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V-Y Myotendinous advancement augmented with peroneus brevis transfer for management of chronic massive Achilles tendon rupture

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Abstract

Background: Chronic tears of the Achilles tendon can result in substantial loss of function, and are often challenging to repair because of muscle and tendon atrophy, retraction and short distal stump.

Methods: Over 24 months follow up, 11 patients with chronic Achilles tendon rupture with a gap length more the 6 cm were treated by V-Y advancement Myotendinous flab augmented with peroneus brevis tendon transfer.

Results: No patient showed re-rupture in the follow up period, the median time for partial weight bearing was 6.7 weeks (ranging from 6-9 weeks). While the median time for full weight bearing was 11.09 weeks (ranging from 10 to 15 weeks). The American Orthopedic Foot and Ankle society (AOFAS) score increased from 53.18 to 90.27, while the the Achilles Tendon Total Rupture Score (ATRS) improved from 26.27 to 84.9. While the pre-injury Tegner activity level score was 4.9 (ranging from 3-6) decreased to 4.6 (ranging from 3-6) 2 years post-operatively.

Conclusions: V-Y Myotendinous advancement augmented with peroneusbrevis transfer is an effective method for management of chronic Achilles tendon rupture with gap length more than 6 cm.

Keywords: Myotendinous, Peroneus Brevis, Achilles, tendon rupture

Introduction

Achilles tendon ruptures are the most common tendon ruptures of the lower limbs and accounts up to 40% of all operated tendon ruptures^[1]. The increase in frequency is thought to be due to an increased interest and participation in recreational sports by middle- aged and older patients and also to better reporting^[2].

Patients with Achilles tendon ruptures are often unable to stand on the toes of the involved side, however, active plantar flexion maybe intact due to partial ruptures, recruitment of plantar flexors, and an intact Plantaris muscle. The lack of pain and no obvious loss of Plantar flexion can be misleading and up to 20-25% of cases the diagnosis is missed initially^[3]. The failure to establish the diagnosis at the initial presentation is the most common reason for delayed treatment.

There is no consensus regarding the specific interval in which an acute rupture becomes a neglected one, however 4 weeks may be the most widely accepted interval^[4].

In chronic or neglected ruptures of the Achilles tendon, the tendon sheath becomes thickened and adherent to the retracted ends of the tendon^[5, 6]. Retraction of the proximal stump produces shortening of the proximal isometric plantar flexor strength of the Gastrocnemius-soleus complex causing weakness of plantar flexion of the ankle and a flatfoot gait without adequate push-off^[1, 7-10]. In chronic injuries, the tendon ends may be thin and atrophic. When surgical interference is planned, augmentation is usually required, tendon grafts, a turn- down flap, a transfer of local tendons, and synthetic materials have all been used for reconstruction^[11-13], with no evidence that one is clearly superior to another^[14].

In our study V-Y Myotendinous advancement flab augmented by peroneus brevis tendon transfer was performed to chronic Achilles tendon ruptures with gap length more than 6 cm. and we reported excellent results within 2 years of follow up.

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Patients and methods

From May 2012 to February 2014, eleven patients composed of 10 male and 1 female were operated for chronic Achilles tendon rupture. Patients' average age was 40.9 years ranging from 28-51 years, 2 patients were diabetic requiring internal medicine consultation and preoperative admission for 2 days for adjusting the blood glucose level. Seven patients had sports acquired injury (5 during playing football and 2 during playing volleyball) while 3 patients had their injury at work and one patient had a domestic injury at home. Moreover, 3 patients reported a history of Achilles Tendinopathy before rupture with one patient received corticosteroid local injection 4 months before rupture. Nine patients seek medical advice after injury and the diagnosis wasn't set in 2 patients and 7 patients were advised to rest and have physical therapy sessions. Furthermore, 2 patients didn't seek medical advice after injury.

Table 1: demographic data of the patients

Number of patients	11
Mean age	40.9 years (range from 28-51)
Gender	10 males, 1 female
Mean time between injury and surgery	5.4 months (range from 4-7 months)

The average interval between the initial trauma and surgical interference was 5.4 months ranging from (4-7 months). All patients were complaining of posterior ankle pain, limping, difficulty in climbing stairs, physical examination revealed a visible and palpable gap at the affected side in all patients (Figure 1). Achilles tendon Intergity test" Thompson test" was positive. All patients can't perform a tip toe stance. Meanwhile, gait observation, calf circumference was measured 10 cm distal to the tibial tubercle and compared to the contralateral side. The American Orthopedic Foot and Ankle society (AOFAS) and the Achilles Tendon Total Rupture Score were determined by means of questionnaire and physical examination. Also, ankle plain X-ray were done in all cases to rule out other diagnoses such as Calcaneal avulsions or other osseous injuries. Calcifications in the distal stump of the Achilles tendon were seen in 2 patients. In

addition, ankle MRI were done for all cases. As a result, ruptures were seen as an area of low signal intensity on T1-weighted images and as discontinuity and altered signal on T2-weighted scans. The gap between distal and proximal stumps was measured average was 3.5 cm ranging from 2cm to 5 cm.

