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Surgical repair of symptomatic chronic achilles tendon rupture using synthetic graft augmentation

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ABSTRACT

Background: Surgical repair of symptomatic chronic Achilles tendon (TA) rupture is a challenging problem due to the presence of a large defect between tendon edges. We report the results of surgical repair of symptomatic chronic TA rupture by synthetic graft augmentation.
Methods: Seven consecutive patients with a symptomatic chronic TA rupture underwent surgical repair by VY plasty and augmentation with bio-absorbable synthetic graft (Artelon®). In all patients, the intraoperative tendon gap after debridement was more than 5 cm (Myerson Grade 3). The total duration of plaster immobilization was 10 weeks. The complications were recorded prospectively and functional outcome was assessed by AOFAS score and Achilles tendon Total Rupture Score (ATRS).
Results: At a mean follow up of 29 months there was no re-rupture or deep infection. All patients reported good functional outcome as shown by AOFAS and ATRS scores. There were no graft related complications. At final follow up, six patients were able to do single stance heel raise however, calf wasting was noted in all patients.
Conclusions: Tendon repair augmented by absorbable synthetic graft is an acceptable technique in Myerson Grade 3 chronic symptomatic TA ruptures.
Level of evidence: Level IV, Case series.

1. Introduction

TA rupture is the commonest tendon rupture in lower limb with an increasing incidence [1,2]. Up to 24% of these injuries are either neglected ruptures or misdiagnosed on acute presentation [3]. An untreated rupture older than 4 weeks is generally considered as chronic or neglected rupture [4]. Patients with chronic TA rupture report diminution of function often with ankle instability and gait abnormality [5]. Chronic rupture in low demand patients is often treated conservatively, but a symptomatic chronic TA rupture with functional deficit is best treated by surgical repair [1,4,6]. End to end surgical repair can usually be performed for chronic TA rupture, where tendon edge defect is 2 cm or less [7]. It is widely agreed that in presence of a larger size gap, surgical repair is likely to require a sliding tendinous flap along with graft augmentation [7,8]. In these cases autografts, allografts and xenografts have all been tried typically with lengthening procedures [9–11]. A synthetic tendon graft, in comparison, provides a sustained source of graft with simplicity of surgical technique, as graft harvesting is not required.

The purpose of this study is to report the functional outcomes and complications in a series of symptomatic chronic TA ruptures surgically repaired using synthetic tendon graft augmentation. We used Artelon®(Artimplant, V. Frölunda, Sweden) synthetic graft which is made of bioabsorbable urethane urea which acts as a biological scaffold [12]. Artelon® synthetic graft is approved by CE and FDA for soft tissue enforcement including TA repairs.

2. Methods

2.1. Patients

Between 2012 and 2013, we surgically treated seven consecutive patients with symptomatic chronic TA rupture by VY plasty combined with synthetic tendon graft augmentation (Artelon®). All Patients included in this pilot study had preoperative confirmation of diagnosis using an Ultrasound or MRI scan (Table 1). Preoperative function was assessed using AOFAS score. Two patients developed chronic symptomatic TA ruptures following re-ruptures after initial conservative management for

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Table 1
Patients.

Pt	Age	Sex	Occupation	Mechanism	Chronicity[a]	Gap[b]	Imaging	Notes
1	36	F	Teacher	Netball	12 weeks	6 cm	MRI/USS	Re-rupture following previous conservative management
2	48	M	Lecturer	Fall	24 weeks	6 cm	MRI	IDDM, smoker
3	56	F	Nurse	Squash	6 weeks	6 cm	MRI	Pre-existing Tendinopathy on MRI
4	52	F	Retail	Slipped	12 weeks	6 cm	MRI	BMI 38
5	38	M	Office	Running	22 weeks	6 cm	MRI	Re-rupture following previous conservative management, smoker
6	66	M	Retired	Slipped	17 weeks	7 cm	USS	Missed injury
7	56	F	Office	Running	12 weeks	7 cm	USS	Missed injury, smoker
	50				15	6.2		

[a] Time interval between date of rupture and the date of surgery.
[b] Intraoperative gap between two tendon edges after debridement of scar tissue.

acute TA rupture. Remaining five patients had neglected or missed injuries. In the study group, six patients were in full time employment and actively participated in sports prior to TA rupture. One patient was retired and not involved in sporting activities prior to the TA rupture.

