Section: Orthopedics

Original Research Article

FUNCTIONAL OUTCOME OF MODIFIED FLEXOR HALLUCIS LONGUS TENDON TRANSFER IN THE MANAGEMENT OF CHRONIC ACHILLES TENDON RUPTURE: A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Chronic Achilles tendon rupture is a challenging orthopaedic condition characterized by delayed presentation, tendon retraction, scar tissue formation, muscle atrophy, and poor tendon quality, making direct end-to-end repair difficult. Flexor Hallucis Longus (FHL) tendon transfer has emerged as a reliable reconstructive technique owing to its favourable biomechanical properties, anatomical proximity, and low donor-site morbidity. However, evidence regarding the functional outcomes of the modified FHL tendon transfer in the Indian population remains limited. The aim is to evaluate the functional outcome of Modified Flexor Hallucis Longus tendon transfer in the surgical management of chronic Achilles tendon rupture.

Materials and Methods: This prospective observational study was conducted in the Department of Orthopaedics, Government Medical College and Government General Hospital, Ongole, Andhra Pradesh, from May 2023 to April 2026. Thirty patients aged ≥18 years with chronic Achilles tendon rupture (>6 weeks), recurrent rupture, or tendon defects unsuitable for primary repair underwent Modified FHL tendon transfer. Functional outcome was assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score. Secondary outcome measures included ankle range of motion, six-minute walk distance, calf circumference, heel-rise ability, return to occupation and recreational activities, patient satisfaction, and postoperative complications. Statistical analysis was performed using the Wilcoxon signed-rank test, with $p<0.05$ considered statistically significant.

Results: The study included 30 patients with a mean age of 50.6 ± 12.4 years, of whom 73.3% were males. The mean duration from injury to surgery was 14.5 ± 4.1 weeks, with a mean tendon gap of 6.4 ± 0.9 cm. The mean AOFAS score improved significantly from 49.2 ± 8.4 preoperatively to 90.1 ± 6.7 postoperatively ($p<0.001$). Significant improvements were also observed in plantar flexion (24.6° to 38.8°), dorsiflexion (6.8° to 13.6°), calf circumference (33.1 cm to 34.5 cm), and six-minute walk distance (392.4 m to 641.2 m) (all $p<0.001$, except calf circumference $p=0.002$). At final follow-up, 90.0% of patients could perform a single heel rise, 93.3% returned to their pre-injury occupation, 80.0% resumed recreational activities, and 96.7% reported satisfactory outcomes. Minor complications included superficial wound infection (3.3%), delayed wound healing (3.3%), skin adhesion (3.3%), and mild great toe weakness (6.7%), while no reruptures or sural nerve injuries were observed.

Conclusion: Modified Flexor Hallucis Longus tendon transfer is a safe, reliable, and effective surgical technique for the management of chronic Achilles tendon rupture. It provides excellent functional recovery, significant

improvement in AOFAS scores and ankle function, high patient satisfaction, and a low complication rate. The procedure represents a valuable reconstructive option for chronic Achilles tendon defects, particularly when primary tendon repair is not feasible.
Keywords: Chronic Achilles tendon rupture, Flexor Hallucis Longus tendon transfer, Modified FHL transfer, Achilles tendon reconstruction, AOFAS score, Functional outcome, Tendon transfer, Chronic tendon injury, Foot and ankle surgery, Prospective observational study.

INTRODUCTION

The Achilles tendon is the largest, strongest, and thickest tendon in the human body, transmitting the powerful forces generated by the gastrocnemius–soleus complex to facilitate plantar flexion during walking, running, jumping, and other weight-bearing activities. Despite its remarkable tensile strength, the tendon is particularly susceptible to rupture because of the relatively hypovascular zone located approximately 2–6 cm proximal to its calcaneal insertion, where degenerative changes frequently occur. Achilles tendon rupture represents the most common tendon rupture of the lower limb, with its incidence increasing steadily owing to greater participation in recreational sports, an ageing yet physically active population, obesity, diabetes mellitus, corticosteroid use, fluoroquinolone therapy, and other metabolic disorders that adversely affect tendon quality.[1–5]

Chronic or neglected Achilles tendon rupture is generally defined as a rupture diagnosed or treated more than six weeks after the initial injury. Delayed diagnosis may result from an initially missed rupture, inadequate clinical assessment, inappropriate conservative management, or late presentation by the patient. Progressive retraction of the tendon ends, interposed fibrous scar tissue, muscle atrophy, and tendon degeneration make primary end-to-end repair technically difficult or impossible. Consequently, patients frequently present with persistent pain, calf weakness, impaired push-off strength, inability to perform a single-leg heel rise, altered gait mechanics, reduced endurance, and substantial functional disability affecting activities of daily living and sports participation.[1,2,5–8]

