Treatment of chronic Achilles tendon rupture by shortening suture and free sural triceps aponeurosis graft

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KEYWORDS
Achilles tendon; Neglected rupture; AOFAS score

Summary
Introduction: The Bosworth technique is old but still widely used. It involves problems of precisely determining the length of the Achilles tendon and of a volume effect in the turndown area.

Hypothesis: A new reconstruction technique is assessed, based on free sural triceps aponeurosis transfer without turndown, associated to tendon shortening suture.

Materials and methods: Twenty-three patients were assessed by AOFAS score and clinical examination (plus MRI in 14 cases) at a mean 24.5 months’ follow-up. Mean age was 52.1 years. Mean pre-operative AOFAS score was 63.6/100.

Results: Mean postoperative AOFAS score was 96.1. Mean graft length was 7.5 cm. Surgical revision was required for one case of postoperative infection. Twelve patients resumed leisure sports at their previous level by a mean 9.4 ± 2 months; three competitive sportsmen resumed sport at their previous level by a mean 7.6 months. None were dissatisfied or disappointed with their operation. MRI performed at 1 year found increased tendon volume without abnormality in 57% of cases; 43% showed abnormal images.

Discussion: Functional results were comparable to literature reports. It can be difficult to determine Achilles length for the Bosworth technique: this is made easier by conserving a fibrous support of a length determined with reference to the healthy side. The technique avoids aponeurosis turndown, and thus avoids the problem of plasty volume effect. The two cases of cutaneous complication occurred in the two most elderly patients, raising the question of the indications

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Introduction

Achilles tendon rupture may become chronic due to initial misdiagnosis, falsely reassuring ultrasound results or failure of initial treatment. In the first 3 weeks, direct suture is often feasible. Chronification takes place between 3 weeks and 3 months. Lengthening may then be indicated if loss of substance exceeds 2.5 cm [1,2]. Beyond 3 months, retraction necessitates reconstruction or transfer. Surgery may be indicated in case of pain, instability, impaired sports activity, or loss of independence in elderly subjects. Several techniques have been described, using tendon transfer [3–5], autograft [6–9] or synthetic ligament [10,11]. The technique of sural triceps aponeurosis turndown, popularized by Bosworth [7], has certain drawbacks, such as the difficulty of determining plasty length and a subcutaneous volume effect in the turndown area that is not described in the literature (Fig. 1). The authors’ own experience testifies to increased cutaneous traction in exactly that area, hindering incision closure. The ideal technique should combine robust restoration of tendon continuity, optimal length and the lowest possible surgical morbidity. The authors have used a technique of shortening suture of the fibrous tissue associated to a free sural triceps aponeurosis graft since 2005. The principal objective of the present study was to assess medium-term functional results and peri-operative morbidity and to analyze the restoration of Achilles length.

Materials and methods

Series

Our department has since October 2005 replaced the Bosworth technique by free sural triceps aponeurosis graft. Between October 2005 and April 2010, the technique was applied in 27 patients. One was lost to follow-up and three were excluded from analysis as lacking the minimum 1 year’s follow-up; 23 patients thus underwent retrospective assessment by AOFAS score [12] and clinical examination; 1-year control MRI was also performed in 14 cases. The series comprised 20 men and three women, with a mean age of 52.1 years (range, 28–79 yrs) at surgery. Mean BMI was 25.5 ± 3.1 (20.2–33.4). Mean time to surgery was 13.4 ± 17.3 months (3–72). Eight patients had experienced pain before the rupture; two had long-course corticotherapy (one for multiple sclerosis and one for rheumatoid arthritis); six were smokers; one had well-controlled type-2 diabetes. Acute rupture had been overlooked in 18 cases, including seven who underwent early rehabilitation without contention for mistakenly diagnosed ankle sprain, and 11 with no diagnosis or treatment. In five cases, the initial diagnosis was correct, leading to surgery (one conventional, one percutaneous) in two cases and conservative treatment in three. Table 1 reports presenting symptoms and clinical assessment. Mean pre-operative AOFAS score was 63.6 ± 11.5 (Table 1). Sixteen patients played sports (13 leisure, three competition), of whom none were able to continue after rupture; sports data are reported in Fig. 2. Anatomically, there were 21 Achilles body lesions and two lesions close to the insertion, with a small distal stump. All patients were operated on by one by two senior surgeons.

Surgical technique

Surgery was performed with the patient in ventral decubitus with a pneumatic tourniquet. Contra-lateral “physiological” equinus was recorded by goniometry. The distal approach was posteromedial up the median line, centered on the rupture site. The skin, subcutaneous tissue and tendon sheath were incised in a single plane. Scar tissue was left in place unresected (Fig. 3) in continuity with the healthy tissue, and released from the sheath. After location of the proximal and distal healthy areas of the Achilles, a Z-plasty was performed (Fig. 4), shortening the fibrous area. This fibrous support was left open in the center, each end finishing in a healthy area (Fig. 5). The size of the area to be filled in the center of the support was measured precisely. The graft was harvested from the mid-third of the triceps aponeurosis (Fig. 5) and transposed to the center of the filling area, without turndown. Suturing was performed from within the fibrous to the healthy area (Fig. 6). Equinus was restored with reference to the healthy side. If the filling area was close to the insertion, the graft was fixed in a bone trench.
Table 1 Details and evolution of pre- and postoperative AOFAS score.

