



Reconstruction of chronic achilles tendon ruptures in elderly patients, with vascularized flexor hallucis longus tendon transfer using single incision technique

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The purpose is to report the outcome following reconstruction of neglected Achilles tendon ruptures in elderly patients with Flexor hallucis longus tendon (FHL) biotenodesis.

Seventeen cases (mean age 65.7 years), of Achilles tendon reconstruction with FHL biotenodesis for chronic ruptures were reviewed. Outcomes evaluated with American orthopaedic foot and ankle score (AOFAS), calf girth atrophy, range of ankle movement, ability to perform single leg heel raise and patient satisfaction.

The mean follow up was 27 months (range 17-52). The mean AOFAS score improved from 57.47 (+/- 5.98) to 96.71(+/-3.57). Mean calf girth atrophy was 1.53 (+/- 0.43) cm on the operated side. There was no significant difference in the range of ankle movement. All except one patient were able to perform single leg heel raise. We observed an inverse relation for patient age and chronicity of tear to the endurance strength of Achilles tendon. All the patients were satisfied with the outcome. We had one complication of superficial wound infection.

Single incision FHL biotenodesis is a safe and effective procedure for this complex condition. It mitigates the need for extensive soft tissue procedures like turn down flaps or V-Y plasty.

Keywords : Achilles tendon ; chronic rupture ; Flexor hallucis longus.

INTRODUCTION

The Achilles tendon is the most commonly injured tendon with an incidence of 13.4 per 100.000 adults in the European population (10). Chronic Achilles tendon ruptures are those with a delay of at least 4 weeks following injury (11) and in large proportion of cases it is due to delay in the diagnosis (3,17). This condition is disabling with pain, weak ankle plantar flexion and altered gait mechanics (18,19). Though most surgeons agree that surgical management of this condition gets better outcome, it has always been a challenge with higher complications and poor outcome. There are two classification systems recommending tendon transfers as the treatment of choice if the defect is more than 5cm (9,16). Autologous tendon transfer using Peroneus brevis was popularized by Teuffer

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(24), Flexor digitorum longus (FDL) augmentation was described by Mann (13) and Flexor hallucis longus tendon transfer was first described by Wapner (27). Other procedures like V-Y advancement or turn down flaps of gastrocnemius have also been described with satisfactory outcome. Free tissue transfer using allografts and synthetic materials like Dacron mesh graft and carbon fibre composites has also been used for this difficult condition.

On the background of these numerous treatment options, we report the mid-term results of neglected Achilles tendon reconstruction in the elderly population with a single incision technique using vascularized Flexor hallucis longus tendon autograft.

MATERIAL AND METHODS

This study was a retrospective review of cases. Sixteen patients (one patient had bilateral chronic tear) over the age of 50 who presented with a delayed diagnosis (> 6 weeks) of Achilles tendon rupture, from January 2005 to May 2010 and who had the FHL biotenisodesis procedure, were identified and reviewed. All operations were performed by a single surgeon (RK) and the patients were assessed in dedicated research clinic by author (AP) after getting Ethics approval from the Trust Audit, Research and Development department as well as from the Biomedical Research Ethics Committee (Warwick University, UK).

The primary outcome measure was AOFAS scores. The scores were compared to the pre-operative scores from the case notes, noted at the time of presentation. The secondary outcome measures were: calf muscle atrophy, ankle range of movement and ability to do single leg heel raise as an indicator of the push off strength. In addition, any complications of the procedure were recorded and patient's subjective satisfaction with the procedure and ability to return to pre-injury level of activity was noted.

In all the cases the patients reported a period of prodromal discomfort around the Achilles tendon followed by history of minor trauma. None of the patients had a formal diagnosis of Achilles tendinopathy prior to the injury. None of the cases had any history of use of Fluoroquinolone group of

antibiotics or steroids (topical or systemic). In over half the cases the patients were initially investigated by the general practitioner for suspected deep vein thrombosis resulting in a missed diagnosis. The patients were eventually referred to the hospital with symptoms ranging from pain, weakness in plantar flexion, swelling and gait problems.

The clinical findings included palpable defect in the Achilles tendon, deficient dorsiflexion during gait cycle, inability to perform single leg heel raise, hyper-dorsiflexion of the ankle compared to the other side and positive Thompson's test (25). In our experience excess dorsiflexion on the affected side was a much more reliable test compared to Thompson's test.

All patients had either pre-operative ultrasound or MRI as a part of operative work up and AOFAS scores were recorded. Intra-operative findings noted, that all the tears were located in a range of 3 to 5 cm from insertion on to the calcaneum and the average gap bridged by the pseudo-tendon between the tendon ends was 4 cm. No patient had an insertional tear. One patient had bilateral tears and mean time delay between symptoms and operation was 31.5 weeks (13-65 weeks).

