

Functional Outcomes of Flexor Hallucis Longus Tendon Transfer after Excision of Achilles Tendon Xanthoma: A Case Series

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ABSTRACT

Background

Achilles tendon xanthoma is an uncommon manifestation of lipid metabolism disorders that may lead to progressive tendon enlargement, painless functional impairment and tendon defects after excision. This study evaluated the functional outcome of flexor hallucis longus (FHL) tendon transfer following surgical excision of a symptomatic Achilles tendon Xanthoma.

Methods

This single-center prospective observational case series comprised eight consecutive patients who underwent surgical excision of Achilles tendon xanthoma followed by FHL tendon transfer at the Department of Orthopaedic Surgery, Bangladesh Medical University (BMU), Dhaka, Bangladesh, between July 2024 and June 2026. Functional status was assessed using the American Orthopaedic Foot & Ankle Society (AOFAS) Ankle-Hindfoot Scale and pain was assessed using the Visual Analog Scale (VAS). Ankle dorsiflexion and plantarflexion were recorded preoperatively and postoperatively at 3 months, 6 months, up to final follow-up. Postoperative complications were documented. Changes across follow-up assessments were analysed using the Friedman test.

Results

The mean age was 31.6 ± 6.8 years, and 5 (62.5%) patients were female. Bilateral involvement was observed in 6 (75.0%) patients and dyslipidaemia/hypercholesterolaemia was present in 5 (62.5%). The mean AOFAS score improved from 51.8 ± 8.7 preoperatively to 89.1 ± 5.4 at final follow-up ($p = 0.012$), while VAS pain scores decreased from 7.0 ± 1.1 to 1.6 ± 0.7 ($p = 0.011$). Dorsiflexion and plantarflexion also improved significantly ($p = 0.018$ and $p = 0.012$, respectively). Seroma, superficial wound infection, delayed wound healing, and persistent plantarflexion weakness occurred in 1 (12.5%) patient each. No tendon re-rupture or revision surgery occurred.

Conclusion

FHL tendon transfer following excision of Achilles tendon xanthoma was associated with favourable functional outcomes and improved ankle range of motion in this case series. No tendon re-rupture or revision surgery was observed during follow-up.

Keywords

Achilles tendon xanthoma; Flexor hallucis longus tendon transfer; Achilles tendon reconstruction; Functional outcome; Ankle function.

INTRODUCTION

Tendinous xanthomas are deposits of lipid-laden foam cells with fibrous tissue in tendons and are strongly associated with lipid-metabolism disorders, particularly familial hypercholesterolemia (FH). The Achilles tendon is mostly affected, showing increased thickness and lipid deposits, common signs of hypercholesterolemia and FH.^[1,2] FH affects about 1 in 200–300 people globally.

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^[3] Achilles tendon xanthoma can be an early sign of severe hypercholesterolemia and is associated with an increased risk of premature cardiovascular disease.^[1,4]

Clinically, Achilles tendon xanthomas typically present as slowly progressive tendon enlargement. They may initially be asymptomatic but later cause mild pain, functional limitation and in advanced cases, tendon rupture.^[4,5] Although treating the underlying lipid abnormality remains fundamental to reducing cardiovascular risk, established large or symptomatic tendon xanthomas may require surgical management.^[5,6] Surgical excision can relieve local symptoms and restore tendon contour; however, extensive lesions may involve a substantial portion of the tendon and complete excision can consequently result in a large Achilles tendon defect.^[6,7] Reconstruction of these defects therefore represents a major technical challenge.

Various techniques, like tendon transfers, autologous grafts, V-Y advancement, turn-down flaps and allografts have been proposed for repairing large Achilles tendon defects.^[6,7] No gold standard exists for reconstructing extensive defects after xanthoma removal.^[7] The flexor hallucis longus (FHL) tendon stands out due to its close anatomical relation, biomechanical compatibility, strength and capacity as a vascularized transfer.^[8] FHL transfer has shown promising results in repairing chronic Achilles injuries, especially large defects needing transosseous calcaneal fixation.^[9,10] Recent reports highlight successful outcomes with FHL tendon transfer after extensive Achilles xanthoma excision.

