International Journal of Research in Orthopaedics
Nagakiran KV et al. Int J Res Orthop. 2019 Mar;5(2):264-270
http://www.ijoro.org

Original Research Article

DOI: http://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20190493

Flexor hallucis longus vs. peroneus brevis: the better tendon for augmentation surgery in chronic achilles tendon ruptures

K. V. Nagakiran[1]*, Sudeep Madhukar Nambiar[1], Prasad Soraganvi[2], Sameer Wooly[2], H. Balakrishna Gadiyar[3]

[1]Assistant Professor, [2]Associate Professor, [3]Professor, Department of Orthopaedics, PES Institute of Medical Sciences and Research, Kuppam, Chittoor, Andhra Pradesh, India

Received: 17 January 2019
Accepted: 04 February 2019

***Correspondence:**
Dr. K. V. Nagakiran,
E-mail: drnagakiran@gmail.com

ABSTRACT

Background: Chronic degenerative Achilles tendon ruptures are increasing in incidence. Calcific tendonitis, poor vascularity, prior steroid injections, and proximal migration of tendon render conservative management ineffective. Flexor hallucis longus (FHL) and peroneus brevis (PB) have shown promising results with tendon augmentation procedures. The study was done to find out which was a better tendon for augmentation among the two.
Methods: A total of 27 patients underwent tendon augmentation surgeries using FHL (n=14) and PB (n=13) after randomization at PES Institute of medical sciences and research, Kuppam from March 2014 to December 2018. Both the groups had a standard postoperative regimen and rehabilitative protocol. Functional outcome was assessed using AOFAS, Leppilahti score and ATRS scores.
Results: The functional outcome was comparable in both FHL and PB and there was no clear winner in the study.
Conclusions: Predictably good results are seen with tendon augmentation procedures for Achilles tendon rupture. Both FHL and PB are equally good in providing good plantar flexion power needed in achilles tendon rupture.

Keywords: Achilles tendon, Achilles tendon rupture, Tendinopathy, Tendon augmentation surgery, Flexor hallucis longus, Peroneus brevis, Patient reported outcome measure

INTRODUCTION

Achilles tendon is the strongest and most frequently ruptured tendon in the human body. The incidence of Achilles tendon disorders is on a rise. The overall incidence of achilles tendon ruptures (ATR) in the United States is 2.1 per 100,000 person-years; being more common in men (3.5:1).[1] Exact incidence in Indian population is not known. The cause for tendinopathy is multi-factorial. Mechanical overuse in athletes with repetitive microtrauma, advancing age with the poor blood supply in the area, intralesional steroid injections, fluoroquinolone antibiotics have all been implicated in the weakening of tendon, making them more prone for rupture.[2-5] Diabetes and connective tissue disorders like Marfan's, Ehler danlos syndrome, rheumatoid arthritis also play a major role.[6]

Conservative-non operative treatment for achilles tendinitis includes rest, cold packs, supportive insoles, and ultrasonic therapy and shock waves.[7,8] Surgery is indicated in failed conservative therapy. Options include calcaneal osteotomy with debridement of tendon.[9-12]

ATR is considered chronic/neglected when they seek treatment after 6 weeks. End to end surgeries does not work in these cases as there is significant calcific degeneration in the tendon, tendon gap- usually more

than 25 mm.[13] Christensen in 1953 reported a very limited success rate (56%) and slowed healing of chronic ruptures treated with conservative versus surgical intervention.[14] Flexor hallucis longus (FHL), peroneus brevis (PB) and flexor digitorum longus (FDL) have all been used for augmentation in ATR. Qu et al in 2008 retrospectively reviewed 8 patients with FHL transfers demonstrated a 100% success rate and 5 patients with FDL transfers with 80% success rates.[15] Pintore et al reported on 59 patients who received either a PB transfer or an end-to-end repair (for acute ruptures). Although most patients were generally satisfied, they experienced a greater loss of strength and calf circumference.[16] Mafulli et al evaluated 32 peroneus brevis transfers Although all patients were able to perform a single heel-rise test, both calf circumferences as well as the strength of the gastroc/peroneal complex were noted to have diminished significantly.[17,18]

There are conflicting reports in the literature about the choice of the tendon that can be used for augmentation in ATR. There are proponents "for" and "against" both FHL and PB.