Surgical technique

All procedures were performed under general anaesthesia and a popliteal block with tourniquet control. The average tourniquet time was 55 minutes. The patients were positioned in prone position. A single posteromedial incision was made centred on the palpable defect and extending up to the posterior superior aspect of the calcaneum. Care was taken to raise full thickness flaps. Sural nerve was isolated and protected throughout the procedure. The pseudo-tendon was identified but carefully preserved in all the cases. The rationale behind this was to avoid large defects and extensive gaps post debridement. This pseudo-tendon has been demonstrated to have good bio-mechanical properties to resist substantial tensile forces (30). The Achilles tendon was mobilised and FHL tendon was dissected by incising the deep posterior compartment fascia. The tendon was confirmed by passive great toe movement and presence of muscle tissue extending distally up to tibio-talar

joint. The FHL tendon was divided distally, deep to the flexor retinaculum taking care of the adjoining neuro-vascular bundle. Two whip stitches with fibre wire were passed in the harvested tendon and the tendon was sized in preparation for the fixation into the calcaneum. With the ankle in neutral position the length of FHL tendon needed to be transfixed in to the bone was marked with a marking pen. Appropriate sized tunnel was made with a coring reamer, in the posterior superior aspect of the calcaneum immediately anterior to the insertion of the Achilles tendon directed in superior medial to plantar lateral trajectory. The depth of the tunnel was the same as the length of the tendon to be transfixed into the bone. Once satisfied with the tension, final fixation was achieved with the Arthrex bio-tenodesis screw (Arthrex, Naples, FL) (see figure 1 and 2). The commonest screw size used was 7mm diameter and 23mm length. The proximal part of the FHL muscle tendon unit was sutured to the proximal part of Achilles tendon with interrupted absorbable sutures. The wound was closed in layers, taking particular care to close the paratenon.

A below knee plaster of paris, back slab was applied for 2 weeks with ankle in 10-15° of equinus. All the patients were given chemical thromboprophylaxis. The cast was changed to a weight bearing cast in neutral ankle position at 2 weeks, after wound review. At six weeks, ankle mobilisation was commenced in a removable walking boot splint. At 12 weeks the splint was



Fig. 1. — Harvested FHL tendon being prepared for biotenodesis, intact pseudo-tendon can be seen more superficially in the wound

discarded and patients allowed unrestricted, non-strenuous activity under the supervision of the physiotherapist. The physiotherapy regime consisted of ankle stretches, plantar flexor strengthening, proprioceptive exercises and gait training. The patients were reviewed in the clinic till 12 months post-operatively and were finally assessed in the research clinic by the author (AP).

Data Analysis

Analysis of the results was carried out using SPSS 16.0 program for windows (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used for single parameters. Students paired t tests was used to compare AOFAS scores, calf atrophy and range of ankle movement. A p-value of less than 0.05 was considered significant.

RESULTS

There were 12 male and 4 female patients in the study, one of the female patient had bilateral chronic Achilles tendon rupture. The mean age of the patients was 65.7 years (range 51-82), The mean follow up was 27 months (range 17 to 52 months). The average delay between the presenting symptoms and operation was 31.5 weeks (range 13-65 weeks). The mean pre-operative AOFAS score was 57.47 (SD 5.98, range 46-66). The mean post-operative AOFAS score was 96.71 (SD 3.57, range 93-100). The mean improvement was 39.35. This improvement was very significant ($p < 0.001$).



Fig. 2. — Completed biotenodesis, FHL sutured to the proximal portion of Achilles tendon

All patients except one were able to perform 1 repetition of single leg heel raise. To analyse the endurance strength, ability to perform 5 repetitions of single leg heel raise was reviewed. Interestingly 4 cases (20%) were not able to perform the task. The mean age of these 4 patients was 76.25 years (range 73-82 years) and the mean time delay for their procedure was 51 weeks (range 35-65 weeks).

The mean calf muscle atrophy on the operated side compared to the contralateral side was 1.53 centimetre, this was statistically significant ($p < 0.001$).

The mean ankle plantar flexion on the operated side was 43.82° (range $35-50^\circ$) and on the non-operated side was 44.41° (range $35-50^\circ$). The mean ankle dorsiflexion on the operated side was 13.53° (range $5-10^\circ$) and on the non-operated side was 14.12° (range $10-20^\circ$). This difference in the range of motion was not statistically significant ($p = 0.4$ and $p = 0.33$ respectively).