Accurate diagnosis requires a combination of detailed clinical examination and appropriate imaging. Clinical findings including a palpable tendon gap, positive Thompson squeeze test, loss of plantar flexion strength, and inability to perform a single-leg heel rise strongly suggest chronic rupture. Magnetic resonance imaging (MRI) remains the imaging modality of choice because it accurately delineates tendon discontinuity, measures the tendon defect, evaluates tendon degeneration, and assists in preoperative planning, particularly in chronic cases where scar tissue may obscure the true extent of injury.[3,4]

Several surgical techniques have been described for reconstruction of chronic Achilles tendon rupture depending on the duration of injury, tendon gap, quality of the remaining tendon, and patient characteristics. These include direct end-to-end repair for small defects, V-Y gastrocnemius advancement, gastrocnemius fascial turndown flaps, tendon grafts, peroneus brevis transfer, flexor digitorum longus transfer, semitendinosus graft reconstruction, and flexor hallucis longus (FHL) tendon transfer. Although numerous reconstructive procedures have been reported, there remains no universally accepted gold standard, particularly for tendon defects exceeding 5 cm.[2,5–9]

Among the available reconstructive options, Flexor Hallucis Longus (FHL) tendon transfer has gained widespread acceptance because of its favourable anatomical location, similar line of pull to the Achilles tendon, adequate muscle strength, synchronous contraction with the gastrocnemius–soleus complex, and relatively low donor-site morbidity. The tendon can be harvested through the same operative incision, allowing restoration of plantar flexion strength while minimizing additional soft tissue dissection. Several clinical studies have demonstrated favourable functional recovery, high patient satisfaction, low complication rates, and reliable restoration of ankle function following FHL tendon transfer for chronic Achilles tendon rupture.[8–10]

Functional outcome following reconstruction is commonly assessed using validated scoring systems such as the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score, which comprehensively evaluates pain, function, walking ability, gait, alignment, and range of motion. In addition, objective functional assessment including the six-minute walk test provides valuable information regarding postoperative endurance, ambulatory capacity, and return to functional activity, thereby complementing clinical outcome measures.[10,11]

Despite encouraging reports in the literature, relatively few studies from the Indian population have evaluated the functional outcomes of Modified Flexor Hallucis Longus tendon transfer in chronic Achilles tendon rupture. Furthermore, variations in surgical technique, rehabilitation protocols, patient characteristics, and outcome assessment continue to limit direct comparison among published studies. Therefore, the present prospective observational study was undertaken to evaluate the functional outcomes, clinical recovery, and postoperative complications following Modified Flexor Hallucis Longus tendon transfer in patients with chronic

Achilles tendon rupture treated at a tertiary care teaching hospital.

Aim

To evaluate the functional outcome of Modified Flexor Hallucis Longus (FHL) tendon transfer in the surgical management of chronic Achilles tendon rupture.

Objectives

1. To assess the postoperative functional outcome following Modified Flexor Hallucis Longus tendon transfer using the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score.
2. To evaluate postoperative clinical recovery, functional performance, and procedure-related complications following Modified Flexor Hallucis Longus tendon transfer in patients with chronic Achilles tendon rupture.

MATERIALS AND METHODS

Study Design: A prospective observational study was conducted in the Department of Orthopaedics, Government Medical College and Government General Hospital, Ongole, Andhra Pradesh, over a period of three years from 1 May 2023 to 30 April 2026, after obtaining approval from the Institutional Ethics Committee. The study was undertaken to evaluate the functional outcome of Modified Flexor Hallucis Longus (FHL) tendon transfer in the management of chronic Achilles tendon rupture. A total of 30 consecutive patients fulfilling the eligibility criteria were enrolled after obtaining written informed consent.

Inclusion and Exclusion Criteria

Patients aged 18 years and above with a documented history of chronic Achilles tendon rupture, defined as a delay of more than six weeks between injury and surgical intervention, recurrent Achilles tendon rupture, or chronic ruptures associated with significant tendon degeneration and tendon defects unsuitable for primary end-to-end repair were included in the study. Diagnosis was established clinically based on a positive Thompson squeeze test, inability to perform a single-leg heel rise, palpable tendon gap, weakness of plantar flexion, and was confirmed by magnetic resonance imaging (MRI).

Patients presenting with acute Achilles tendon rupture, open injuries, active local infection, associated fractures, vascular or nerve injuries, severe peripheral vascular disease, neurological disorders affecting lower limb function, previous Achilles tendon surgery with extensive soft tissue compromise, or those unwilling to participate or comply with regular follow-up were excluded from the study.

Preoperative Evaluation

A detailed clinical history was obtained from all patients, including demographic characteristics, mechanism of injury, duration from injury to surgery, previous treatment, associated comorbidities, occupation, and activity level. Clinical examination included assessment of tendon continuity, calf muscle wasting, ankle range of motion, plantar flexion strength, Thompson squeeze test, heel-rise ability, gait pattern, and neurovascular status. Routine preoperative laboratory investigations were performed in all patients. Plain radiographs were obtained to exclude associated bony pathology, while MRI was performed to confirm the diagnosis, determine tendon gap length, evaluate tendon degeneration, and assist in operative planning.