Surgical Technique

The procedure was done under spinal anesthesia in 10 patients and general anesthesia in one patient. The patients were positioned prone on well-padded chest rolls. Both extremities are prepared and exposed to a level above the knee for surgery. This is to allow for tendon length and tension comparison between the operated and the normal limb. Both feet were dangling from the end of the operating table, the involved leg was exsanguinate by elevation for four minutes and the tourniquet on the thigh of the injured limb was inflated to 100 mm Hg above the patient systolic pressure 5 minutes after the administration of third-generation cephalosporin.

An extensile posterior Lazy S incision over the calf is required for the procedure. The initial incision is made distally at the rupture level, placed medial to the Achilles tendon to avoid potential sural nerve injury. Once the diagnosis and rupture gap is confirmed, the incision is extended proximally along the posterior midline of the calf and extended to the Myotendinous junction. Extensive care should be taken to identify and protect the Sural nerve as it crosses from lateral to central in the mid-calf area. The nerve is usually found with the lesser saphenous vein, which aids in its identification.

The paratenon, if not disrupted, was incised longitudinally in the midline for the length of the skin incision. The Achilles tendon thus, was exposed, and dissection was performed to release the tendon from adhesion and fibrosis (Figure 2).

After which, the ruptured tendon ends are freshened to macroscopically healthy tissue (Figure 3) and the gap between the proximal and distal ends of the tendon was measured and recorded. The average gap length was 7.2 cm ranging from 6 cm to 9 cm (Figure 5). The Plantaris tendon was intact in 3 cases and was used in the final repair (Figure 3).



Fig 1: A visible and palpable gap at the site of rupture.



Fig 2: Atrophic retracted proximal end with cut plantaris tendon.



Fig 3: Another case of Achilles tendon tear with intact plantaris tendon.



Fig 4: Debridement of the end till reaching a macroscopic healthy tendon and harvesting plantaris tendon.



Fig 5: Measuring a gap of 8.4 cm and application of sutures to the proximal end.



Fig 6: V-Y advancement with gentle pulling of the proximal tendon

A heavy braided non-absorbable suture (No. 5 Ethibond, Ethicon-J & J, Piscataway, NJ) is then sutured into the ends of the ruptured tendon using a locking Krakow technique with five locked loops on each of the medial and lateral sides, with the suture ends exiting out of the ends of the rupture stump. An inverted V incision is made within the Myotendinous portion of the Gastrosoleus-Achilles mechanism, with the apex of the V placed midline at the most proximal portion of the Myotendinous junction (Figure 6). The limbs of the V diverge to exit through the medial and lateral borders of the tendon. The V is then incised through

the tendinous portion (superficial) only, leaving the underlying muscle fibers intact.

The suture is then used to apply longitudinal traction to the proximal tendon stump, while gently teasing the muscle fibers longitudinally, allowing the Myotendinous junction to slide distally. It should be done with great patience and care not to detach the tendon from the underlying muscle, which would de-vascularize the tendon, This step is continued until the tendon ends are approximated. The stump sutures are tied together and the V incision is repaired using non-absorbable suture creating an inverted Y repair (Figure 7).



Fig 7: closing the V into Y and suturing both ends of the tendon.



Fig 8: Harvesting the peroneus brevis through a small incision over the base of the 5th metatarsal.



Fig 9: Delivering the peroneus brevis tendon to the proximal wound.



Fig 10: Passing the peroneus brevis tendon through the repaired Achilles tendon and suturing it to itself.



Fig 11: The intact plantaris tendon was fanned and used to cover the repair site.



Fig 12: Patient standing on tip toes 8 weeks post-operative.

The distal portion of the tendon of the peroneus brevis was exposed through a 1.5cm longitudinal incision starting from the lateral aspect of the base of the fifth metatarsal. A stay suture was applied at the distal end of the tendon (Figure 8), which was then detached from the base of the fifth metatarsal. Next, the distal portion of the peroneus brevis muscle belly was exposed by accessing the peroneal compartment through a small (Figure 9), longitudinal incision in the lateral aspect of the floor of the Achilles tendon compartment. By applying gentle traction, the distal part of the Peroneus brevis tendon is delivered to the proximal main wound.