Despite these advances, the available evidence remains limited, consisting predominantly of case reports and small retrospective series.^[5,6,8-10] Furthermore, evidence on the surgical management of Achilles tendon xanthoma in South Asia is sparse. Regional reviews of FH have highlighted substantial gaps in diagnosis and management across the Asia-Pacific region, including limited availability of genetic testing, cascade screening and contemporary lipid-lowering therapies in many countries.^[11] Data specifically addressing the surgical treatment and functional outcomes of Achilles tendon xanthoma in Bangladesh are particularly limited. Therefore, the present study aimed to evaluate the functional outcomes of FHL tendon transfer after surgical excision of an Achilles tendon xanthoma in a single-center cohort in Bangladesh. The study specifically assessed changes in functional status, pain, ankle range of motion and postoperative complications following reconstruction.

METHODS

Study design and setting

This single-center prospective observational case series assessed the functional outcome of patient with symptomatic Achilles tendon xanthoma who underwent surgical removal followed by reconstruction using the flexor hallucis longus (FHL) tendon transfer. The study Conducted at the Department of Orthopaedic Surgery, Bangladesh Medical University (BMU), Dhaka, Bangladesh, from July 2024 to June 2026 and included consecutive patients meeting the eligibility criteria. It examined clinical presentation, functional recovery, pain levels, ankle range of motion and postoperative complications after surgery with FHL tendon transfer.

Patient selection and recruitment

Patients presenting with symptomatic Achilles tendon xanthoma during the study period were assessed prospectively for eligibility. Patients were eligible if they had symptomatic Achilles tendon xanthoma with clear tendon enlargement and underwent surgical excision followed by Achilles tendon reconstruction using flexor hallucis longus (FHL) tendon transfer. Patients with incomplete clinical data or inadequate postoperative follow-up for assessment of the specified outcomes were excluded. Eligible patients were included consecutively. Demographic and clinical data collected included age, sex, laterality, duration of swelling, pain or tenderness, functional impairment, relevant comorbidities, family history of hypercholesterolemia, and history of trauma to the affected area.

Bilateral Disease and Unit of Analysis

Eight patients underwent FHL tendon reconstruction, involving one Achilles tendon per patient. In patients with bilateral disease, surgery was performed on the symptomatic or more severely affected side. The patient was used as the unit of analysis, and each patient contributed one set of observations to the outcome analysis.

Preoperative assessment

All patients underwent a standardised clinical assessment of the affected Achilles tendon, which included evaluating swelling, pain or tenderness, functional limitations, laterality and ankle range of motion. Their medical history was recorded, noting trauma, family history of hypercholesterolemia and other relevant health conditions. Laboratory testing involved lipid

profiling when possible, measuring total cholesterol, LDL, HDL and triglycerides. Plain radiographs of the ankle and foot were performed to see bone structures as well as to exclude bony abnormalities. The diagnosis of Achilles tendon xanthoma was established through clinical signs with imaging results supported by histopathological examination of the excised tissue.

Surgical Technique

The surgical procedure involved meticulous excision of the xanthomatous tissue while preserving as much viable Achilles tendon tissue as technically feasible.

A longitudinal posterior approach was used to expose the Achilles tendon, followed by careful dissection of the xanthomatous tissue from the surrounding soft tissues and residual tendon. The extent of xanthomatous involvement and the integrity of the remaining tendon were assessed intraoperatively. The involved tissue was excised while preserving structurally sound tendon fibers whenever possible. Following complete excision, the Achilles tendon defect measured approximately 15 cm, and the residual tendon was evaluated for its integrity and suitability for primary repair (Figure 1A–D).