The advantages of FHL being it is an (a) in-phase transfer, (b) less dissection needed because of is close proximity (c) axis of contraction of FHL closely resembles tendon Achilles (d) Strong plantar flexor next only to gastrosoleus.[19] The drawback being the loss of some push-off.[20] The pros of peroneus brevis are (a) in-phase transfer (b) no residual eversion weakness as peroneus longus is a stronger everter (c) next only to FHL and gastrosoleus as far as plantar flexor strength goes.[19]

This study was undertaken to compare and analyze the outcomes following tendon augmentation surgeries using PB and FHL.

FHL scores over peroneus brevis in that it can help bridge larger defects and also its muscle belly provides vascularity to the distal part of Achilles tendon.[13]

METHODS

This was a prospective randomized intention to treat study done in PES Institute of medical sciences and research, Kuppam from March 2014 to Dec 2018. All adult patients presenting with Achilles tendon ruptures were included in the study. Patients with open ruptures, associated fractures/ neurovascular injury and foot ulcers in the vicinity of rupture were excluded from the study. The consenting study subjects were randomly allocated into two groups (FHL & PB) using the sealed envelope technique with computer-generated randomization codes.

The American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot scale and the Leppihilati scores and The Achilles tendon total rupture score (ATRS) were employed for outcome assessment.

The AOFAS ankle-hindfoot scale developed in 1994 is a universally accepted outcome measure for comparing different conditions of hind foot.[20] This is a clinician-based outcome scale collects both subjective and objective factors into numerical scales and has a maximum total score of 100 points. The subjective portion has been shown to have satisfactory reliability and responsiveness.[21,22]

The Leppilahti score, described in 1998 by Leppilahti et al is a specific evaluation tool for assessing outcome after Achilles tendon ruptures.[23] This scoring system combines both subjective assessments of symptoms and objective measures, such as ankle range of motion (ROM) and isokinetic calf strength. It has a total of seven items giving a sum of 100 points as the best possible score.

The ATRS developed in 2007, is a patient-reported outcome measure with high reliability, validity, and sensitivity for measuring outcome after treatment in patients with a total Achilles tendon rupture.[24] It has ten items evaluating symptom and function. Each item is scored from 0-10 on a Likert scale. 100 correspond to full function and no symptoms.

Figure 1: Showing rupture of Achilles tendon.

Figure 2: Harvested peroneus brevis.

Figure 3: Pulvertaft suturing.

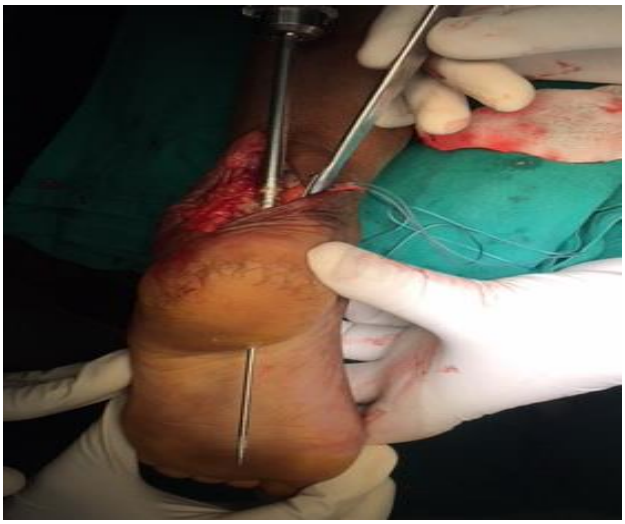

Figure 4: Drilling of Calcaneal tunnel.

Figure 5: Postoperative X-ray.

Figure 6: After wound healing.