Using a hemostat, the distal end of the tendon was passed through the substance of the distal stump of the Achilles tendon in a lateral-to-medial direction. The distal end of the tendon was then pulled proximally and through the substance of the proximal stump of the Achilles tendon in a medial-to-lateral direction. The Peroneus brevis tendon was sutured to the Achilles tendon at each entry and exit point with use of No. 2 Vicryl sutures (Ethicon, Johnson & Johnson). Sutures that secured the Musculo-tendinous junction of the peroneus brevis to the adjacent area of the Achilles tendon were added. Finally, interrupted sutures were placed across the gap approximating the two parts of the Peroneus brevis tendon (Figure 10).

For the 3 patients with intact plantar tendon, the plantaris tendon was severed and fanned to cover the repair site (Figure 11). Tourniquet was deflated and hemostasis was obtained. Interrupted 2-0 Vicryl re-absorbable sutures were used for the subcutaneous fat, and the skin was closed with interrupted mattress sutures over No. 12 suction drain. The wound was dressed, a below-the-knee cast was applied with the patient prone, and the foot was placed in gravity equinus. Patient was turned supine and the cast was completed to above knee cast with the knee flexed to 30 degrees. A window opening was made at the third day to inspect the wound, drain removal and the skin sutures were removed two to three weeks postoperatively.

Post operative care

Patients were told to keep the limb elevated as much as

possible for the first two postoperative weeks. The cast was changed at the third week to below knee cast with the ankle positioned plantigrade, the cast was removed six weeks after the operation. After removal of the cast, patients were allowed to mobilize the ankle with physiotherapy guidance. They were allowed to partially bear weight and then commenced gradual stretching and strengthening exercises, gradually proceeding to full weight-bearing eight to ten weeks after surgery. Patients were encouraged to increase the frequency of their self-administered exercise program and were allowed to return to their primary sports activities by the sixth postoperative month.

Results

The median time for partial weight bearing was 6.7 weeks (ranging from 6-9 weeks). While the median time for full weight bearing was 11.09 weeks (ranging from 10 to 15 weeks).

Six patients were to able to return to their pre-injury sport activity, median time for return to pre-injury sport activity was 7 months (ranging from 6-8 months), the other 5 patients didn't had pre-injury sport activity and were able to return to their pre-injury activity level within the same period.

The American Orthopedic Foot and Ankle society (AOFAS) score increased from 53.18 (range from 27-64) to 90.27 (range from 86-97), while the the Achilles Tendon Total Rupture Score (ATRS) improved from 26.27 (range from 19-31) to 84.9 (ranging from 73-91). While the pre-injury Tegner activity level score was 4.9 (ranging from 3-6) decreased to 4.6 (ranging from 3-6) 2 years post-operatively. The mean calf circumference of the operated side measured 10 cm from the tibial tuberosity was 40.5 cm (ranging from 37-44cm) compared with the non-operated side 41.9cm (ranging from 38.5-47cm). (Table 2)

No patient showed re-rupture in the follow up period, however two patients developed superficial wound infection, both patients were diabetic and were managed with oral antibiotics and settled down without operative intervention. One patient developed persistent numbness along the distribution of the sural nerve.

Table 2: Dataset and results

Patient	Age (Y)	intraoperative gap length (cm)	Partial weight bearing (week)	Full weightbearing (week)	Contralateral calf circumference (cm)	Ipsilateral calf circumference	AOFAS score preop.	AOFAS score postop	ATRS preop.	ATRS postop.
1	44	8	7	11	43	40	59	89	25	86
2	34	6	7	10	47.5	43	48	89	30	90
3	38	7.6	6	12	40	40	64	90	26	91
4	42	6	6	10	40	39.6	52	97	31	86
5	51	9	8	13	42	40	57	89	26	86
6	33	8.4	9	15	38.5	37	27	86	19	75
7	28	6	6	10	40	42	61	96	26	84
8	44	7	6	10	46	44	55	90	18	73
9	47	7.2	7	11	41	40.4	39	89	31	90
10	45	8	6	10	39.5	39	64	89	30	86
11	44	7	6	10	43.4	41	59	89	27	87
Mean	40.9	7.2cm	6.7	11.09	41.9	40.5	53.18	90.27	26.27	84.9

Discussion

Management of chronic Achilles tendon ruptures is challenging. The ends of the tendon are frequently retracted and have an atrophic appearance.