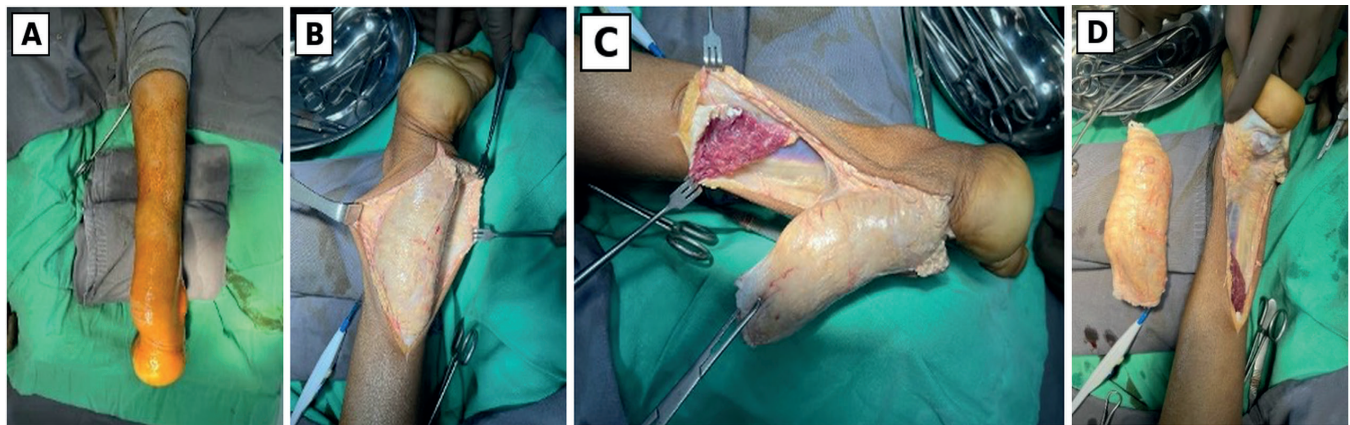


Figure 1 illustrates the intraoperative findings the excision of Achilles tendon xanthoma, including the external appearance after draping of the affected region (A), after incision and exposure of the xanthomatous Achilles tendon (B), the excised extensive Achilles tendon xanthoma (C) and a large Achilles tendon defect seen after excision of the xanthomatous tissue (D).

Because of the extensive tendon defect and insufficient residual tendon tissue for reliable primary repair, Achilles tendon reconstruction using flexor hallucis longus (FHL) tendon transfer was performed. FHL tendon transfer is an established reconstructive option for large Achilles tendon defects and severe tendon degeneration, with favorable functional outcomes reported in previous clinical studies.^{12,13} The FHL tendon was harvested and its length was assessed to ensure adequate coverage of the approximately 15-cm Achilles tendon defect (Figure 2A). A 6-mm calcaneal osseous tunnel was then prepared, and the harvested FHL tendon was transferred posteriorly toward the calcaneus through the tunnel (Figure 2B). The transferred tendon was tensioned with the ankle maintained at approximately 30° of plantarflexion and secured using a biodegradable interference screw (Figure 2C). Where technically feasible, the remaining

viable Achilles tendon tissue was incorporated into the reconstruction. The principles of transosseous FHL tendon transfer and calcaneal fixation are consistent with contemporary techniques described for reconstruction of large Achilles tendon defects.¹⁰

Postoperative Protocol and Follow-up

Post-surgery, the patient's limb was immobilized in a below-knee anterior slab with the ankle in full equinus for 4 weeks. During this time, patients were non-weight-bearing and wound care was carried out as needed. Sutures were removed around 2 weeks after surgery. After 4 weeks, the anterior slab was replaced with a below-knee full plaster with maintaining the ankle position in gravity equinus and immobilization was extended for another 4 weeks.

After 8 weeks, protected weight-bearing began with a high-heel raised shoe featuring a total heel height of 4