Preoperative functional assessment was performed using the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score. Additional baseline evaluation included calf circumference measurement, ankle dorsiflexion and plantar flexion range of motion, and the six-minute walk test.

Surgical Technique

All procedures were performed by the same senior orthopaedic surgeon under spinal or general anaesthesia with the patient positioned prone under pneumatic tourniquet control following standard aseptic precautions. A longitudinal posteromedial incision was made over the Achilles tendon to provide adequate exposure while minimizing the risk of sural nerve injury. The paratenon was carefully preserved, and fibrotic scar tissue together with degenerated tendon ends was excised until healthy tendon tissue was identified. The tendon defect was measured intraoperatively.

The Flexor Hallucis Longus tendon was identified anterior to the Achilles tendon and harvested using a short-harvest technique through the same incision. The tendon was prepared with Krackow locking sutures using high-strength non-absorbable sutures. A calcaneal tunnel was created immediately anterior to the native Achilles tendon insertion. The harvested tendon was passed through the tunnel ,tied to the sole using a guaze piece with the ankle maintained in approximately 30° of plantar flexion to achieve optimal graft tension. The proximal FHL muscle belly was passed through the gastrocnemius–soleus complex to reinforce the reconstruction. The repair was further augmented using interrupted non-absorbable sutures and covered with the preserved paratenon and deep fascia to facilitate biological healing.

Following meticulous haemostasis, the wound was irrigated with normal saline and closed in layers using absorbable sutures for the deep tissues and Allgower Donati sutures for better healing of the skin. A sterile compression dressing was applied, and the limb was immobilized in a below-knee plaster cast with the ankle maintained in approximately 30° of plantar flexion.

Postoperative Rehabilitation

Postoperatively, intravenous antibiotics and analgesics were administered according to institutional protocol. The operated limb was elevated during the immediate postoperative period,

and all patients remained non-weight bearing for six weeks. Wound inspection and suture removal were performed approximately two weeks after surgery. Serial casting was subsequently undertaken with gradual reduction in plantar flexion every two weeks until a neutral ankle position was achieved.

Supervised physiotherapy was initiated at six weeks along with progressive full weight bearing using an air-cast walker boot. Rehabilitation consisted of gradual ankle mobilization, gastrocnemius–soleus strengthening, proprioceptive training, gait re-education, heel-rise exercises, balance training, and progressive return to activities of daily living. The walker boot was gradually discontinued over the subsequent six weeks according to functional recovery.

Outcome Assessment

Patients were reviewed at two weeks, six weeks, three months, six months, and twelve months following surgery. At each follow-up visit, wound healing, pain, ankle range of motion, calf circumference, tendon continuity, gait pattern, heel-rise ability, great toe function, return to work, return to recreational activities, and postoperative complications including superficial wound infection, delayed wound healing, sural nerve injury, skin adhesion, re-rupture, and donor-site morbidity were assessed.

Functional outcome was evaluated using the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score, which served as the primary outcome measure. Secondary outcome measures included ankle range of motion, calf circumference, six-minute walk distance, single-leg balance test, return to pre-injury occupation, return to recreational activities, and patient satisfaction.

Statistical Analysis

All clinical, operative, and follow-up data were recorded using a pre-designed case record proforma and entered into Microsoft Excel before statistical analysis. Statistical analysis was performed using IBM Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, USA).

Continuous variables were expressed as mean ± standard deviation or median with interquartile range depending on data distribution, whereas categorical variables were presented as frequencies and percentages. Normality of data distribution was assessed using the Shapiro–Wilk test. Comparison of preoperative and postoperative AOFAS scores was performed using the Wilcoxon signed-rank test. Continuous variables were analysed using the paired Student's *t*-test or Wilcoxon signed-rank test, whereas categorical variables were analysed using the Chi-square test or Fisher's exact test, wherever appropriate. A *p* value of <0.05 was considered statistically significant.

RESULTS

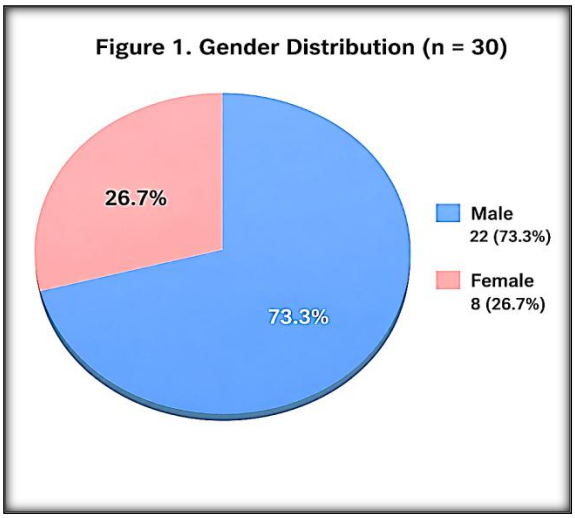

Figure 1: Gender Distribution of the Study Population (n = 30)