Demographic data, a detailed history and physical examination, necessary lab and radiological evaluation were done for all patients. After pre-anesthetic evaluation and counseling, patients underwent surgery under spinal anesthesia and tourniquet control. The surgical incision was based on the type of tendon selected as per randomization (postero-lateral for PB and posteromedial for FHL). Ruptured achilles tendon ends were debrided and freshened. Single-incision technique for FHL and Pulvertaft method for PB was employed for Achilles tendon reinforcement. Appropriate tendons (FHL/PB) after distal division and reinforcement was inserted into the calcaneal tunnel and secured with an interferential screw (Figure 1-6). Layered tension free suturing was done. Operated limb was immobilized in plaster slab in resting equinus position. Suture removal was done at 2 weeks and later limb was immobilized in a plaster cast in plantigrade position. At 6 weeks passive range of motion (ROM) exercises were initiated. Graduated weight-bearing was allowed on the operated limb from 12 weeks onwards.

Patients were assessed before surgery and during follow-up at six weeks, 3rd month and at 6th month using AOFAS ankle-hindfoot scale, the Leppihilati and the ATRS scores. Standard physical rehabilitation was given to all patients in the postoperative period.

Statistical analysis

The comparison was done between FHL group and PB group using data obtained from the AOFAS ankle-hindfoot scale, the Leppihilati score and ATRS scores. Statistical analysis was done by using SPSS 20 software. Independent t-test was used to compare the mean difference between two groups. Tests for statistical significance were assessed.

RESULTS

A total of 30 patients presented with Achilles tendon injury from 2014 to 2018. Three patients were excluded from the study. Among them, one young patient had acute tear following penetrating injury and underwent end to end repair. Another two patients who were lost for follow-up were also excluded from the study. 27 patients who fit into the criteria were included in the study.

Table 1: Group demographics.

		N (%)
Age (years)	35-45	6
	46-55	14 (51.85)
	55 and more	7
Gender	Male	20 (74.07)
	Female	7
Side	Left	15 (55)
	Right	12
Mechanism of injury	Stumble	17 (62.96)
	Jumping	4
	Unclear	6
Delay in presentation	Within 3 weeks	4
	3 to 6 weeks	17 (62.96)
	More than 6 weeks	6
Previous local steroid injection		6
Comorbidities	Diabetes mellitus	6 (22.22)
	Hypertension	2

Table 2: Gender data.

Parameter	Male	Female	P value
Average age at presentation (years)	51.4	54.85	
AOFAS* score: pre-op	42.69	37.57	0.26
AOFAS score: post-op at 6M	91.38	90.29	0.64
Leppilahti score pre-op	24.38	20.0	0.30
Leppilahti score post-op at 6M	89.38	87.86	0.47
ATRS# score –pre-op	21.06	18.86	0.38
ATRS score –post op at 6M	80.25	81.71	0.44

*-AOFAS- The American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot scale; #-Achilles tendon total rupture score.

Mean age at presentation was 52.3 years (Table 1). There was an average delay at presentation to the hospital by 39.3 days. Preponderance was seen among men in the study group (2.85:1) (Table 2). Six patients (22.22%) had type 2 diabetes mellitus in the study group. Six out of twenty-seven patients had received intra-lesional steroid injections in the past one year prior to presenting with ruptures. All the ruptures were unilateral; being slightly more common on the left side (55.55%). After randomization, 14 patients underwent surgery using FHL tendon (FHL group) and 13 patients with PB (PB group). There was surgical site infection in one patient in PB group; who was also a diabetic (Figure 7). The infection in this patient settled with surgical debridement and intravenous antibiotic.

Figure 7: Surgical site infection in PB group.

Average preoperative AOFAS ankle-hindfoot scale was 39.78 and 41.92 respectively in FHL group and PB group. In FHL group ankle-hindfoot score improved to 50.71, 83.5 and 91.14 at 6 weeks, 3rd month and 6th months respectively. In PB group the scores were 36.15, 79.23 and 88.46 at similar 6th week, 3rd month and 6th month. Although the difference in scores was seen in both groups, the difference was not statistically significant.

The mean preoperative Leppihilati score was 20.71 and 23.46 in FHL group and PB group respectively. The mean difference at six weeks and 3rd month and 6th-month scores between FHL and PB groups were not statistically significant (p-value 0.10, 0.23 and 0.89 respectively).

