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CLINICAL, FUNCTIONAL AND RADIOLOGICAL OUTCOMES OF FLEXOR HALLUCIS LONGUS TRANSFER IN CHRONIC ACHILLES TENDON RUPTURE: A PROSPECTIVE STUDY

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ABSTRACT **Background:** Chronic Achilles tendon ruptures present a surgical challenge due to tendon retraction and large defects. Flexor hallucis longus (FHL) transfer is a commonly used reconstructive option in such cases. **Methods:** This hospital based prospective observational study was conducted on 30 patients with chronic Achilles tendon rupture (>6 weeks) in the Department of Orthopedics at M.L.N. Medical College, Prayagraj, over a period of 12 months. Functional outcomes were assessed using the Visual Analogue Scale (VAS), American Orthopedic Foot and Ankle Society (AOFAS) score, and Achilles Tendon Total Rupture Score (ATRS), along with radiological evaluation of tendon healing. **Results:** Significant improvement in pain was observed, with mean VAS decreasing from 6.16±0.88 preoperatively to 3.42±0.51 at 12 months ($p<0.001$). Good to excellent functional outcomes were seen in 56.6% of patients. Radiological healing was observed in 83.4% of cases, and 66.7% of patients reported complete satisfaction. **Conclusion:** FHL tendon transfer is a reliable and effective surgical option for chronic Achilles tendon rupture, providing significant pain relief, functional improvement, and satisfactory radiological healing.

KEYWORDS : Chronic Achilles Rupture, FHL Transfer, Tendon Healing

INTRODUCTION

Chronic rupture of the Achilles tendon, typically defined as injury left untreated for more than six weeks, remain a challenging clinical problem for both patients and surgeons. In such cases, the tendon ends are often retracted, degenerated, and surrounded by fibrotic tissue, rendering primary end-to-end repair unreliable and technically demanding.[1] Delayed diagnosis or inappropriate initial management further complicates treatment and may result in persistent functional impairment, reduced plantar flexion strength, or altered gait mechanics.[2]

To address these challenges, reconstructive procedures such as tendon augmentation and tendon transfer have been increasingly advocated. Among these, transfer of the flexor hallucis longus (FHL) tendon has emerged as a widely accepted and effective surgical option due to its anatomical proximity, adequate length, and biomechanical strength.[3] The FHL muscle contracts in synchrony with the gastrocnemius soleus complex, thereby facilitating restoration of push-off power during gait while producing minimal functional deficit of the great toe.

Several clinical studies have demonstrated consistently favorable outcomes following FHL transfer, including significant improvement in functional scores, pain relief, and low complication rates.[4,5] Furthermore, systematic reviews and contemporary literature support the reliability and reproducibility of this technique, with most patients successfully returning to daily activities and recreational levels of physical activity with minimal donor-site morbidity.[6]

An important consideration in the management of chronic Achilles tendon rupture is achieving an optimal balance between surgical efficacy and donor site morbidity. Alternative techniques, such as peroneus brevis tendon transfer and V–Y advancement, have been described. However, these methods may be associated with prolonged rehabilitation, increased morbidity, or compromised push-off strength.[7,8] In contrast, FHL transfer offers a technically straightforward and biomechanically sound reconstruction, particularly in cases involving large tendon defects where primary repair is not feasible.

In addition, advances in imaging modalities, particularly magnetic resonance imaging (MRI), have enabled objective assessment of tendon healing, muscle adaptation, and integration of the transferred tendon within the Achilles mechanism.[9] Despite these advances, limited data exist correlating radiological findings with functional outcomes, especially in resource limited settings. The present study was therefore conducted to evaluate both clinical and radiological outcomes of FHL tendon transfer in patients with chronic Achilles tendon rupture over an year follow up. This study aimed to evaluate clinical, functional and radiological outcomes of FHL tendon transfer in chronic Achilles tendon rupture.

MATERIAL AND METHODS

The present hospital based prospective observational study was conducted in the Department of Orthopedics at M.L.N. Medical College, Prayagraj for a period of 12 months. Patients were selected using a non-probability convenience sampling technique. Pre-operative evaluation included clinical and radiological assessment using MRI. Patients were followed up at 6 weeks, 3 months, 6 months, and 12 months. A total of 30 participants fulfilling the inclusion criteria were enrolled after obtaining institutional ethical approval and written informed consent.

Inclusion and Exclusion Criteria

Adult patients aged ≥18 years of either gender presenting with chronic Achilles tendon rupture of more than six weeks duration were included. Eligibility criteria included a tendon gap greater than 5 cm after intraoperative debridement, clinical features such as inability to perform a single-leg heel raise, increased dorsiflexion compared to the contralateral side, or a palpable tendon defect, along with radiological confirmation of complete rupture by MRI or ultrasonography. Patients with acute ruptures (<6 weeks), local or systemic infections, prior surgery or open rupture at the same site, uncontrolled systemic comorbidities such as diabetes or chronic kidney disease, and those unwilling to participate were excluded.