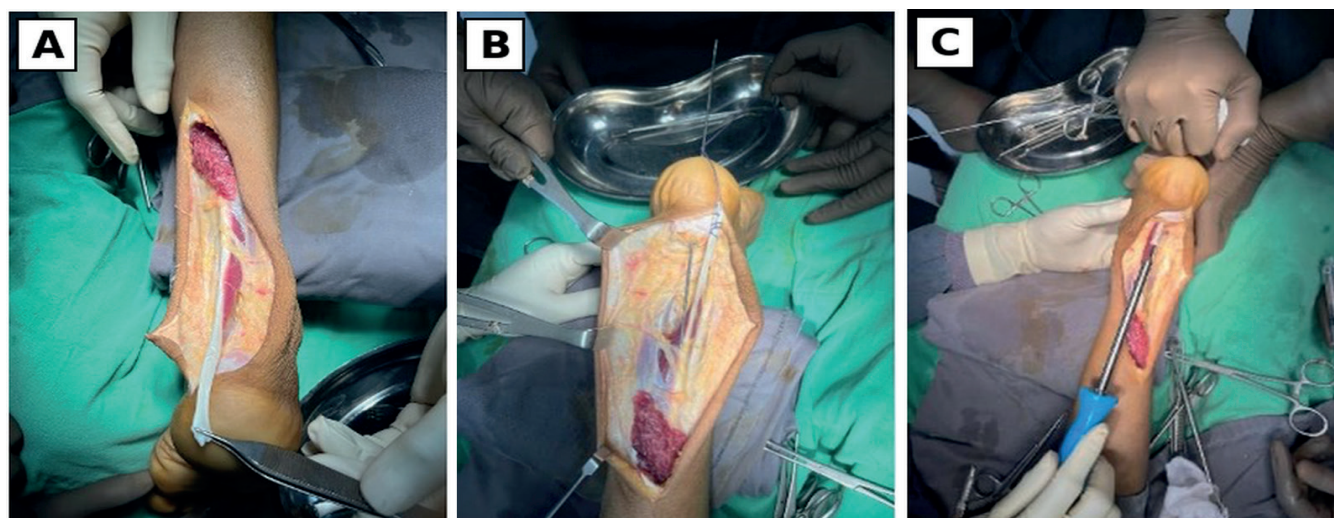


Figure 2 demonstrates the intraoperative stages of Achilles tendon reconstruction, including measuring the length of the FHL tendon (A), preparation and positioning of the FHL tendon for transfer (B) and FHL tendon transfer with calcaneal fixation (C).

cm. This heel height was achieved using 4 blocks where 1 cm height in each block and one block was removed each week over the next four weeks to facilitate a gradual transition to a neutral ankle position.

Clinical follow-up assessments were conducted at 3 months, 6 months and final follow-up 1 year after surgery. At each visit, patients were evaluated for functional status, pain, ankle range of motion, tendon integrity and postoperative complications.

Outcome Assessment

Functional outcome was assessed using the American Orthopaedic Foot & Ankle Society (AOFAS) Ankle-Hindfoot Scale. The AOFAS scale was selected because it is a widely used clinical outcome measure in foot and ankle surgery and provides an assessment of pain, functional status, and alignment. In this study, the AOFAS score was used alongside the Visual Analog Scale (VAS) for pain and objective measurements of ankle dorsiflexion and plantarflexion to provide a broader assessment of postoperative recovery.

Outcome Measures

The primary outcome was improvement in functional status, assessed by the change in AOFAS Ankle-Hindfoot Scale score from the preoperative assessment to final follow-up.

Secondary outcomes included changes in VAS pain score, ankle dorsiflexion and plantarflexion.

Postoperative safety outcomes included seroma, superficial wound infection, delayed wound healing, persistent plantar-flexion weakness, tendon re-rupture, and the need for revision surgery.

Statistical Analysis

Statistical analysis was performed using SPSS version 26.0. Continuous variables were summarized using mean $\pm$ standard deviation or median with interquartile range (IQR), as appropriate, while categorical variables were presented as frequencies and percentages. Because of the small sample size and the repeated-measures nature of the outcome assessments, changes in AOFAS score, VAS pain score, ankle dorsiflexion, and plantarflexion across the preoperative and postoperative assessment points were evaluated using the non-parametric Friedman test. The Friedman test statistic (χ^2) and corresponding p-value were reported. Where the overall Friedman test was statistically significant, post-hoc pairwise comparisons were performed using the Wilcoxon signed-rank test with Bonferroni adjustment for multiple comparisons. A two-sided p-value <0.05 was considered statistically significant.