Similar findings were seen in ATRS scale also. The p-value preoperatively, then at six weeks and 3rd month and 6th month were 0.87, 0.86, 0.29 and 0.62 which were not statistically significant.

DISCUSSION

In the present study average ATR was seen at a slightly younger age in men (51.4 yrs) as against women (54.85). The incidence in men in our study was nearly 3 times more common as compared to women. This was in line with the observations done by Lemme et al in his epidemiological study done on US population [1]. Although there were differences in the incidence and in the outcome scores between men and women, the observations were not statistically significant (p>0.05). All the patients had unilateral ruptures in our study which was more common and left side. Similar observations have been found by Chang et al and they have attributed

it to more frequent "left foot push off" with right-hand dominant individuals.[25,26] Stumble and fall was the common mechanism observed in our study. Six patients did not remember the causative mechanism. Sudden forceful dorsiflexion, tendon degeneration, intra-lesional steroid all have been associated with increased ATR.[1,5]

Table 3: Group statistics: FHL vs. PB.

Parameters		FHL group	PB group	P value
Average age		53.50	51.00	0.33 (NS)
Average delay in presentation in days		35.29	37.38	0.70 (NS)
AOFAS score	Pre-op	39.79	41.92	0.57 (NS)
	Post-op at 6 weeks	50.71	52.80	0.60 (NS)
	Post-op at 3 months	83.50	81.5	0.35 (NS)
	Post-op at 6 months	91.14	90.08	0.58 (NS)
Leppilahti score	Pre-op	20.71	23.46	0.44 (NS)
	Post-op at 6 weeks	31.79	36.15	0.10 (NS)
	Post-op at 3 months	82.14	79.23	0.23 (NS)
	Post-op at 6 months	88.21	88.46	0.89 (NS)
Achilles tendon total rupture score	Pre-op	19.64	20.0	0.87 (NS)
	Post-op at 6 weeks	42.07	42.46	0.86 (NS)
	Post-op at 3 months	70.00	67.08	0.29 (NS)
	Post-op at 6 months	81.14	80.38	0.62 (NS)

AOFAS- The American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot scale; FHL- Flexor hallucis longus tendon; PB- peroneus brevis tendon; NS- Not significant (p>0.05).

Table 4: Functional outcome with different scoring systems.

	FHL group (n=14)			PB group (n=13)		
	AOFAS scale	Leppilahti score	ATRS scale	AOFAS scale	Leppilahti score	ATRS scale
Excellent results (>85)	12	13	2	11	11	2
Good (70-84)	2	1	12	2	2	11
Fair (50-69)	Nil	Nil	Nil	Nil	Nil	Nil
Poor (<50)	Nil	Nil	Nil	Nil	Nil	Nil

Table 5: Complications.

Complications	FHL group (n=14)	PB group (n=13)
	N (%)	N (%)
Wound healing problems	Nil	1 (7)*
Infections	Nil	1 (7)*
Rerupture	Nil	Nil
Parasthesia	Nil	1 (7)*
Weakness of great toe flexion	Nil	Nil

*The same patient had superficial infection and sensory problem. This patient was also a diabetic. The infection settled with surgical debridement and intravenous antibiotic.

In the present study, there was an improvement in both the FHL and PB groups (Table 3). The mean AOFAS scores improved from 39.79 to 91.14 and from 41.92 to 90.08 in FHL and PB groups respectively (Figure 8). Although there was inter-group variation in improvement, the difference was not statistically significant (p=0.58). Our results in both the groups were similar with a study done by Wegrzyn where there was an improvement in AOFAS score from 64 to 98 at 79 months follow-up.[27] Anatomically contractile force of FHL is more in line with Achilles tendon and its muscle belly is in close contact with the repaired area in contrast PB.[28] The percentage of good to excellent in both the FHL and PB groups was comparable with AOFAS and Leppilahti scores. However, with patient-reported outcome score (ATRS), the percentage of good scores outnumbered other excellent outcomes (Table 4).

One patient in PB group developed surgical site infection which settled with surgical debridement and intravenous antibiotic (Table 5).

In our study, we did not find any statistically significant difference in the outcome between FHL and PB groups.

