RESEARCH PAPER

Functional Outcomes of Single-Incision Flexor Hallucis Longus Tendon Transfer for Chronic Achilles Tendon Rupture: A Prospective Case Series

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ABSTRACT

Introduction: Chronic Achilles tendon rupture is a debilitating condition frequently resulting from missed or delayed diagnosis, often requiring surgical reconstruction to restore functional capacity. Flexor hallucis longus (FHL) tendon transfer has emerged as a preferred reconstructive technique. This study evaluates the functional outcomes and safety profile of FHL transfer for chronic Achilles tendon rupture at a tertiary care centre in India.

Methods: A prospective case series was conducted at the Department of Orthopaedics, Adichunchanagiri Institute of Medical Sciences, from September 2024 to March 2026. Twelve patients with chronic Achilles tendon rupture (rupture duration >4 weeks) underwent open FHL transfer via a single posterior incision with biodegradable interference screw fixation. Functional outcomes were evaluated using the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score, ankle range of motion (ROM), and the single heel raise test. Patients were assessed at 3, 6, and 9 months postoperatively.

Results: The mean patient age was 52.4 years (range: 36–68), with male predominance. The mean AOFAS score improved significantly from 61.3 ± 5.4 preoperatively to 91.8 ± 4.2 at final follow-up ($p < 0.001$). Plantarflexion ROM increased from 12.4° to 34.6°, and dorsiflexion from 8.6° to 18.1°. Eleven patients (91.7%) achieved a single heel raise by 3 months. One superficial wound infection resolved with antibiotics, two patients reported mild stiffness of the interphalangeal joint of the great toe; no re-ruptures or major complications were encountered.

Conclusion: Single-incision FHL tendon transfer demonstrates excellent functional recovery with minimal donor-site morbidity in patients with chronic Achilles tendon rupture. Its technical reproducibility and cost-effectiveness render it particularly suitable for resource-variable healthcare settings.

Keywords: Chronic Achilles tendon rupture, FHL transfer, AOFAS score, Single incision, Tendon reconstruction

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Introduction

The Achilles tendon, the largest and strongest tendon in the human body, plays an essential role in ambulation by enabling plantarflexion during gait, running, and jumping.1 Acute ruptures are prevalent, particularly in males aged 30–50 years, and are most frequently attributed to sports-related trauma or sudden mechanical overloading.2,3 However, a clinically significant subset—estimated at 20–25% of cases—goes unrecognized at initial presentation, ultimately resulting in chronic rupture characterized by tendon retraction, muscular atrophy, and fibrous scar tissue deposition.4,5

Chronic Achilles tendon rupture (CATR) is defined as a rupture left untreated beyond four weeks when then produces marked functional deficits including diminished push-off strength, inability to perform a single-leg heel raise, and gait disturbances that substantially impair quality of life.6,7 Because degenerative tissue changes and gap formation between the ends of the tendon preclude satisfactory spontaneous healing, surgical reconstruction represents the cornerstone of management.8 Although various techniques have been described—including V-Y advancement, synthetic grafts, and allografts—FHL tendon transfer has gained prominence because of its biomechanical advantages. Its anatomical proximity to the Achilles tendon, synchronous activation with the gastrocnemius-soleus complex, and robust vascularity make it a very suitable donor for reconstructing defects ≥5 cm.9,10 Furthermore, FHL harvest through a single posterior incision reduces operative morbidity and simplifies the surgical workflow.11

Despite growing adoption of FHL transfer, the majority of supporting evidence originates from urban or well-resourced settings, with limited data available from rural or semi-urban tertiary care centers where delayed presentations are considerably more frequent.12,13 Variability in surgical technique (e.g., single- vs. dual-incision approaches) and differing rehabilitation protocols further complicate cross-study comparisons.14 The present study aims to address these gaps by reporting the functional outcomes and safety of standardized single-incision FHL transfer in a cohort of CATR patients managed at a tertiary hospital in southern India, with the objective of validating this approach as a reliable, cost-effective option for resource-variable settings.

Materials and Methods

This prospective case series was conducted at the Department of Orthopaedics, Adichunchanagiri Institute of Medical Sciences, Karnataka, India, from September 2024 to March 2026

Inclusion Criteria

Patients aged ≥18 years with a confirmed chronic Achilles tendon rupture (>4 weeks post-injury), inability to perform a single-leg heel raise, positive Thompson/Matles test, radiologically confirmed tendon gap ≥5 cm on ultrasound or MRI, and willingness to comply with the postoperative rehabilitation programme were eligible.

Exclusion Criteria

Patients with acute ruptures (<4 weeks), open or actively infected wounds, peripheral neuropathy, vascular insufficiency, or prior ipsilateral ankle surgery were excluded.