RESULTS

Table 1 presents the demographic and clinical characteristics of the eight patients who underwent surgical management of Achilles tendon xanthoma. The mean age was 31.6 ± 6.8 years. Of the eight

patients, 5 (62.5%) were female and 3 (37.5%) were male. Six patients (75.0%) had bilateral Achilles tendon involvement, while one patient each (12.5%) had right-sided or left-sided involvement. The mean duration of swelling was 6.8 ± 3.1 years. Seven patients (87.5%) had mild pain or tenderness, and six (75.0%) had functional limitation. Dyslipidemia or hypercholesterolemia was present in five patients (62.5%). Diabetes mellitus and hypertension were each present in one patient (12.5%), while two patients (25.0%) had no reported comorbidities. A family history of hypercholesterolemia was reported in one patient (12.5%), and one patient (12.5%) had a history of prior trauma.

Table 1: Demographic and clinical characteristics of patients undergoing surgical management of Achilles tendon xanthoma

Variable	Frequency (n)	Percentage (%)
Number of patients	8	100.0
Age, years		
Mean $\pm$ SD	31.6 ± 6.8	
Sex		
Female	5	62.5
Male	3	37.5
Laterality		
Bilateral	6	75.0
Right	1	12.5

Variable	Frequency (n)	Percentage (%)
Left	1	12.5
Duration of swelling, years	6.8 ± 3.1	
Mild Pain/tenderness	7	87.5
Functional limitation	6	75.0
Comorbidities		
Dyslipidemia/hypercholesterolemia	5	62.5
Diabetes mellitus	1	12.5
Hypertension	1	12.5
No comorbidity	2	25.0
Family history of hypercholesterolemia	1	12.5
History of trauma	1	12.5

Values are presented as frequency (n) and percentage (%) or mean $\pm$ SD. Patients may have more than one comorbidity.

Table 2 summarizes the changes in functional status, pain, and ankle range of motion over the follow-up period. The mean AOFAS score increased from 51.8 ± 8.7 preoperatively to 89.1 ± 5.4 at final follow-up (Friedman $\chi^2 = 10.950$, $p = 0.012$). The mean VAS pain score decreased from 7.0 ± 1.1 preoperatively to 1.6 ± 0.7 at final follow-up (Friedman $\chi^2 = 11.139$, $p = 0.011$). Mean ankle dorsiflexion increased from $11.9 \pm 3.2^\circ$ to $18.2 \pm 2.4^\circ$ (Friedman $\chi^2 = 10.068$, $p = 0.018$), while mean plantarflexion increased from $31.5 \pm 5.2^\circ$ to $43.6 \pm 3.8^\circ$ (Friedman $\chi^2 = 10.950$, $p = 0.012$).

Table 2: Functional outcomes following FHL tendon transfer

Outcome measure	Preoperative	3 months	6 months	Final follow-up	Friedman test, χ^2	p-value
AOFAS score	51.8 ± 8.7	71.6 ± 6.3	84.8 ± 6.2	89.1 ± 5.4	10.950	0.012
VAS pain score	7.0 ± 1.1	3.8 ± 1.0	2.4 ± 0.9	1.6 ± 0.7	11.139	0.011
Ankle dorsiflexion, $^\circ$	11.9 ± 3.2	14.8 ± 2.8	17.1 ± 2.6	18.2 ± 2.4	10.068	0.018
Ankle plantarflexion, $^\circ$	31.5 ± 5.2	36.9 ± 4.7	41.2 ± 4.2	43.6 ± 3.8	10.950	0.012

AOFAS: American Orthopedic Foot & Ankle Society; VAS: Visual Analog Scale; FHL: flexor hallucis longus.

Postoperative complications are summarized in Table 3. Seroma, superficial wound infection, delayed wound healing, and persistent plantarflexion weakness were each reported in one patient (12.5%). No tendon re-rupture or revision surgery was observed during the follow-up period.

Table 3: Postoperative complications following FHL tendon transfer

Postoperative complication	Frequency (n)	Percentage (%)
Seroma	1	12.5
Superficial wound infection	1	12.5
Delayed wound healing	1	12.5
Persistent plantar-flexion weakness	1	12.5
Tendon re-rupture	0	0.0
Revision surgery	0	0.0

FHL: flexor hallucis longus.