We used Myerson classification to assess these chronic TA ruptures [7]. In this series, the average intraoperative tendon edge gap after debridement was 6.2 (range, 6–7) cm and hence classified as Grade 3 ruptures. At final follow up a detailed clinical assessment was performed along with functional outcome assessment. As per our current practice, we assessed function using American Orthopaedic Foot and Ankle Society (AOFAS) score and Achilles Tendon Total Rupture Score (ATRS). ATRS is a validated score for measuring outcome after TA rupture [13].The patients were also asked to score Visual analogue scale (VAS) for pain and function.

2.2. Surgical technique

Senior author performed all surgeries. A single postero-medial incision was used to expose ruptured TA with patient in prone position. The tissue at the tendon edges was freshened while preserving the vascular fibrous stump. The gap between tendo-nedges was measured (Fig. 1). The gap was closed with tendon mobilization and proximal VY plasty with ankle in maximal planter flexion (Fig. 2). Tendon was repaired with number 2 Ethibond® using Krakow suture technique. In All cases, end-to-end repair was deemed unsatisfactory due to poor quality tissues that were maximally mobilized in order to close the gap. The tendon repair site was reinforced by synthetic tendon graft (Fig. 3). Two narrow strips, each measuring 4 cm × 0.5 cm were used to augment medial and lateral aspects of the tendon repair. The graft was sutured to the tendon substance using number 2 Ethibond® and Krakow suture technique. Paratenon was closed as a separate layer using a 2-0 Vicryl® and skin closed with 3-0 Ethilon® interrupted mattress sutures. Plaster of Paris backslab was applied with the foot in full plantar flexion. Wound check was performed at 2 weeks and backslab was re applied in reduced plantar flexion. At 4 weeks, skin sutures were removed and below knee fiberglass cast applied with ankle in neutral position. Patients were allowed full weightbearing at 4 weeks in fiberglass focus rigidity cast (FRC) with two crutches.

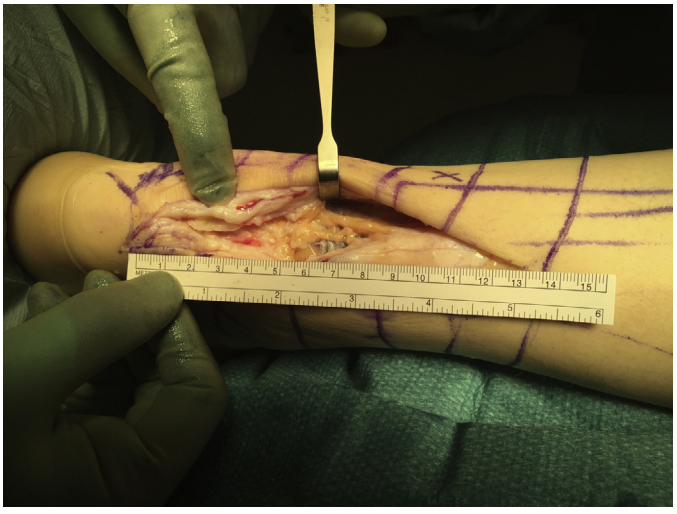

Fig. 1. Gap between tendon edges after debridement.

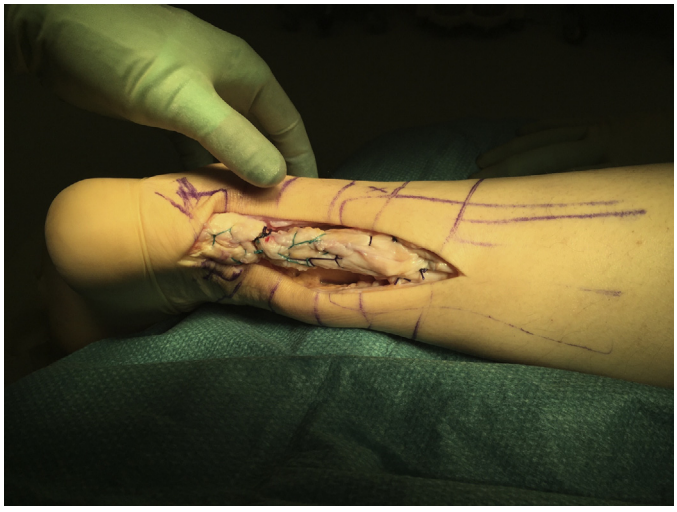

Fig. 2. Core suture and VY plasty.