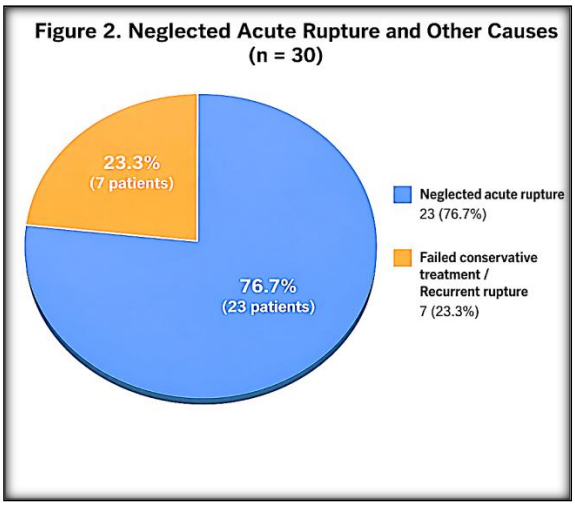

Figure 2: Etiology of Chronic Achilles Tendon Rupture in the Study Population (n = 30)

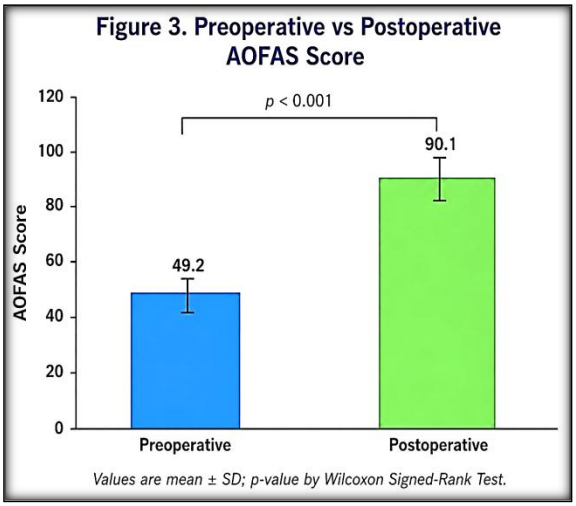

Figure 3: Comparison of Preoperative and Postoperative AOFAS Scores Following Flexor Hallucis Longus Tendon Transfer