All the patients but two, reported to have gone back to pre-injury level of activities. Of the two case one patient had bilateral ruptures and the other one was an elderly patient in his eighties. Both of them reported some restriction to their activity level.

We noticed a decreased plantar flexion strength in the great toe interphalangeal joint on the operated side, for all the patients. No patient developed great toe hyper extension deformity.

Subjectively all the patients expressed satisfaction with their procedure. We did not encounter any nerve injury or wound problems. One patient had superficial cellulitis around the incision noted at 3 weeks, post-surgery and was successfully managed with oral antibiotic course. There were no re-ruptures in our series.

DISCUSSION

Acute Achilles tendon ruptures can be missed in as many as a quarter of the cases making it a surgical challenge (3). In the elderly age group there are even greater diagnostic and surgical challenges due to preceding symptoms of Achilles tendinitis and poor quality of the tendon tissue. A variety of procedures have been described for neglected Achilles tendon

ruptures. Abraham and Pankovich (1) described the V-Y advancement technique; however it has associated morbidity and limitations to the amount of gap which can be bridged. Turn down flaps first described by Christensen (4), have shown good results but Mulier et al. (15) have reported high complication rate. Free tissue grafts like hamstring tendons and fascia lata have been used, but they have donor site morbidity. These are avascular grafts and carry the associated risks of introducing them in an area with poor vascularity, especially on the background of tendinopathy. Allografts have similar limitations to their use in this cohort of patients. Synthetic grafts have also been used for reconstruction, but have a high complication rate (8), use of carbon fibre composite polymer was also associated with fragmentation and poor collagen production (2). The most commonly used technique for this problem has been of utilizing FDL or Peroneus brevis or FHL tendon and good outcomes have been reported for all (12,13,14,21,29).

The FHL tendon graft has some inherent benefits compared to other tendons. Flexor hallucis longus is the second strongest plantar flexor with a relative strength of 3.6% compared to FDL (2.6%) and peroneus brevis (1.8%), after the gastrocnemius complex (49.1%) (22). The FHL fires in phase with gastrocnemius complex and the axis of contraction is more in line with the Achilles tendon. Anatomically it is in closer proximity to the Achilles tendon and the distal extension of the muscle belly helps in vascularity of the relatively avascular area. The FHL tendon has anatomical variations at its distal portion (20) and hence we feel, it is much more reliably and safely harvested deeper to the flexor retinaculum, avoiding a second incision in the forefoot. This is even more important in elderly age group with associated co-morbidities and poor peripheral perfusion. The intact interdigitations with the FDL distally, preserve the relative power in the great toe and prevents hyperextension deformity. This was observed in all our cases.

The AOFAS score improvement we observed is similar to what has been reported by other studies utilising the FHL tendon transfer (6,12,23,28). However, the operative techniques in these series, either mention of augmentation of the tendon

Table I. — Outcome data of the patients in this series

No.	Age years / Sex	Delay to procedure (weeks)	Follow up in (months)	Pre-op. AOFAS score	Post-op. AOFAS score	Mean calf atrophy	Ability to perform single leg heel raise repetitions	Satisfaction Yes / No	Return to pre injury activity level	Complications
1	51M	21	39	64	100	1.4	Yes	Yes	Yes	
2	75M	35	30	49	90	2.5	No	Yes	Yes	
3	82F	65	28	56	93	2	No	Yes	With restrictions	
4	55M	13	20	60	100	1.7	Yes	Yes	Yes	
5	51M	35	20	66	100	1.5	Yes	Yes	Yes	
6	67M	13	26	58	100	1.8	Yes	Yes	Yes	
7*	73F	61	43	46	93	1.8	No	Yes	With restrictions	
8*	73F	54	52	46	100		Yes	Yes		
9	76M	43	22	58	97	1	Yes	Yes	Yes	Superficial infection
10	75F	43	23	56	93	1.2	No	Yes	Yes	
11	56F	13	17	62	100	1	Yes	Yes	Yes	
12	76M	39	22	56	93	1.6	Yes	Yes	Yes	
13	51M	13	23	60	100	1	Yes	Yes	Yes	
14	58M	24	24	56	95	1	Yes	Yes	Yes	
15	62M	18	24	66	97	1.5	Yes	Yes	Yes	
16	65M	20	20	58	93	2	Yes	Yes	Yes	
17	71M	26	26	60	100	1.5	Yes	Yes	Yes	

* represents single case of bilateral rupture.

transfer with V-Y advancement or turn down flaps, second incision for harvesting the FHL or of debridement of the scar tissue. Our operative technique differs in certain key aspects: we utilised the pseudo-tendon at the rupture site, we have not used any additional form of augmentation and have harvested the FHL tendon through the same incision. This technique is similar to that reported by Wong et al. (29), in their series of 5 patients.