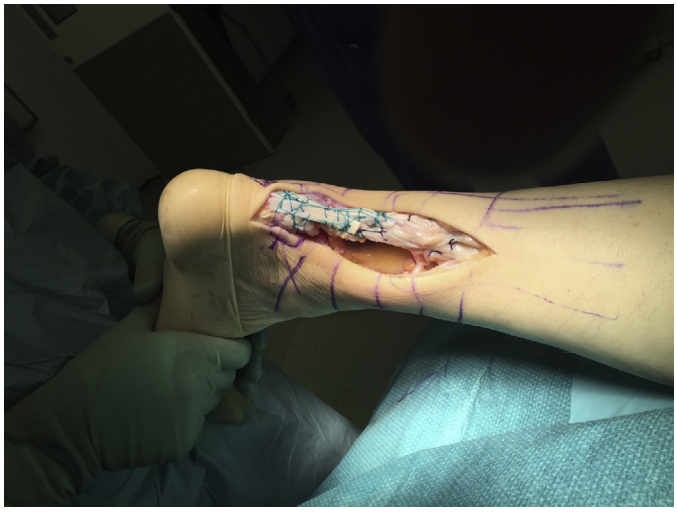

Fig. 3. Repair augmentation using synthetic graft.

The cast was removed at 10 weeks and patients were allowed to mobilize in their own footwear with 1 cm heel raise and referred to physiotherapy. As per hospital protocol, low molecular weight heparin was given to all patients post operatively for the duration of plaster immobilization.

3. Results

3.1. Physical assessment

This study has a mean follow up of 29 (range, 24–36) months. Satisfactory surgical scars were noted with an average length of 13.5 (range, 12–15) cm. There were no visible or palpable gaps over TA in any patient. Calf wasting was noted in all patients as compared to the contralateral side. The maximum calf diameter difference was less then 2 cm in all patients in comparison to the uninjured side. Calf squeeze test for TA insufficiency was negative in all patients. The range of motion of the ankle joint was clinically assessed and compared with the contralateral side with no significant difference noticed. Two patients had objective numbness in sural nerve territory but without any paraesthesia or scar sensitivity. Six patients were able to do a sustained single stance heel raise.

3.2. Functional Outcome

The preoperative AOFAS score improved from an average 59 to 91 ($p = 0.018$, Wilcoxon Signed Rank Test, SPSS 20). The mean Achilles Tendon Total Rupture Score (ATRS) at the final follow up was 92 out of 100 (Table 2). Preoperative ATRS was not available for these patients as this score was not in clinical use at our unit at the time. VAS for pain was zero in all patients (0 = no pain and 10 = Worse pain). VAS for function reported good outcome with an average of 8 out of 10 (0 = poor function and 10 = Normal pre injury function). On final follow up all patients had returned to satisfactory daily functional activity. Four out of six patients returned to sports and other leisure activities. All patients who were in employment prior to surgery returned successfully to work. Average time off work was 14 (range, 9–24) weeks.

3.3. Complications

At the final follow up there were no reported re-ruptures, deep infection or graft rejection. One patient had superficial postoperative infection that resolved with a single course of oral antibiotic. Wound healing was satisfactory in all patients at 4 weeks. Two patients reported postoperative numbness in the sural nerve territory. One patient developed a sensitive scar with paraesthesia that settled by 12 months after surgery. Two patients reported occasional cramps in calf muscles on the operated side that persisted at final follow up. Both these patients however reported excellent functional outcome and these cramps did not affect their function or quality of life.

4. Discussion

There is a wide variation in surgical techniques and graft utilization for chronic TA rupture repair [4,6]. Technical difficulty arises after tendon debridement where the surgeon is left with a significant gap and poor quality tissue at the rupture site. In this situation various autografts, allografts, xenografts and synthetic grafts have been tried to augment the repair [1,6,14–17]. A US survey study showed that most surgeons prefer to treat large gap chronic TA rupture by Flexor Hallucis Longus (FHL) tendon transfer combined with VY plasty [18]. Flexor digitorum longus [14] and Peroneus brevis [1] autografts have also been used for repair of chronic TA ruptures with good clinical outcome. FHL autograft has been considered a good choice by some as it can be harvested by single incision technique and is a strong plantar flexor of the ankle joint with similar axis of contraction as TA [15]. A variable extent of donor site morbidity has been reported with use of autografts in the form of decrease in range of movement and muscle strength in the affected joints [7,15,19]. Allograft and Xenograft have also been tried successfully for chronic TA rupture repair [16]. Synthetic grafts like Carbon Fiber [17], Marlex Mesh [20] and Dacron [21] have been used in the past with good clinical outcome but lacked biodegradation and remodeling. There is some concern regarding use of synthetic tendon material as it can result in higher rate of infection [22] and graft material related foreign body reaction [23]. Artelon® synthetic graft acts as a degradable bioscaffold that allows tissue ingrowth and provides mechanical support to the repaired tissue [12,24].