DISCUSSION

This single-center case series examined the outcomes of FHL tendon transfer after removing symptomatic Achilles tendon xanthoma in eight patients. The main observation was a steady improvement in function and ankle mobility following the reconstruction. The average AOFAS score rose from 51.8 ± 8.7 before surgery to 89.1 ± 5.4 at the final follow-up, and the average VAS pain score dropped from 7.0 ± 1.1 to 1.6 ± 0.7 . Dorsiflexion and plantarflexion also showed continuous enhancement. Although the small sample size limits definitive conclusions, the consistent improvements in multiple functional measures indicate a positive response to the reconstruction.

The high occurrence of bilateral involvement (75.0%) and dyslipidemia/hypercholesterolemia (62.5%) aligns with the well-known link between Achilles tendon xanthoma and lipid metabolism disorders. Achilles tendon thickening and lipid buildup are common signs of hypercholesterolemia, especially familial hypercholesterolemia.^[1,2] Tendon xanthomas can serve as important clinical indicators of systemic lipid abnormalities and increased cardiovascular risk.^[3,4] The long duration of swelling observed in our patients highlights the chronic nature of the condition and the tendency for delayed diagnosis.

Removing extensive xanthomatous tissue completely can create a large Achilles tendon defect, posing a reconstructive challenge. Various methods have been documented, including tendon grafting and transfer.^[5,7] FHL transfer is especially appealing because it offers a strong, local tendon with a compatible pull line, making it suitable for reconstructing large Achilles defects. Notably, a recent 2025 case report detailed successful en-bloc removal of a massive Achilles tendon xanthoma followed by FHL transfer, demonstrating this technique's potential for treating xanthomatous tendon disease.^[8]

Our findings align with current research on FHL reconstruction. Friederichsen et al. observed notable improvements in function and pain after transosseous FHL transfer for large Achilles tendon defects, with positive two-year results.^[10] Likewise, a recent systematic review and meta-analysis found significant gains in functional outcomes from FHL transfer across the literature.^[9] While these studies mainly focused on chronic Achilles tendon ruptures or degenerative issues rather than xanthoma, they support the functional effectiveness of FHL reconstruction.

In our series, postoperative complications were minimal. Each of the issues seroma, superficial wound infection, delayed healing, and persistent plantar-flexion weakness occurred in just one patient. No cases of re-rupture or need for revision surgery were reported. These results are promising, but the small sample size suggests that rare complications might not be fully represented.

This study has several limitations. The small sample size, single-center design, absence of a control or comparison group, and relatively limited follow-up restrict the generalizability of the findings and the ability to draw definitive conclusions regarding the effectiveness and long-term durability of the procedure. In addition, the AOFAS Ankle-Hindfoot Scale includes both patient-reported and clinician-assessed components and may not fully capture patient-reported functional recovery. Nevertheless, Achilles tendon xanthoma requiring extensive surgical excision and reconstruction is an uncommon clinical condition, and this prospective case series provides clinical and functional outcome data from Bangladesh. The observed improvements in functional scores, pain, and ankle range of motion suggest favourable outcomes following FHL tendon transfer in this series. Larger multicenter studies with longer follow-up and validated

patient-reported outcome measures are warranted to further evaluate the effectiveness, safety, and durability of this reconstructive approach.

CONCLUSION

FHL tendon transfer following Achilles tendon xanthoma excision was associated with favourable short-term functional and pain outcomes in this small prospective case series. No tendon re-rupture or revision surgery was observed during follow-up. Given the small sample size and absence of a comparison group, these findings should be interpreted cautiously. Larger multicentre studies with longer follow-up are required to further evaluate the effectiveness, safety, and durability of this reconstructive approach.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical Considerations

The study was conducted in accordance with institutional ethical standards. Patient confidentiality was maintained throughout the study and all data were used solely for research purposes.

Informed Consent

Written informed consent was obtained from all participants before data collection.

Author Contributions

All authors contributed to the conception and design of the study, patient management, data collection, analysis, and interpretation of the findings. The manuscript was drafted and critically reviewed by all authors. All authors approved the final version of the manuscript and take responsibility for the integrity and accuracy of the work.

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Declaration of Interests

The authors declare that they have no conflict of interest.

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