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Mean 28.3 39.6 35.3 56.5 63.6 96.1
SD 9.4 2.1 8.1 5.9 11.5 6.8

P < 0.00001 P = 0.005 P < 0.00001

so as to obtain bone-tendon cicatrization (Fig. 7). Careful hemostasis was performed, with closure in three planes by separate sutures, with drainage.

Immobilization used a resin boot in 20° equinus, leaving the knee free, for 6 weeks without weight-bearing, followed by a removable orthosis with adjustable equinus, progressively reduced over 6 weeks. Weight-bearing was authorized once the orthosis had been adjusted to the 90° position, at 2.5 months postoperatively. Active rehabilitation, including muscular reinforcement, began in month 3.

Assessment

All patients were followed up by two surgeons, one of whom was not the operating surgeon. Assessment consisted of AOFAS scoring and a specific comparative clinical examination of the Achilles tendon, comprising assessment of foot sensitivity disorder, equinus, range of motion, increased dorsiflexion, stability in unipodal weight-bearing and unipodal rising.
or inflammatory infiltration areas, a gadolinium-enhanced FatSat T1-weighted slice was acquired for differentiation purposes. STIR sequences were also acquired to obtain a more homogeneous signal if the exploration field was large.

Statistical analysis

Statistical analysis used a Shapiro test to check normality. For continuous variables, the Student test was used for normal distributions, and otherwise the Mann-Whitney test. For non-continuous variables, the Chi² test was used. The significance threshold was set at $P \leq 5\%$.

Results

Mean follow-up was 24.5 $\pm$ 9.4 months (range, 12–43 mo). Mean graft length was 7.5 $\pm$ 2.8 cm and mean filling area length 5.7 $\pm$ 2.9 cm (2–11). There were three complications: one partially regressive sural nerve hypoesthesia, probably caused by compression within the fibrosis; two patients had cutaneous cicatrization problems, one 66-year-old man with infracentimetric aseptic superficial skin necrosis managed by local treatment and one 79-year-old with septic partial tendon necrosis requiring surgical resection conserving the macroscopically healthy tendon, with excellent evolution.
after 4 weeks’ directed cicatrization and adapted antibiotic therapy.

Mean postoperative global AOFAS score was 96.1 ± 6.8 (range, 79–100). Figs. 2 and 8 illustrate postoperative evolution, with a mean gain of 32 ± 11 (12–49) points.

A single patient experienced apprehension walking and pain under the heel cup, due to an attack of ankylosing spondylarthritis, that differed from his pre-operative pains and prevented return to sports activity; his AOFAS gain was 16 points, reaching 79/100. One patient did not return to sport; 12 resumed leisure sports by a mean 9.4 ± 2 (7–12) months; the three competitive players returned to their previous level of sport by a mean 7.6 months. None were dissatisfied or disappointed with their operation, including those with complications. There were no thromboembolic complications or reruptures.

There were 14 1-year MRIs. All showed increased Achilles volume all along the graft, and all showed continuity. Eight showed homogeneous tendons without abnormality between graft and fibrous support (Fig. 9). Six had images considered abnormal: mainly longitudinal fissures of varying size; these images showed residual limited integration defect between the graft and fibrous support; on the horizontal views, these defects were negligible compared to the tendon diameter (Fig. 10). Both transosseous reinsertions were perfectly healed (Fig. 11). There were no cysts or signs of inflammation. The group without abnormal MRI signal had a mean AOFAS score of 98.3 ± 3.9, and those with abnormality 92.5 ± 10.5. MRI abnormality was uncorrelated with functional results (P = 0.1).

Discussion

In the authors’ experience, the Bosworth technique involves a problem of graft volume effect in the turndown area that has not been reported in the literature. This area has double tendon thickness (Fig. 1), which we find increases the risk of skin lesion. The exact graft length required to restore length is also hard to determine. We therefore use free aponeurosis transposition, the main advantage of which is to avoid the volume effect. The technique conserves foot and ankle tendon motor function and allows the length of the Achilles tendon to be adjusted by shortening the scar tissue and bringing healthy tissue into the middle of the fibrosis. In our experience, it has been possible to fill areas as long as 11 cm. Unlike Nilsson-Helander et al. [13], we conserve the fibrosis, despite its having no mechanical or biological value; this enables length to be adjusted by the Z-plasty in the fibrosis on the opposite side. If, however, the fibrous tissue is lacking or of poor quality, transfer is performed without shortening suture, which is no longer the technique described here but closer to that of Bosworth. Correct length restoration can be judged from the ability to run or stand on tiptoes. At last follow-up, 20 patients could run and only two could not stand on tiptoes on the operated foot. These straightforward clinical parameters correlated with the anatomic parameter of tendon length and ankle propulsion force [10]. Mean AOFAS score was 96.1 ± 6.8 (79–100), in agreement with the literature and with Nilsson-Helander et al. in particular [13]. Efficacy can also be judged from return to sport: 12 of the 16 players resumed leisure sports at a mean 9.4 months and the three competitive players recovered their previous level at a mean 7.6 months; these data agree with those of Wegrzyń et al. [5].