We feel that use of synthetic graft augmentation in our series of patients allowed for simplicity of the surgical technique with minimal tissue handling and without the requirement of a graft harvesting procedure. A cadaveric study found significant improvement in load to failure when Artelon® reinforced repair of TA was compared to suture only repair [24]. This cadaveric study used larger tubular Artelon® grafts while we used two 0.5 cm × 4 cm Artelon® strips. Larger tubular graft can provide more mechanical strength but can also enhance the theoretical risk of graft related immune reaction. Calf wasting has been reported after chronic TA rupture repair [11]. All patients in our series had calf wasting of less than 2 cm as compared to the contralateral side. Wasting could be related to the original injury or due to the use of immobilization devices such as a walker boot or a walking Focus Rigidity Cast (FRC). Following the augmented tendon repair, weight bearing was commenced at 4 weeks. We felt that an initial period of non-weightbearing immobilization was essential for wound healing and to protect the repair. Preservation of vascular fibrous scar at the tendon stump and its inclusion in the repair also contributes to improved mechanical strength [15]. We used Ethibond as core

Table 2
Functional outcome.

Patient	Follow up duration	Time off-work	Return to sports	Return to pre injury function	Single stance heel raise	Pre OP AOFAS	Post OP AOFAS	VAS for pain	VAS for function	Post OP ATRS
1	36 months	24 weeks	Yes	Yes	Yes	31	67	0	7	79
2	36 months	12 weeks	No	Yes	Yes	65	97	0	8	100
3	30 months	14 weeks	Yes	Yes	Yes	64	97	0	9	97
4	30 months	10 weeks	No	Yes	No	73	90	0	7	83
5	26 months	9 weeks	Yes	Yes	Yes	64	90	0	8	92
6	24 months	Retired	n/a	Yes	Yes	54	100	0	9	97
7	24 months	16 weeks	Yes	Yes	Yes	65	100	0	8	97
Mean	29.42	14.16				59.42	91.5	0	8	92.14

suture and also for securing synthetic graft to the tendon. We felt that it was important to use a non-absorbable suture to secure synthetic graft to the tendon as the synthetic graft resorbs in 6 years [12].

Two patients had postoperative numbness in sural nerve territory. The senior author has now modified surgical technique to routinely locate and mobilise sural nerve during proximal exposure to avoid this complication. The outcome scores and functional assessment of these patients at final follow-up confirms satisfactory outcome. Synthetic graft also avoids donor site morbidity and there is no risk of transferable diseases that are associated with allografts and Xenografts. Our study has shown satisfactory clinical outcome with use of synthetic graft in absence of graft related morbidity.

Limitations of this series include, small number of patients andan absence of a comparison group. We have used AOFAS score, which is widely used to assess outcome for various foot and ankle disorders [25] but it is not validated for TA rupture outcome. AOFAS score is based on pain, deformity and range of motion questions, which may not truly reflect functional deficit in chronic TA rupture patients. Our study is also limited by the lack of preoperative ATRS which was recently introduced and validated [13] but not used at our center when these patients were assessed preoperatively. However, ATRS outcome scores from this study could provide future studies with a cohort for comparison. According to manufacturer's data, Artelon® synthetic graft integrates with body by 6 years [12], hence longer follow up study is required to predict the ultimate fate of synthetic graft in vivo. The cost of synthetic tendon implant could also be a limiting factor to its use in some centers. The overall cost comparison of use of synthetic graft with other techniques is not available at present.

5. Conclusion

Chronic TA ruptures with a gap of more than 5 cm can be surgically treated by VY plasty combined with Artelon® Synthetic graft augmentation. This repair provided satisfactory clinical outcome with no significant graft related complications in this case series. A larger prospective and controlled study is required with longer follow up comparing currently accepted techniques with a repair using absorbable synthetic graft.

Conflicts of interests

None of the authors of this article have any financial or personal relationships with other people or organizations that could inappropriately influence this work.

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