The mean calf atrophy noticed in our series was 1.53 centimetre after a mean follow up of 27 months, this has also been observed in other studies (21,28,29). This is a reflection of limit to the hypertrophy possible in the FHL muscle post transfer (7).

All patients but one demonstrated the ability to perform single leg heel raise; an indicator of push off strength. Four cases (including the aforementioned case) in our series were unable to perform

5 repetitions of single leg heel raise. We found an association for this reduced endurance strength with higher age and time delay to the procedure (76.25 years and 51 weeks compared to 62.40 years and 25.5 weeks for those able to perform the task). Two patients in this group experienced some restrictions compared to the pre-injury status.

In our study there was no statistical difference regards the range of ankle movements. In the study by Elias et al. (6) they reported significant reduction in the range of movement. We believe the observation in our study was due to preservation of pseudo-tendon and avoiding debridement of the scar tissue preventing excess tightness in the repaired Achilles tendon. The results in our series, are similar to those reported by Miskulin et al. (14).

Though decreased great toe flexion strength was observed, in all the patients compared to

the opposite side, it did not cause any functional limitation or hyperextension deformity of the great toe. This is due to the anatomical interdigitations between the FHL and the FDL in the foot. This was also proven by Coull et al. (5) using pedobarography and clinical study.

There were no deep wound complications. Superficial infection developed in one of the cases and was successfully treated with a course of oral antibiotics, with satisfactory outcome. There were no Sural nerve injuries. The reported rates of re-rupture are as high as 5% after surgical reconstruction (26), we did not encounter any re-rupture in our series at mean follow-up period of 27 months. This is possibly, a reflection of elderly patients in this study with lower demands compared to other series with younger patients.

There are certain limitations to this study as well. The number of patients in this series are small and we have specifically reported on patients in the older age group. Despite this, our series is one of the larger studies reporting on this complex problem and the mean follow up period of over 2 years, provides a good estimate of the outcome following this procedure. The experience of this unit has been, of a higher prevalence of neglected Achilles tendon ruptures in the elderly population due to missed diagnosis. In the younger patient group, Achilles tendon injuries generally tend to get managed by an early surgical intervention.

CONCLUSION

FHL tendon transfer by a single incision technique is a safe and reliable procedure. It is ideal for elderly patients with chronic tears on a background of associated co-morbidities and diseased Achilles tendon. It avoids excessive tissue dissection and debridement of the pseudo-tendon, preventing creation of large gaps in a relatively avascular area. It does not affect ankle stability as can occur with Peroneus brevis transfer. It also has inherent bio-mechanical advantages compared to other tendon transfers.

REFERENCES

1. **Abraham E, Pankovich AM.** Neglected rupture of the Achilles tendon. Treatment by V-Y tendinous flap. *J Bone Joint Surg* 1975 ; 57 : 253-5.
2. **Amis AA, Campbell JR, Kempson SA, Miller JH.** Comparison of the structure of neotendons induced by implantation of carbon or polyester fibres. *J Bone J Surg Br* 1984 ; 66 : 131-139.
3. **Ballas MT, Tytko J, Mannarino F.** Commonly missed orthopaedic problems. *Am Fam Physician* 1998 ; 57 : 267-74.
4. **Christensen I.** Rupture of the Achilles tendon; analysis of 57 cases. *Acta Chir Scand* 1953 ; 106 : 50-60.
5. **Coull R, Flavin R, Stevens MM.** Flexor hallucis longus tendon transfer: evaluation of postoperative morbidity. *Foot Ankle Int* 2003 ; 24 : 931-934.
6. **Elias I, Besser M, Nazarian LN, Raikin SM.** Reconstruction for missed or neglected Achilles tendon rupture with V-Y lengthening and flexor hallucis longus tendon transfer through one incision. *Foot Ankle Int* 2007 ; 28 : 1238-1248.
7. **Hahn F, Meyer P, Maiwald C, Zanetti M, Vienne P.** Treatment of chronic Achilles tendinopathy and ruptures with flexor hallucis tendon transfer: clinical outcome and MRI findings. *Foot Ankle Int* 2008 ; 29 : 794-802.
8. **Jennings AG, Sefton GK.** Chronic rupture of tendo Achilles. Long term results of operative management using polyester tape. *J Bone J Surg Br* 2002 ; 84 : 361-3.
9. **Kuwada GT.** Classification of tendon Achilles rupture with consideration of surgical repair techniques. *J Foot Surg* 1990 ; 29 : 361-5.
10. **Levi N.** The incidence of Achilles tendon rupture in Copenhagen. *Injury* 1997 ; 28 : 311-313.
11. **Maffulli N, Ajis A.** Management of chronic ruptures of Achilles tendon. *J Bone J Surg (Am)* 2008 ; 90 : 1348-60.
12. **Mahajan RH, Dalal RB.** Flexor hallucis longus tendon transfer for reconstruction of chronically ruptured Achilles tendons. *J Orthop Surg* 2009 ; 17 : 194-8.
13. **Mann RA, Holmes GB, Seale KS, Collins DN.** Chronic rupture of the Achilles tendon: A new technique of repair. *J Bone Joint Surg (Am)* 1991 ; 73 : 214-219.
14. **Miskulin M, Miskulin A, Klobucar H, Kvalja S.** Neglected rupture of the Achilles tendon treated with peroneus brevis transfer: A functional assessment of 5 cases. *J Foot Ankle Surg* 2005 ; 44 : 49-56.
15. **Mulier T, Pienaar H, Dereymaeker G, Reynders P, Broos P.** The management of chronic Achilles tendon ruptures: gastrocnemius turn-down flap with or without flexor hallucis longus transfer. *Foot Ankle Surg* 2003 ; 9 : 151-156.
16. **Myerson MS.** Achilles tendon ruptures. *Instruct Course Lect* 1999 ; 48 : 219-30.
17. **Nestorson J, Movin T, Moller M, Karlsson J.** Function after Achilles tendon rupture in the elderly: 25 patients older than 65 years followed for 3 years. *Acta Orthop Scand* 2000 ; 71 : 64-8.