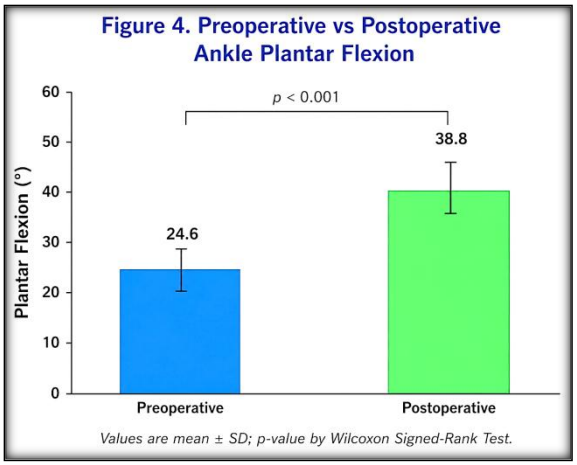

Figure 4: Comparison of Preoperative and Postoperative Ankle Plantar Flexion

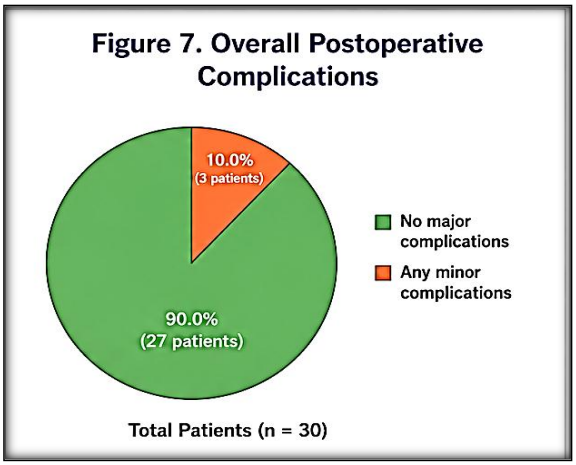

Figure 7: Distribution of Postoperative Complications

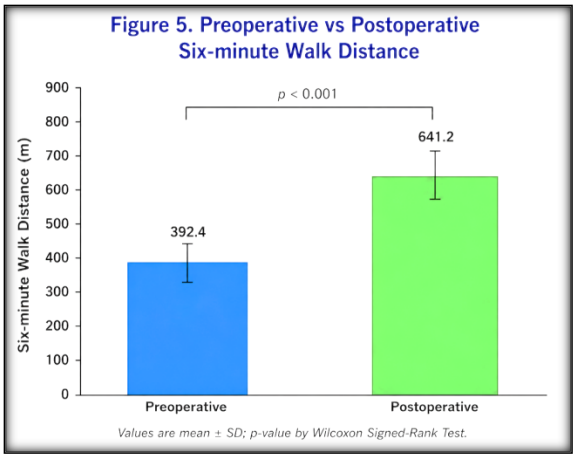

Figure 5: Comparison of Preoperative and Postoperative Six-Minute Walk Distance

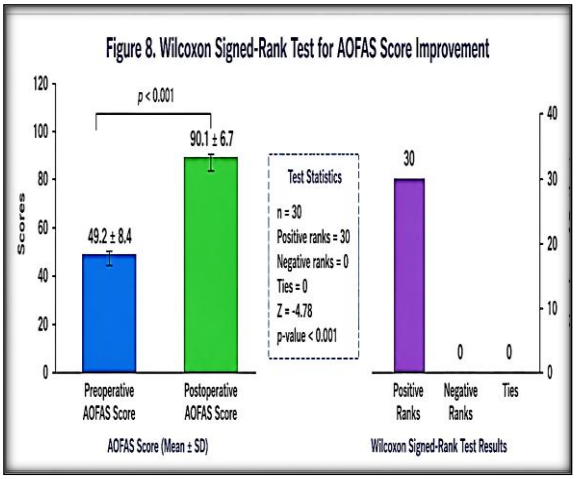

Figure 8: Improvement in AOFAS Score Following Surgery: Wilcoxon Signed-Rank Test Analysis

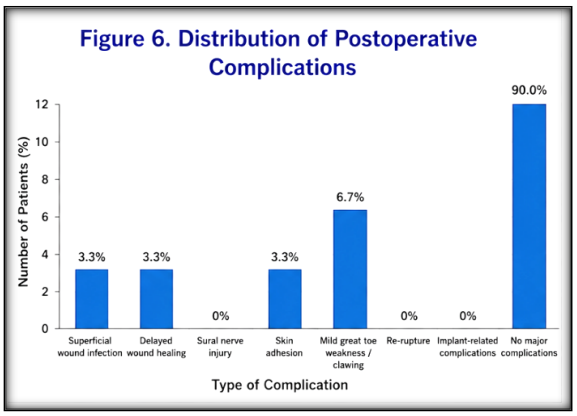

Figure 6: Distribution of Postoperative Complications

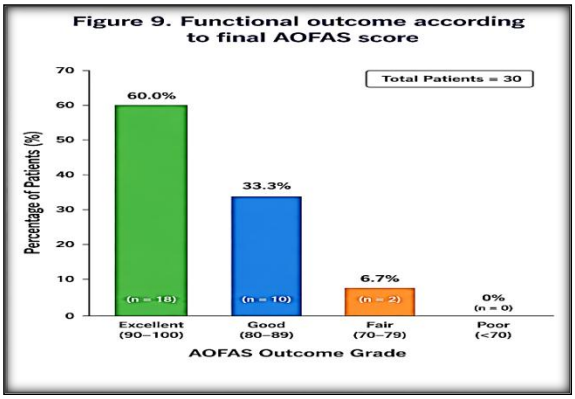

Figure 9: Functional Outcome According to Final AOFAS Score

Table 1: Baseline demographic and clinical characteristics of the study population (n = 30)

Variable	Value
Number of patients	30
Mean age (years)	50.6 ± 12.4
Age range (years)	31–78
Male, n (%)	22 (73.3%)
Female, n (%)	8 (26.7%)
Right side involvement, n (%)	18 (60.0%)
Left side involvement, n (%)	12 (40.0%)
Mean duration from injury to surgery (weeks)	14.5 ± 4.1
Neglected acute rupture, n (%)	23 (76.7%)
Failed conservative treatment/recurrent rupture, n (%)	7 (23.3%)

Mean tendon gap (cm)	6.4 ± 0.9

Table 2: Preoperative clinical characteristics

Variable	Value
Positive Thompson test, n (%)	30 (100%)
Inability to perform single heel rise, n (%)	30 (100%)
Palpable tendon gap, n (%)	28 (93.3%)
Mean preoperative AOFAS score	49.2 ± 8.4
Mean ankle plantar flexion (°)	24.6 ± 5.2
Mean ankle dorsiflexion (°)	6.8 ± 3.1
Mean calf circumference on affected side (cm)	33.1 ± 2.7
Mean calf circumference on normal side (cm)	35.0 ± 2.5
Mean 6-minute walk distance (m)	392.4 ± 74.8