Ethical Considerations

The study was approved by the Institutional Ethics Committee of Motilal Nehru Medical College, Prayagraj with IEC approval number IEC/MLNMC/2025/TP-197. Written informed consent was obtained from all the participants prior to enrollment. Deidentified data are available from the corresponding author.

Preoperative Preparation:

A detailed clinical history and physical examination were performed for all patients. Radiological assessment using MRI or ultra-sonography confirmed the diagnosis and tendon gap. Patients were adequately informed regarding the procedure, potential risks, expected outcomes, and postoperative rehabilitation protocol.

Surgical Procedure:
All procedures were performed under spinal, epidural, or general anesthesia with the patient in the prone position. A posterior longitudinal incision was used to expose the ruptured Achilles tendon and degenerative ends were debrided. The FHL tendon was harvested via a medial approach while preserving its vascularity. A calcaneal tunnel was created, and the FHL tendon was passed and secured using an interference screw or suture anchor. Residual Achilles tendon tissue was utilized for augmentation. Wound closure was performed in layers, followed by a sterile dressing and immobilization in below-knee cast in plantarflexion.

Postoperative Care:
The operated limb was immobilized in plantarflexion for 4–6 weeks. Patients remained non weight bearing for initial 6 weeks followed by gradual progression to full weight bearing by 12 weeks. After 12 weeks, a structured rehabilitation program including strengthening, proprioceptive training, and functional exercises was initiated.

Data Collection and Tools
Data were collected at preoperative, intraoperative, and postoperative stages. Baseline variables included demographic details, pain assessment using the Visual Analog Scale (VAS), functional status, and radiological evaluation of tendon gap using MRI or ultrasonography.

Intraoperative parameters such as tendon gap measurement, duration of surgery, and intraoperative complications were recorded. Patients were followed at 6 weeks, 3 months, 6 months, and 12 months. Functional outcomes were assessed using the American Orthopedic Foot and Ankle Society (AOFAS) score and the Achilles Tendon Total Rupture Score (ATRS), along with VAS for pain assessment. Radiological healing, postoperative complications, and patient satisfaction were also documented.

Statistical Analysis
Data were analysed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation, categorical variables were presented as frequencies and percentages. The paired t-test was used to compare preoperative and postoperative functional and pain scores. Chi-square test or Fisher's exact test was applied for categorical variables. A p-value of <0.05 was considered statistically significant.

OBSERVATIONS AND RESULTS

Table No. 1: Distribution of Study Participants According to Demographic and Clinical Characteristics

Variable	Category	Percentage (%)
Age group (years)	18–35	16.7
	36–55	53.3
	56–70	30
Gender	Male	66.7
	Female	33.3
Side of injury	Left	53.3
	Right	46.7
Types of complications	Infection	6.7
	Wound healing issue	3.3
	Donor site morbidity	3.3

Present study found that most participants belonged to age group 36–55 years (53.3%), followed by 56–70 years (30.0%) and 18–35 years (16.7%). Males formed a larger proportion (66.7%) compared to females (33.3%). Left-sided injuries were slightly more common (53.3%) than right-sided (46.7%). Among complications, infection occurred in 6.7%, while wound healing issues and donor site morbidity were noted in 3.3% each. (Table no 1)

Table no. 2: Distribution of Study Participants According to Functional, Radiological and Satisfaction Outcomes

Variable	Category	Percentage (%)
Score	95–100	23.3
	75–94	33.3
	51–74	16.7
	0–51	26.7
ATRS	1–30	30
	31–60	46.7
	61–100	23.3
Radiological evaluation	Normal	83.4
	R/ED	13.3
	LD/D	3.3
Satisfaction (cases)	Completely satisfied	66.7
	Moderately satisfied	23.3
	Neutral	10

Present study assessed the functional, radiological, and satisfaction outcomes of the participants. In terms of functional scoring, about one-quarter (23.3%) achieved very good results (scores 95–100), while one-third (33.3%) had good outcomes (scores 94–75). Moderate outcomes (scores 51–74) were seen in 16.7%, and poor results (≤50) in 26.7% of cases. On ATRS assessment, nearly half of the patients (46.7%) showed moderate recovery (31–60), while 30.0% had poor scores (1–30) and 23.3% attained good scores (61–100). Radiological evaluation demonstrated normal findings in most cases (83.4%), with minor changes in 13.3% and degenerative changes in 3.3%. Regarding satisfaction, two-thirds of the participants (66.7%) were completely satisfied with the outcome, 23.3% were moderately satisfied, and 10.0% remained neutral. R/ED = Residual edema, LD/D = Late degeneration (Table 2)

Table no. 3: Trend of VAS Scores Over Follow-up Period

Time Point	Mean ± SD	p-value
Pre-operative	6.16 ± 0.88	< 0.001
6 weeks	6.12 ± 0.59	
3 months	5.77 ± 0.81	
6 months	4.31 ± 0.55	
12 months	3.42 ± 0.51	
Overall (Repeated Measures ANOVA)	—	