Both FHL and PB are good methods with predictable outcome rates. FHL may be preferred as (a) it can be accessed through the single incision; (b) it is more in line with Achilles tendon (c) theoretical advantages of improved vascularity at achilles tendon repair site.

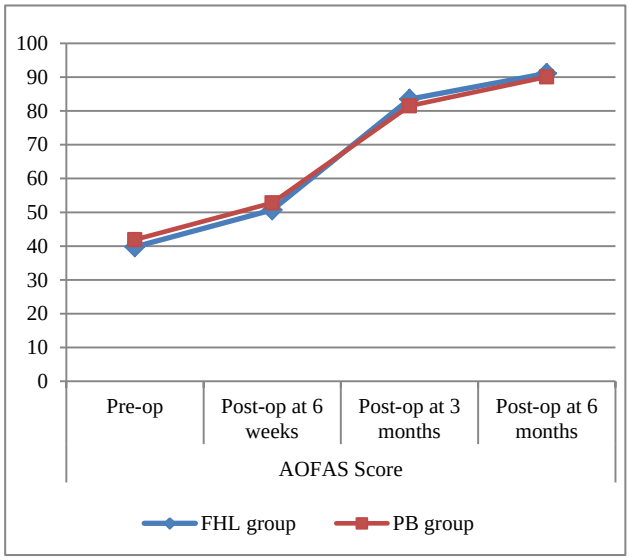

Figure 8: Comparison in mean AOFAS scores between FHL and PB groups.

AOFAS- The American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot scale; FHL- flexor hallucis longus tendon; PB- peroneus brevis tendon.

Limitations

This was a single center study. We suggest a multi-centric study with larger sample size for better comparison.

CONCLUSION

Predictably good results are seen with tendon augmentation procedures for Achilles tendon rupture. Both FHL and PB are equally good in providing good plantar flexion power needed in Achilles tendon rupture.

ACKNOWLEDGEMENTS

We have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals. I would like to extend my sincere thanks to all of them. I am highly indebted to Prof H B Gadiyar for his guidance and constant support in completing the project. My thanks and appreciations also go to my colleagues in developing the project and people who have willingly helped me out with their abilities. I would like to express my special gratitude and thanks to nursing and physiotherapy team for giving my patients such attention and time. I would like to express my gratitude towards my parents and family for their kind co-operation and encouragement which helped me in completion of this project.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. Lemme NJ, Li NY, DeFroda SF, Kleiner J, Owens BD. Epidemiology of Achilles Tendon Ruptures in the United States: Athletic and Nonathletic Injuries From 2012 to 2016. Orthop J Sports Med. 2018;6(11):2325967118808238.
2. Jhingan S, Perry M, O'Driscoll G, Lewin C, Teatino R, Malliaras P, Maffulli N, Morrissey D. Thicker Achilles tendons are a risk factor to develop Achilles tendinopathy in elite professional soccer players. MLTJ. 2011;2:53-8.
3. Kleinman M, Gross AE. Achilles tendon rupture following steroid injection. Report of three cases. J Bone Surg Am. 1983;65(9):1345-7.
4. Irwin TA. Current concepts review: insertional Achilles tendinopathy. Foot Ankle Int. 2010;31(10):933-9.
5. Nagakiran KV, Soraganvi P, Uma MA, Sudeep PM, Bharadwaj MSC. An analysis of functional outcome following tendon augmentation surgeries in patients presenting with steroid-induced tendo achilles rupture and spontaneous tendo achilles ruptures. Indian J Orthop Surg. 2018;4(4):394-401.
6. Aström M, Westlin N. Blood flow in the human Achilles tendon assessed by laser Doppler flowmetry. J Orthop Res. 1994;12(2):246-52.
7. Loppini M, Maffulli N. Conservative management of tendinopathy: an evidence-based approach. MLTJ. 2011;1:133-6.
8. Rasmussen S, Christiansen M, Mathiesen I, Simonson O. Shockwave therapy for Achilles tendinopathy: a double blind, randomized trial of efficacy. Acta Orthop. 2008;79(2):249-56.
9. Rees JD, Wilson AM, Wolman RL. Current concepts in the management of tendon disorders. Rheumatology. 2006;45(5):508-21.
10. Toolan BC, Wright Quinones VJ, Cunningham BJ, Brage ME. An evaluation of the use of retrospectively acquired preoperative AOFAS clinical rating scores to assess surgical outcome after elective foot and ankle surgery. Foot Ankle Int. 2001;22:775-8.
11. Lui TH. Arthroscopy and endoscopy of the foot and ankle: indications for new techniques. Arthroscopy. 2007;23(8):889-902.
12. Maffulli N, DBA, Testa V, Capasso G, Oliva F, Denaro V. Safety and outcome of surgical debridement of insertional Achilles tendinopathy using a transverse (Cincinnati) incision. J Bone Joint Surg Br. 2011;93:1503-7.
13. Maffulli N, Ajis A. Management of chronic ruptures of the Achilles tendon. J Bone Joint Surg Am. 2008;90:1348-60.