Table 3: Operative details

Variable	Value
Mean operative time (minutes)	72.6 ± 12.8
Mean tendon gap reconstructed (cm)	6.4 ± 0.9
Bio-interference screw fixation, n (%)	25 (83.3%)
Metallic interference screw fixation, n (%)	5 (16.7%)
Mean hospital stay (days)	4.1 ± 1.2
Intraoperative complications, n (%)	0 (0%)

Table 4: Functional outcome following surgery

Variable	Preoperative	Postoperative	p-value
AOFAS score	49.2 ± 8.4	90.1 ± 6.7	<0.001
Plantar flexion (°)	24.6 ± 5.2	38.8 ± 4.6	<0.001
Dorsiflexion (°)	6.8 ± 3.1	13.6 ± 2.8	<0.001
Calf circumference on affected side (cm)	33.1 ± 2.7	34.5 ± 2.5	0.002
Six-minute walk distance (m)	392.4 ± 74.8	641.2 ± 86.5	<0.001

Table 5: Functional performance at final follow-up

Parameter	Value
Patients performing single heel rise, n (%)	27 (90.0%)
Successful one-leg balance test, n (%)	28 (93.3%)
Return to pre-injury occupation, n (%)	28 (93.3%)
Return to sports/recreational activities, n (%)	24 (80.0%)
Satisfactory great toe function, n (%)	28 (93.3%)
Patient satisfaction, n (%)	29 (96.7%)

Table 6: Postoperative complications

Complication	Number (%)
Superficial wound infection	1 (3.3%)
Delayed wound healing	1 (3.3%)
Sural nerve injury	0 (0%)
Skin adhesion	1 (3.3%)
Mild great toe weakness/clawing	2 (6.7%)
Re-rupture	0 (0%)
Implant-related complications	0 (0%)
No major complications	27 (90.0%)

Table 7: Distribution of Postoperative Complications

Variable	Value
Mean follow-up duration (months)	18.6 ± 6.4
Follow-up range (months)	12–30
Tendon continuity maintained, n (%)	30 (100%)
MRI performed at follow-up, n (%)	18 (60.0%)
MRI showing satisfactory healing, n (%)	18 (100%)
Return to unrestricted walking, n (%)	29 (96.7%)
Return to unrestricted daily activities, n (%)	28 (93.3%)

Table 8: Comparison of preoperative and postoperative AOFAS scores using Wilcoxon Signed-Rank Test

Statistical parameter	Value
Number of patients (n)	30
Mean preoperative AOFAS score	49.2 ± 8.4
Median preoperative AOFAS score	49
Mean postoperative AOFAS score	90.1 ± 6.7
Median postoperative AOFAS score	91
Mean improvement	40.9

Positive ranks	30
Negative ranks	0
Ties	0
Test statistic (Z)	-4.78
p-value	<0.001

Table 9: Functional outcome according to final AOFAS score

AOFAS Outcome Grade	Score Range	Number of Patients (n)	Percentage (%)
Excellent	90–100	18	60.0
Good	80–89	10	33.3
Fair	70–79	2	6.7
Poor	<70	0	0
Total		30	100

Table 10: Comparison of Functional Outcome According to Tendon Gap Size

Variable	Tendon Gap ≤6 cm (n = 14)	Tendon Gap >6 cm (n = 16)	p-value*
Mean age (years)	48.8 ± 11.5	52.2 ± 13.1	0.463
Mean duration from injury to surgery (weeks)	12.8 ± 3.2	15.9 ± 4.4	0.041
Mean operative time (minutes)	68.4 ± 10.6	76.3 ± 13.2	0.072
Mean preoperative AOFAS score	50.8 ± 7.9	47.9 ± 8.8	0.356
Mean postoperative AOFAS score	92.1 ± 5.4	88.4 ± 7.3	0.118
Mean AOFAS improvement	41.3 ± 6.8	40.5 ± 7.4	0.754
Mean six-minute walk distance (m)	652.6 ± 78.4	631.4 ± 92.1	0.489
Patients performing single heel rise, n (%)	13 (92.9%)	14 (87.5%)	0.624
Overall postoperative complications, n (%)	1 (7.1%)	3 (18.8%)	0.332
Return to pre-injury occupation, n (%)	14 (100%)	14 (87.5%)	0.170
Return to sports/recreational activities, n (%)	12 (85.7%)	12 (75.0%)	0.466