The mean VAS score at baseline was 6.16 ± 0.88, which remained almost unchanged at 6 weeks (6.12 ± 0.59). At 3 months, the score showed a gradual decline to 5.77 ± 0.81, followed by a marked reduction at 6 months (4.31 ± 0.55). By 12 months, pain scores had further decreased to 3.42 ± 0.51, indicating sustained improvement in symptoms over time (Table 3, Figure 1). Repeated measures ANOVA was used for comparison of VAS scores across follow-up intervals, and the analysis revealed a statistically significant reduction in pain intensity over time ($F(4,116) = 77.01$, $p < 0.001$). (Table 3)

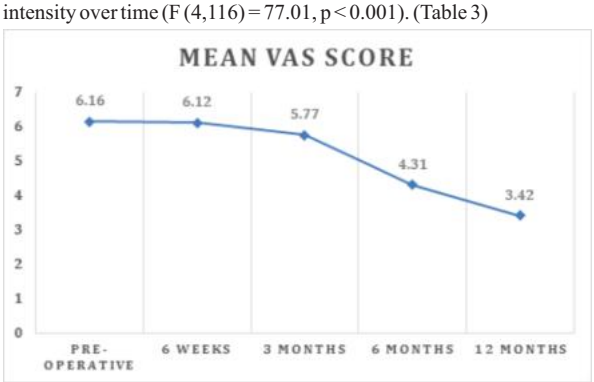

Figure No. 1: Trend of VAS Scores Over Follow-up Period

DISCUSSION

The present study demonstrates that Flexor Hallucis Longus (FHL) tendon transfer is an effective surgical modality for the management of chronic Achilles tendon rupture, resulting in significant improvement in pain, functional outcomes, and radiological healing over an year of follow-up. The progressive reduction in pain and restoration of activity levels observed in our cohort indicate satisfactory clinical recovery and functional reintegration.

These findings are consistent with recent literature evaluating FHL tendon transfer in chronic Achilles tendon ruptures. A recent meta-analysis reported that FHL transfer significantly improves functional outcomes and patient-reported satisfaction, supporting its role as a reliable surgical option.[10] Similarly, contemporary clinical studies have demonstrated that patients undergoing FHL transfer show marked improvement in pain and functional scores postoperatively, reinforcing its effectiveness in chronic cases.[11]

Radiological healing observed in our study, including restoration of tendon continuity, is supported by recent imaging-based evaluation. These studies have demonstrated successful graft integration and adaptive remodeling following FHL transfer, highlighting its biological suitability for reconstruction. [12] The structural compatibility

and proximity of the FHL tendon facilitate effective incorporation and long-term stability.

Functional recovery in our cohort, with a significant proportion achieving very good outcomes, is in agreement with recent systematic reviews. A comprehensive review published in a high-impact journal reported substantial improvements in AOFAS and ATRS scores, along with a high rate of return to pre-injury activity levels following tendon transfer procedures. [13] The moderate ATRS scores observed in a subset of patients in our study may reflect incomplete restoration of calf muscle strength and endurance, which has also been reported in previous studies. This highlights that while structural healing is achieved, functional recovery may vary depending on rehabilitation compliance and patient-related factors. Furthermore, recent evidence suggests that minimally invasive and endoscopic approaches to FHL transfer may provide comparable functional outcomes with reduced complication rates. [14]

From a biomechanical and surgical perspective, FHL transfer offers distinct advantages. Recent evidence-based guidelines and systematic reviews emphasize that FHL transfer restores tendon continuity effectively while maintaining plantarflexion strength and functional biomechanics.[15] Additionally, tendon transfers in the foot and ankle have been associated with high satisfaction rates and low complication profiles, further supporting their use in chronic Achilles ruptures. [16]

From a patient-centered perspective, return to activity and satisfaction remain key outcome measures. Recent clinical studies have demonstrated that most patients regain pre-injury functional levels and report high satisfaction following FHL transfer, despite minor residual deficits in strength or endurance.[17] This aligns with the subjective and functional improvements observed in our study.

Despite these encouraging findings, the results of the present study should be interpreted in light of certain limitations. The relatively small sample size and single-centre design may limit generalizability. The absence of a control group and lack of randomization restrict direct comparison with alternative surgical techniques. Additionally, the follow-up duration of one year may not adequately capture long-term outcomes or late complications.

Overall, the findings of the present study, in conjunction with recent high-quality literature, suggest that FHL tendon transfer provides consistent and reliable outcomes in the management of chronic Achilles tendon rupture. It results in significant improvement in pain, functional recovery, and structural integrity, making it a valuable surgical option, particularly in cases with large tendon defects. The study is limited by small sample size, single-center design, lack of control group, and short follow-up duration.

CONCLUSION

FHL tendon transfer is a reliable and effective surgical option for chronic Achilles tendon rupture, providing significant pain relief and satisfactory radiological healing. However, variability in functional outcomes suggests that complete recovery may not be achieved in all patients. Further large-scale comparative studies are required to establish its superiority over other surgical techniques.

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