14. Christensen I. Ruptures of the Achilles tendon; analysis of 57 cases. Acta Scand. 1953;106:50-60.
15. Qu JF, Cao LH, Zhao HB, Gao JH, Li SG, Du XJ, et al. FDL muscle tendon transfer in the repair of old rupture of the Achilles tendon. Zhongguo Gu Shang. 2008;21:297-9.
16. Pintore E, Barra V, Pintore R, Maffulli N. Peroneus brevis tendon transfer in neglected tears of the achilles tendon. J Trauma. 2001;50:71-8.
17. Maffulli N, Spiezia F, Longo UG, Denaro V. Less-invasive reconstruction of chronic achilles tendon ruptures using a peroneus brevis tendon transfer. Am J Sports Med. 2010;38(11):2304-12.
18. Miskulin M, Miskulin A, Klobucar H, Kuvalja S. Neglected rupture of the Achilles tendon treated with peroneus brevis transfer: a functional assessment of five cases. J Foot Ankle Surg. 2005;44:49-56.
19. 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 Joint Surg Br. 1985;67:432-7.
20. Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, midfoot, hallux and lesser toes. Foot and Ankle int. 1994;15:349-53.
21. Ibrahim T, Beiri A, Azzabi M, Best AJ, Taylor GJ, Menon DK. Reliability and validity of the subjective component of the American orthopaedic Foot and Ankle society clinical rating scales. J Foot Ankle Surg. 2007;46:65-74.
22. Spennacchio P, Vascellari A, Cucchi D, Canata GL, Randelli P. Outcome evaluation after Achilles tendon ruptures. A review of the literature. Joints. 2016;4(1):52-61.
23. Leppilahti J, Forsman K, Puranen J, et al. outcome and prognostic factors of Achilles Rupture repair using a new scoring method. Clin Orthop Relat Res. 1998:(346):152-61.
24. Kearney RS, Achten J, Lamb SE, Parsons N, Costa ML. The Achilles tendon total rupture score:a study of responsiveness, internal consistency and convergent validity on patients with acute Achilles tendon ruptures. Health Qual Life Outcomes. 2012;10:24.
25. Chang HJ, Burke AE, Glass RM. JAMA patient page. Achilles tendinopathy. JAMA. 2010;303:188.
26. Singh R, Manoharan G, Moores TS, Patel A. Nintendo Wii related Achilles tendon rupture:first reported case and literature review of motion sensing video game injuries. BMJ Case Rep. 2014;2014:bcr2013202657.
27. Wegrzyn J, Luciani JF, Philippot R, Brunet-Guedj E, Moyen B, Besse JL. Chronic Achilles tendon rupture reconstruction using a modified flexor hallucis longus transfer. Int Orthop. 2010;34(8):1187-92.
28. Den Hartog BD. Surgical strategies: delayed diagnosis or neglected Achilles' tendon ruptures. Foot Ankle Int. 2008;29:456–63.

Cite this article as: Nagakiran KV, Nambiar SM, Soraganvi P, Wooly S, Gadiyar HB. Flexor hallucis longus vs. peroneus brevis: the better tendon for augmentation surgery in chronic achilles tendon ruptures. Int J Res Orthop 2019;5:264-70.