18. **Ozaki J, Fujiki J, Sugimoto K, Tamai S, Masuhara K.** Reconstruction of neglected Achilles tendon rupture with Marlex mesh. *Clin Orth Rel Res* 1989 ; 238 : 204-8.
19. **Panchbhavi VK.** Chronic Achilles tendon repair with flexor hallucis longus tendon harvested using a minimally invasive technique. *Tech Foot Ankle Surg* 2007 ; 6 : 123-9.
20. **Pichler W, Tesch NP, Grechenig W, Tanzer K, Grasslobler M.** Anatomical variations of the flexor hallucis longus muscle and the consequences for tendon transfer. A cadaver study. *Surg Radiol Anat* 2005 ; 27 : 227-31.
21. **Pintore E, Barra V, Pintore R, Maffulli N.** Peroneus brevis tendon transfer in neglected tears of the Achilles tendon. *J Trauma* 2001 ; 50 : 71-78.
22. **Silver RL, de la Garza J, Rang M.** The myth of muscle balance: a study of relative strengths and excursions of normal muscles about the foot and ankle. *J Bone J Surg Br* 1985 ; 67 : 432-437.
23. **Tay D, Lin HA, Tan S, Chong KW, Rikhranj IS.** Chronic Achilles tendon rupture treated with two turndown flaps and flexor hallucis longus augmentation – two year clinical outcome. *Annals Academy of Medicine* 2010 ; 39 : 58-60.
24. **Teuffer AP.** Traumatic rupture of the Achilles tendon: reconstruction by transplant and graft using lateral peroneus brevis. *Orthop Clin North Am* 1974 ; 5 : 89-93.
25. **Thompson TC, Doherty JH.** Spontaneous rupture of tendon of Achilles: a new clinical diagnostic test. *J Trauma* 1962 ; 2 : 126-9.
26. **van der Linden-van der Zwang HMJ, Nelissen RGHH, Sintenie JB.** Results of surgical versus non-surgical treatment of Achilles tendon rupture. *Int Orthop* 2004 ; 28 : 370–373.
27. **Wapner KL, Pavlock GS, Hecht PJ, Naselli F, Walther R.** Repair of chronic Achilles tendon rupture with flexor hallucis longus tendon transfer. *Foot Ankle* 1993 ; 14 : 443-9.
28. **Wegrzyn J, Luciani JF, Philippot R et al.** Chronic Achilles tendon rupture reconstruction using a modified flexor hallucis longus transfer. *Internat Orthop* 2010 ; 34 : 1187-1192.
29. **Wong MWN, Ng VWS.** Modified flexor hallucis longus transfer for Achilles insertional rupture in elderly patients. *Clin. Orthop. Relat. Res* 2005 ; 431 : 201-206.
30. **Yasuda A, Kinoshita M, Okuda R.** Reconstruction of chronic Achilles tendon rupture with the use of interposed tissue between the stumps. *Am J Sports Med* 2007 ; 35 : 582-588.