To our knowledge, there are no evidence-based guidelines for choosing the type of operative management of chronic ruptures of the Achilles tendon. However, Myerson [15] classified chronic Achilles tendon into three types; Type-1

defect is no more than 1 to 2 cm long and can be managed with end-to-end repair and a posterior compartment fasciotomy. Type-2 defect ranges between 2 and 5 cm. It is managed with V-Y lengthening, with or without a tendon transfer. A Type-3 defect is >5 cm and is bridged by the use of a tendon transfer, alone or in combination with a V-Y advancement [16].

The use of peroneus brevistendonfor Achilles tendon rupture

was first popularized by Perez Teuffer^[17]. The tendon was passed through a trans-osseous drill hole in the calcaneus. The tendon was then passed back on itself and sutured over the Achilles tendon.

Turco and Spinella^[18] augmented an end-to-end repair of the Achilles tendon with a modification of Perez Teuffer's technique, by passing the tendon of the Peroneus brevis through the distal stump rather than through the calcaneus. Excellent results were reported. Miskulin *et al.*^[19] also passed Peroneus brevis through the distal Achilles tendon stump and used Plantaris tendon as suture material. In their series of five patients, all patients had an improvement in peak plantar flexion torque (range, 21% to 41%) and no complications were reported at one year after the operation.

V-Y tendon advancement was first described by Abraham and Pankovich^[20] for the treatment of chronic Achilles tendon ruptures. Leitner *et al.*^[21] reported good results in three patients in whom a tendon defect of 9 to 10 cm had been managed with this technique. Kissel *et al.*^[22] used this technique, with augmentation with the Plantaris tendon and a pullout suture, successfully in fourteen patients.

Although the harvest of the flexor hallucis longus is more common than peroneus brevis harvesting for management of chronic Achilles tendon rupture. The harvest of flexor hallucis longus carries the risk of impaired push-off strength after the procedure, which could be problematic for athletic and young people^[23-25], although there is also loss of the active interdigital planter flexion of the hallux and this usually had no concern to the patient^[26].

The major concerns about the transfer of the tendon of the peroneus brevis are the reduced strength of plantar flexion and the eversion of the ankle^[27]. The peroneal muscles provide only 4% of the total work capacity in plantar flexion, and the peroneus brevis provides 28% of the eversion capacity of the hindfoot^[28].

This study used a combination of V-Y advancement and Peroneus brevis augmentation for management of chronic Achilles rupture with a gap defect more than 6 cm, over a follow up period of 24 months we reported no re-rupture and improvement of the overall Achilles tendon total rupture score from 26.27 to 84.9 and improvement of AOFAS score from 53.18 to 90.27.

Our results are comparable to similar procedures for chronic Achilles tendon rupture; Maffulli *et al.*^[29] used Peroneus brevis transfer for reconstruction of chronic Achilles tendon rupture and reported a post operative Achilles tendon total rupture score of 89.5, Elias *et al.*^[30] combines V-Y advancement technique augmented with FHL tendon transfer their post operative AOFAS score was 94.1. Ibrahim SA^[31] used Ligament Advanced Reinforcement System (LARS) graft which is made of terephthalic polyethylene (polyester) fibers and reported a post operative AOFAS score of 85.86.

In this study patients were able to return to their pre-injury level of sport activity and work within 7 months (28 weeks) postoperatively. Saxena and Cheung^[32] described 5 patients treated with turn-down flaps with and without flexor hallucis longus tendon reinforcement, and described a return-to-activity duration of 34 weeks. Porter *et al.*^[27] In a series of 11 patients treated with freshening of the fibrous scar, reported an average time to return to sports activity of 20 to 32 months while the series described by Lee DK^[33] the return-to-activity time ranged from 15.2 to 17 weeks, which was less than that recorded in this series. this can be attributed to the use of an acellular human dermal matrix to augment the repair.

In regard to re-rupture of the Achilles tendon after surgical

reconstruction, we reported no evidence of re-rupture during the follow up period however in other literatures re-rupture rates as low as 1.4% and as high as 17% have been reported^[32].

The main limitation of our series is the small number of patients included and the short follow up period. A long term follow up period may be required for further evaluation of this technique

Conclusion

The use of V-Y advancement with Peroneus brevis augmentation is an effective method for management of chronic Achilles tendon rupture with a gap of more than 6cm. Without scarifying a strong ankle planter flexor that may affect the push off strength. The patient should be warned that wasting of the calf is not likely to recover fully. Nevertheless, satisfaction and function in these patients remained high.

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