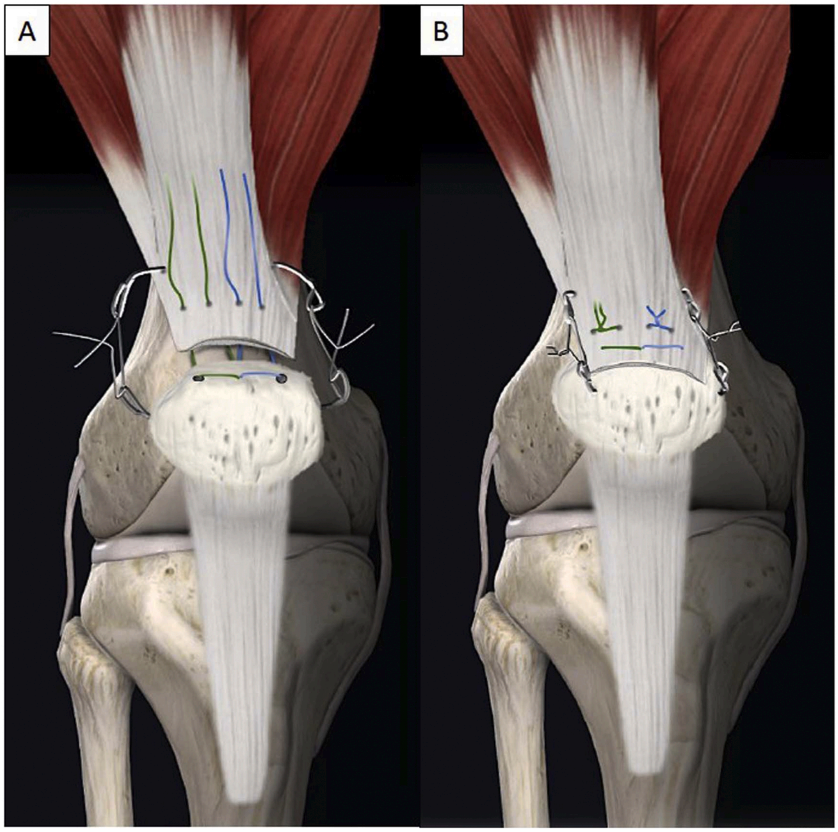

Fig. 4. Schematic representation of quadriceps reinsertion using the sardine can technique.
A. Once all the hardware are in place.
B. After tightening.

Table 1
Pearls and pitfalls of using the Sardine Can technique.

Pearls	Pitfall
- Place the sutures first in the proximal pole of the patella - To facilitate the lowering of a retracted quadriceps, you must release its deep portion - Place a distal counterbaring to place the knee at 20°of flexion for wound closing	- Passing the sutures through the patella might be difficult since the stump is distalized to the patella - Wound closure may be challenging since the approach is performed at 90° of flexion and closure in extension.

Table 2
Advantages and drawbacks of using the Sardine Can technique.

Advantages	Drawbacks
- No morbidity associated with autograft harvesting - Allows protected direct suturing even after large retractions - Enables early rehabilitation - No special equipment required - Cost-effective	- Hardware often needs to be removed due to discomfort - In large retractions, the use of this technique for direct suturing can lead to stiffness in flexion.

cases, the tendon was lowered to the patella at the end of the procedure. In addition, placement of a K-wire through the proximal quadriceps stump ensures stable fixation. In cases of significant tendon retraction, some authors have proposed the use of autograft or allograft reinforcements [14,15,18,25]. Leopardi et al. reported a case of suture augmentation using ipsilateral hamstrings [15]. Others have suggested securing reinsertion by using bilaterally harvested hamstrings. The disadvantage of these techniques is the morbidity associated with harvesting. In addition, a minimum of 5 mm tunnels are needed in the patella for the passage of these grafts, increasing the risk of secondary fracture.

Last, some authors have proposed the use of allograft reinforcement of the anterior tibial tendon or Achilles tendon [18,19]. Like autograft reinforcement techniques, these require the creation of tunnels, potentially weakening the patella. In addition, access to allografts can sometimes be difficult for geographical or economic reasons. The "sardine can" technique avoids the need for augmentation grafts, limits the risk of weakening the patella and is readily available, as it does not require any specific equipment. However, 3 patients (27%) had a complication requiring revision surgery, hardware removal was performed at the same time, and an additional 4 patients (36,4%) underwent hardware removal for discomfort.

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CRediT authorship contribution statement

All the authors participated in: substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; drafting the work or revising it critically for important intellectual content; final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Informed consent

All patients gave valid consent to participate.

Declaration of Generative AI and AI-assisted technologies in the writing process

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Declaration of competing interest

Dr Fayard is consultant for Arthrex and New Clip Technics, he has royalties from New Clip Technics and XNOV. Dr Sébastien Parratte is consultant for Zimmer Biomet, he has royalties from Zimmer Biomet and NewClip Technics, he is board member of European Knee Society.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.otsr.2024.104050.

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