Twelve consecutive eligible patients were enrolled. All procedures were performed under spinal anaesthesia with the patient in the prone position; a thigh tourniquet was inflated to 250 mmHg. A single 8–10 cm posteromedial incision was made over the Achilles tendon, and the ruptured ends were debrided of necrotic tissue. The FHL tendon was identified posterior to the neurovascular bundle and harvested distal to Henry's knot using a tendon stripper. It was then routed through a 6.5 mm drill hole in the calcaneus (avoiding the tuberosity) and secured with a biodegradable interference screw with the ankle held in 40° plantarflexion. Myoplasty between the FHL and the proximal Achilles stump was performed where adequate tissue permitted. The paratenon was repaired with 3-0 Vicryl, followed by layered wound closure; a sterile dressing and below-knee plaster slab were applied with the ankle in 30° equinus.

Postoperatively, patients were maintained non-weight-bearing in a cast for three weeks. At week three, the cast was exchanged for a functional brace and active ROM exercises were commenced. Progressive weight-bearing was introduced at six weeks, supplemented by physiotherapy emphasising eccentric strengthening and proprioceptive training. Full weight-bearing was typically achieved between 10 and 12 weeks.

(Figure 1 – Preoperative X-ray; Figure 2 – Intraoperative images; Figure 3 – C-arm image of interference screw; Figure 4 – Postoperative screw at 1 month)

Outcomes were assessed by an independent observer at 3, 6, and 9 months. The primary outcome measures were the AOFAS ankle-hindfoot score (evaluating pain, function, and alignment), active ROM measured with a goniometer, and the ability to perform 10 consecutive single heel raises. Secondary outcomes include complication rates (infection, re-rupture, donor-site morbidity) and return to pre-injury activity levels.

Statistical analysis was performed using SPSS version 26. Continuous variables (AOFAS scores, ROM) are presented as mean ± standard deviation. Pre- and postoperative comparisons were made using paired t-tests for normally distributed data and the Wilcoxon signed-rank test for non-parametric data. A p-value <0.05 was considered statistically significant.

Images

Figure 1: Preoperative X-ray

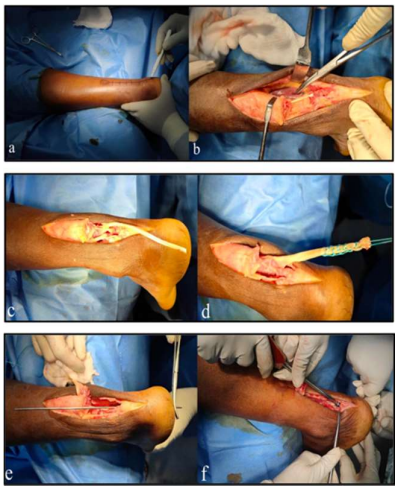

Figure 2: Intraoperative images of the procedure (a) Skin incision (b) Debridement of achilles tendon (c) FHL is harvested (d) Whip stitch taken with Ethibond (e) Calcaneum tunnel (d) Tenodesis done with interference screw

Figure 3: C arm image of interference screw

Figure 4: Postoperative screw at 1 month

Figure 5: Complication – superficial wound infection

Results

The study cohort comprised 12 patients (8 males, 4 females) with a mean age of 52.4 years (range 36–68 years). The mean interval from injury to surgical intervention was 9.1 weeks (range 6–14 weeks). Low-energy trauma accounted for the majority of injuries (10 cases, 83.3%), encompassing accidental falls and domestic incidents, while road traffic accidents accounted for the remaining 2 cases (16.7%). All patients presented with inability to perform a single-leg heel raise and a palpable tendon gap confirmed on imaging; intraoperative measurements revealed a mean tendon defect of 6.2 cm (range 5–8 cm). Patient demographic and clinical characteristics are summarized in Table 1.

Table 1: Patient Characteristics

Characteristic	Patients (n = 12)
Gender	
Male	8 (66.7%)
Female	4 (33.3%)
Age (years)	52.4 ± 9.2
Duration: injury to surgery (weeks)	9.1 ± 2.4
Mechanism of injury	
Low-energy trauma	10 (83.3%)
Road traffic accident	2 (16.7%)
Injury side	
Left	5 (41.7%)
Right	7 (58.3%)
Diabetes mellitus	
Yes	1 (8.3%)
No	11 (91.7%)
Mean tendon defect length (cm)	6.2 ± 0.9
Follow-up duration (months)	9
Complications	
Superficial wound infection	1 (8.3%)

Characteristic	Patients (n = 12)
Great toe IP joint stiffness	2 (16.7%)

Functional outcomes improved substantially following surgery. The mean AOFAS ankle-hindfoot score rose from 61.3 ± 5.4 preoperatively to 91.8 ± 4.2 at final follow-up ($p < 0.001$). Ten patients (83.3%) attained excellent outcomes (AOFAS >90), and the remaining 2 (16.7%) achieved good outcomes (AOFAS 80–89). ROM recovery was equally notable: mean plantarflexion improved from 12.4° ± 3.1° to 34.6° ± 2.8°, and mean dorsiflexion from 8.6° ± 2.4° to 18.1° ± 1.9° at 9 months ($p < 0.001$ for both). Longitudinal functional outcome data are presented in Table 2.