The study had several limitations. It was retrospective and without isokinetic analysis; one of the assessors was one of the surgeons; and the MRI study concerned only 14 of the 23 patients.

Repair technique is usually adapted to the degree of loss of substance [7]. Classically, V-Y plasty is appropriate for 3 to 5 cm loss and tendon transfer when reconstruction is delicate. The Bosworth technique is employed beyond 5 cm loss. Lee et al. [14] used it in 12 patients, to repair a mean 4.2 cm loss of substance, and reported skin necrosis at the turndown. Our present technique is feasible for all sizes of loss of substance.

Failure is most often associated with infectious complications [2,3,15], the recognized risk factors for which [16,17] are age exceeding 60 years, smoking, corticotherapy, diabetes, treatment delayed beyond day 7 and pre-rupture...
tendinopathy. Ibrahim [10] and Jennings et al. [11] reported infection rates of respectively 7% and 19%. In a series of 11 patients treated by flexor hallucis longus transfer, Wegrzyn et al. [5] reported no septic complications. Saxena et al. [17] reported a 10% rate of skin complications and 3% surgical revision for complications in a series of 219 patients. The present series comprised one deep infection (4%) and one minor infracentimetric superficial aseptic skin complication (4%) remote from the turndown site, in patients aged respectively 79 and 66 years. In agreement with Pajala et al. [16], we consider advanced age to be a risk factor for cutaneous or infectious complications. Kosanovic et al. [18], on the other hand, reported a 33% complications rate in 22 patients with chronic rupture managed by minimally invasive surgery.

Mean time to surgery was $13.4 \pm 17.3$ months (range, 3–72 months). Such a long interval entailed severely chronic ruptures, clinically characterized by unstable gait and sural triceps amyotrophy. Long intervals to surgery increase the risk of postoperative complications [16].

Few studies have assessed graft evolution on MRI [19,20]. The present study includes 14 MRIs taken at 1 year. Analysis found homogeneous tendons with systematically increased volume, and perfect radiological graft integration in eight cases (57%) (Fig. 9), confirming the findings of Hahn et al. [19], who reported complete integration of flexor hallucis longus transfer in 46% of cases at a mean 46.5 months’ follow-up. There were, however, numerous abnormalities, such as residual longitudinal fissure (Fig. 10), cicatricial remodeling without cyst, rerupture and inflammation signal. Grafts for insertional rupture all healed (Fig. 11). We consider that all the images of tendon abnormality can be interpreted as non-pathologic cicatricial remodeling in patients with good or excellent results. It would be

**Figure 10** Pre- and postoperative MRI of chronic Achilles rupture. Postoperative MRI shows a tendon fissure that is small compared to the volume on the horizontal slice.

**Figure 11** Pre- and postoperative MRI of tendon graft involving insertion. The graft increases in volume and is homogeneous and perfectly integrated.
interesting to have imaging data at a longer follow-up to shed light on the evolution of these signal abnormalities.

One question that remains in suspense is that of plasty vascularization. The Bosworth technique consists in turning down a plasty that remains pediculated so as to conserve vascularization. The distribution of Achilles tendon vascularization, however, is extremely controversial [21], most authors considering the mid-third, which is the usual rupture area, to be the least vascularized. This deficient vascularization is aggravated if the tendon undergoes torsion [21], which may twist the plasty through as much as 180°. Although vascular supply is possible with small plasties, what really is the situation for longer ones? The present good clinical results and encouraging findings on control MRI led us to abandon the Bosworth technique and adopt free plasty as technique of choice.

Conclusion

Chronic Achilles tendon rupture raises an issue of treatment. A free triceps aponeurosis flap spares the foot and ankle muscles and can repair loss of substance of varying size, including extensive defects. Not turning down the graft avoids the volume effect, which may reduce cutaneous risk. The good functional results derive from restoring tendon volume and length, ensuring propulsive force. Complications seem to correlate with age, and authors recommend great caution in patients aged over 65 years. Intra-tendon abnormalities on postoperative MRI are frequent and may be interpreted as cicatricial remodeling without impact on the final functional result. These findings should be pursued in a longer-term MRI and isokinetic study.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References