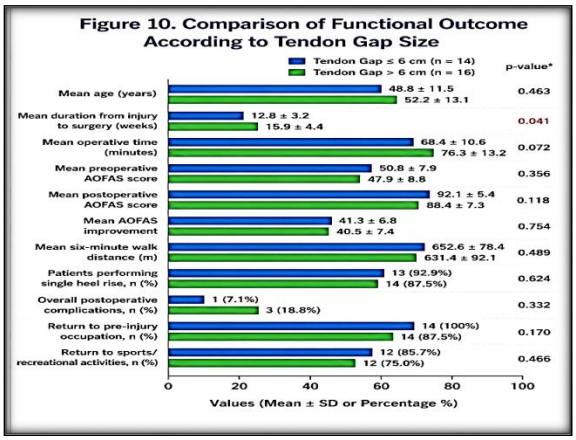

Figure 10: Comparison of Functional Outcomes According to Tendon Gap Size

Figure 11: Tendon Tear

Figure 12: Harvesting FHL

Figure 13: Preparation of FHL graft with Tendoachilles

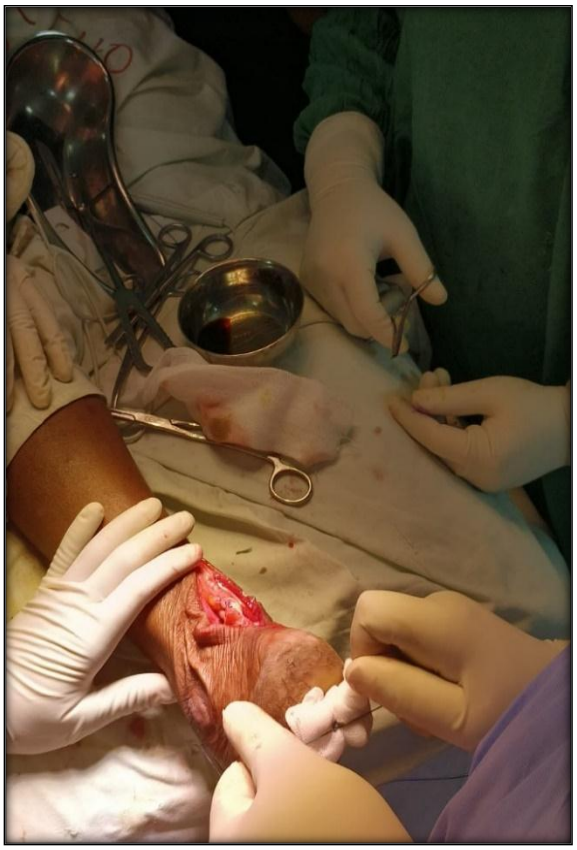

Figure 14: Graft tying to heel

Figure 15: Closure with Allgower Donati sutures

Figure 16: Final Reconstruction of Tendoachilles

Figure 17: Closure with Allgower Donati sutures

DISCUSSION

Chronic Achilles tendon rupture remains one of the most challenging conditions encountered in foot and ankle surgery because delayed presentation is associated with tendon retraction, scar tissue formation, muscle atrophy, and poor tendon quality, making direct end-to-end repair difficult. Consequently, numerous reconstructive procedures have been proposed, including V-Y advancement, gastrocnemius fascial turndown flaps, peroneus brevis transfer, semitendinosus graft reconstruction, flexor digitorum longus transfer, and Flexor Hallucis Longus (FHL) tendon transfer. Among these, FHL tendon transfer has emerged as one of the most widely accepted techniques because of its favourable anatomical position, similar biomechanical axis to the Achilles tendon, adequate muscle strength, and minimal donor-site morbidity.[12,17]

Wegrzyn et al. (2010),[12] evaluated 11 patients with chronic Achilles tendon rupture reconstructed using a modified FHL tendon transfer and reported excellent functional recovery with restoration of ankle plantar flexion, significant improvement in AOFAS scores, and a low complication rate after a mean follow-up of approximately 79 months. Their study demonstrated that FHL transfer provided reliable reconstruction even in patients with large tendon defects while preserving satisfactory ankle function and gait.

Abubeih et al. (2018),[13] reported the outcomes of 28 patients treated using a single-incision FHL tendon transfer. They observed significant improvement in postoperative functional scores, restoration of heel-rise ability in the majority of patients, and a very low incidence of wound-related complications. The single-incision technique also minimized soft-tissue dissection, reduced operative morbidity, and avoided additional donor-site incisions, making it an effective and reproducible surgical option.

A recent study by Sethi et al. (2025),[14] involving 32 patients, further demonstrated the effectiveness of short-harvest FHL tendon transfer fixed using a bio-tenodesis screw. The mean interval between injury and surgery was 14.87 weeks, and the average follow-up period was 31 months. The mean AOFAS score improved from 48.91 ± 8.28 preoperatively to 89.28 ± 9.17 postoperatively, with the improvement being highly statistically significant (Wilcoxon signed-rank test, $p < 0.001$). Only one patient developed a superficial wound infection, while the remaining patients successfully returned to their pre-injury functional status, highlighting the reliability and safety of this technique.

Xu et al. (2023),[15] evaluated long-term clinical outcomes following FHL tendon transfer in patients with chronic Achilles tendon ruptures associated with large tendon defects. Their study demonstrated sustained functional improvement, restoration of ankle strength, and satisfactory long-term patient-reported outcomes, supporting FHL tendon transfer as an effective reconstructive option even in extensive tendon loss. MRI evaluation also confirmed satisfactory tendon continuity and biological incorporation following reconstruction.