Table 2: Functional Outcome Scores Over Time

Follow-up	AOFAS Score (Mean ± SD)	Plantarflexion (°)	Dorsiflexion (°)	Single Heel Raise (n, %)
Preoperative	61.3 ± 5.4	12.4 ± 3.1	8.6 ± 2.4	0 (0%)
3 months	78.5 ± 4.8	24.3 ± 2.5	14.1 ± 2.1	11 (91.7%)
6 months	86.7 ± 3.9	30.5 ± 2.7	16.5 ± 2.0	12 (100%)
9 months	91.8 ± 4.2	34.6 ± 2.8	18.1 ± 1.9	12 (100%)

Eleven patients (91.7%) regained the capacity to perform a single heel raise by 3 months postoperatively; the remaining patient achieved this milestone by 6 months. Independent ambulation was established in all patients by 10 weeks, and 11 of 12 (91.7%) returned to their pre-injury activity levels. One diabetic patient with elevated BMI reported mild fatigue during prolonged ambulation but maintained independent walking throughout follow-up.

Complications were infrequent and minor. One patient (8.3%) developed a superficial wound infection that resolved completely with oral antibiotics and local wound care (Figure 5). Two patients (16.7%) reported mild stiffness of the interphalangeal joint of the great toe, although neither experienced functional limitation in daily activities. No cases of re-rupture, deep infection, sural nerve injury, or clinically significant donor-site weakness were documented. Patient satisfaction was universally high, with all participants indicating willingness to undergo the procedure again.

Discussion

Chronic Achilles tendon rupture poses a formidable reconstructive challenge owing to the progressive degenerative changes, tendon retraction, and fibrosis that accumulate over time. In late-presenting cases, the capacity for spontaneous healing is negligible and the gap between tendon stumps frequently precludes primary repair.6,7 Among the available reconstructive options—including V-Y myoplasty, synthetic grafts, and allograft reconstruction—FHL tendon transfer has attained broad acceptance as a biomechanically sound solution, particularly for defects exceeding 5 cm.10,11

The present study reports encouraging outcomes in 12 patients with CATR managed using a standardised single-incision FHL transfer, demonstrating meaningful gains in both functional scores and ROM alongside a low complication profile. These findings are consistent with the wider literature confirming that FHL, by virtue of its anatomical proximity, comparable pull vector, synchronous firing with the triceps surae, and adequate tensile strength, constitutes an optimal substitute for a degenerated Achilles tendon.8,11,12 Its extended muscle belly and favourable intrinsic vascularity also facilitate biological integration, particularly within the hypovascular watershed zone of the Achilles tendon located 2–6 cm proximal to the calcaneal insertion.13

The mean AOFAS score improvement from 61.3 to 91.8 in our series reflects a high rate of functional recovery, enabling patients to resume independent walking, perform single-leg heel raises, and return to pre-injury activity levels. Comparable gains have been reported by Jadawala et al.,14 Chaudhari et al.,15 and Sidhdhauria et al.,16 all of whom documented significant postoperative AOFAS improvements and high patient satisfaction following FHL transfer.

Donor-site morbidity was minimal. Only two patients experienced mild great toe interphalangeal stiffness, neither of which affected functional daily activities—an observation consistent with the findings of Coull et al.17 and Wapner et al. 18 who attributed preserved toe function to compensatory recruitment of adjacent flexor tendons following FHL harvest.

With respect to surgical safety, the single-incision approach yielded a complication rate of 8.3% (one superficial infection), two patients (16.7%) reported mild stiffness of the interphalangeal joint of the great toe with no re-ruptures, sural nerve injuries, or deep infections encountered. These results corroborate findings by Kirubakaran et al.5 and Nalge et al.16 who similarly highlighted the safety and reproducibility of this technique in experienced hands.

All patients achieved independent ambulation by the 10th postoperative week, and 11 of 12 resumed full activity by 12th week. This early mobilization was facilitated by the rigid fixation afforded by interference screws. Evidence suggests that appropriately supervised early weight-bearing does not elevate failure risk and may instead promote tendon remodeling and muscle reactivation.19

From a biomechanical perspective, FHL transfer more effectively restores push-off strength and normalizes gait mechanics than synthetic or allograft alternatives, particularly in active patients.11 Its anatomical proximity to the Achilles tendon also permits harvesting through the same incision, thereby reducing operative time, intraoperative morbidity, and length of hospital stay.10,15 Limitations of this study include the small cohort (n = 12), the absence of a control arm for direct technique comparison, and a follow-up period restricted to 9 months. Although the results are statistically significant, larger multicentre investigations with extended follow-up are needed to assess long-term durability and sports-specific recovery outcomes.

Conclusion

This study demonstrates that single-incision FHL tendon transfer is a safe and effective reconstructive strategy for chronic Achilles tendon ruptures with tendon gaps ≥5 cm. Significant improvements in AOFAS scores (61.3 to 91.8; $p < 0.001$), early restoration of the single heel raise in 91.7% of patients, and a low complication rate validate the reliability of this technique. The procedure's technical simplicity, cost-effectiveness, and reproducibility make it well suited to resource-variable settings where delayed presentations are the norm. Future studies with larger cohorts and longer follow-up are warranted to further refine patient selection and evaluate outcomes in physically demanding populations.

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