Koh et al. (2019),[16] compared isolated FHL tendon transfer with turndown flaps augmented by FHL transfer in chronic Achilles tendon reconstruction. Both techniques resulted in favourable clinical outcomes with significant postoperative improvement; however, isolated FHL transfer was associated with shorter operative time, reduced surgical exposure, and lower soft-tissue morbidity. The authors concluded that isolated FHL transfer is sufficient for most chronic Achilles tendon defects without the routine need for additional augmentation procedures.

The evidence-based review by Maffulli et al. (2017),[17] emphasized that the choice of reconstruction should primarily depend on tendon defect size, tissue quality, chronicity of injury, and patient functional demand rather than the duration of rupture alone. The authors recommended direct repair for defects less than 2 cm, V-Y advancement for moderate defects, and tendon transfer procedures such as FHL transfer for larger chronic defects. They further highlighted that FHL transfer provides excellent biomechanical compatibility because its line of pull closely parallels that of the Achilles tendon while maintaining sufficient plantar flexion power.

A recent systematic review and meta-analysis by Khair et al. (2025),[18] analysed studies evaluating isolated FHL tendon transfer for chronic Achilles tendon rupture and demonstrated consistently favourable functional outcomes with significant postoperative improvement in AOFAS scores, restoration of heel-rise function, low rerupture rates, and minimal donor-site morbidity. The pooled analysis concluded that isolated FHL transfer is a reliable and reproducible reconstructive technique with predictable clinical outcomes across different patient populations.

Similarly, Karaismailoglu et al. (2025),[19] in a systematic review and meta-analysis comparing open FHL tendon transfer, hamstring tendon transfer, and turndown flap techniques, reported that all reconstructive procedures produced satisfactory functional improvement. However, FHL tendon transfer demonstrated consistently lower complication rates, shorter rehabilitation time, and superior restoration of plantar flexion strength compared with several alternative reconstructive procedures. The authors concluded that FHL transfer currently represents one of the most dependable reconstructive options for chronic Achilles tendon rupture.

Postoperative morbidity associated with harvesting the FHL tendon has been another important

consideration. Coull et al. (2003),[20] demonstrated that although mild reduction in interphalangeal joint motion of the hallux may occur following tendon harvest, patients rarely experience clinically significant impairment during routine walking, stair climbing, or recreational activities. Most patients adapted well to the altered biomechanics, indicating that donor-site morbidity following FHL transfer is generally minimal.

Elias et al. (2007),[21] described reconstruction of neglected Achilles tendon rupture using V-Y lengthening combined with FHL tendon transfer through a single incision and reported excellent tendon healing with satisfactory restoration of ankle function while minimizing soft-tissue complications. Their findings further support the versatility of FHL tendon transfer, particularly in patients with large tendon defects requiring additional tendon lengthening procedures.

Collectively, the available literature consistently demonstrates that Flexor Hallucis Longus tendon transfer provides reliable restoration of plantar flexion strength, significant functional improvement, low rerupture rates, high patient satisfaction, and acceptable donor-site morbidity. Structured postoperative rehabilitation, has further improved clinical outcomes. Although current evidence strongly supports the role of FHL tendon transfer in managing chronic Achilles tendon rupture, future multicentre prospective studies with larger sample sizes, standardized rehabilitation protocols, and long-term follow-up are required to establish definitive treatment guidelines and determine the optimal reconstructive strategy for different tendon defect sizes and patient populations.

Limitations

The present study has several limitations. First, it was conducted at a single tertiary care centre, which may limit the generalizability of the findings to other institutions and patient populations. Second, the relatively small sample size reduces the statistical power for subgroup analysis. Third, the absence of a comparative control group treated with alternative reconstructive procedures precludes direct comparison of different surgical techniques. Functional assessment was primarily based on validated clinical scoring systems without objective gait analysis or isokinetic muscle strength testing. In addition, longer follow-up would be beneficial to evaluate tendon durability, late functional outcomes, and the development of degenerative changes or rerupture.

CONCLUSION

Future multicentre prospective studies with larger sample sizes and longer follow-up periods are required to validate the long-term efficacy of Modified Flexor Hallucis Longus tendon transfer. Randomized comparative studies evaluating FHL transfer against other reconstructive techniques such as peroneus brevis transfer, semitendinosus graft reconstruction, and V-Y advancement would provide stronger evidence for procedure selection. Incorporation of objective functional assessments including gait analysis, plantar pressure analysis, isokinetic muscle strength testing, patient-reported outcome measures, and health-related quality-of-life scores may further improve postoperative evaluation. Advanced imaging modalities such as serial MRI or ultrasonography may also provide valuable information regarding tendon healing, graft incorporation, and long-term structural integrity.

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