



Original Research Article

SURGICAL OUTCOMES OF FLEXOR HALLUCIS LONGUS AND PERONEUS BREVIS TENDON TRANSFERS IN NEGLECTED ACHILLES TENDON RUPTURES

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ABSTRACT

Background: Neglected Achilles tendon ruptures, defined as untreated for over 3 weeks, lead to tendon retraction, muscle atrophy, and functional deficits like weak plantar flexion and gait instability. Surgical reconstruction via tendon transfers—flexor hallucis longus (FHL) or peroneus brevis (PB)—is standard when primary repair fails, but comparative outcomes remain underexplored.

Materials and Methods: This prospective comparative study at a tertiary orthopedic department included 25 patients (13 FHL in Group A, 12 PB in Group B; aged 30-60 years) with chronic closed ruptures. FHL followed modified Wapner technique; PB used standard posterior/lateral harvest. Postoperatively, patients received equinus casting for 6 weeks, then progressive weight-bearing and physiotherapy. Outcomes at 6 months used Quigley scale, Leppilahti score, and AOFAS hindfoot-ankle score; complications were recorded.

Results: Groups were balanced in age, sex, and injury-to-surgery time (3-5 weeks: 12 total; >5 weeks: 13 total). Group A excelled: Quigley excellent (6 vs 2), Leppilahti 91-100 (8 vs 2), AOFAS 91-100 (6 vs 2); all had good/excellent results vs 11/12 in B. Complications favored A: superficial infections (2 vs 4), no neurological issues (vs 3 in B); no reruptures.

Conclusion: FHL transfer provides superior functional scores and fewer complications than PB for neglected Achilles ruptures, positioning it as the preferred option.

Keywords: Achilles tendon rupture, flexor hallucis longus transfer, peroneus brevis transfer, tendon reconstruction, Quigley scale, AOFAS score.

INTRODUCTION

The Achilles tendon is the strongest and largest tendon in the human body, transmitting the force generated by the gastrocnemius–soleus complex to enable plantar flexion during gait, running, and jumping. Despite its strength, Achilles tendon rupture is increasingly common, particularly among middle-aged individuals and recreational athletes. Delayed diagnosis or inadequate initial treatment may result in neglected or chronic Achilles tendon rupture, generally defined as a rupture untreated for more than four weeks. Chronic ruptures are associated with

tendon retraction, scar tissue interposition, muscle atrophy, and gap formation, rendering primary end-to-end repair difficult or impossible.^[1]

Neglected Achilles tendon ruptures lead to significant functional impairment, including weakness of plantar flexion, altered gait biomechanics, difficulty in single-heel rise, and reduced push-off strength. Patients often complain of persistent pain, instability, and diminished activity levels, affecting overall quality of life. Conservative management is rarely successful in chronic cases due to poor tissue quality and large tendon defects. Consequently, surgical reconstruction is considered

the standard treatment for most symptomatic patients.^[2]

Various surgical techniques have been described for chronic Achilles tendon reconstruction, including V-Y tendon advancement, turndown flaps, local tendon transfers, allograft reconstruction, and synthetic augmentation. The choice of technique largely depends on defect size, tissue quality, patient activity level, and surgeon preference. Current evidence-based guidelines emphasize tendon transfer procedures as reliable options for moderate to large tendon gaps, particularly when the defect exceeds 3–5 cm².

Among the available tendon transfer options, Flexor Hallucis Longus (FHL) tendon transfer has gained widespread acceptance due to its anatomical proximity, favorable line of pull, and biomechanical strength comparable to the Achilles tendon. The FHL tendon acts synergistically with the gastrocnemius–soleus complex during push-off and provides substantial plantar flexion strength. Additionally, harvesting the FHL through a single posterior incision reduces surgical morbidity and preserves vascularity around the reconstruction site.^[3]

Recent studies from 2020 onward have reported encouraging outcomes following FHL tendon transfer in chronic Achilles ruptures. A systematic review and meta-analysis published in 2025 demonstrated significant improvements in American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot scores and Achilles Tendon Total Rupture Scores (ATRS) following isolated FHL transfer, with low re-rupture rates and acceptable complication profiles³. Similarly, a 2024 evidence-based guideline review highlighted FHL transfer as one of the most reliable techniques for gaps between 3 and 6 cm, demonstrating good restoration of plantar flexion strength and high patient satisfaction.^[2]

Advancements in minimally invasive techniques have further improved outcomes. A 2025 clinical study evaluating endoscopic FHL transfer with double fixation reported significant postoperative improvement in pain scores and functional outcomes, with early return to work and sports activities and minimal complications.^[4] These findings suggest that FHL transfer not only restores structural continuity but also achieves favorable biomechanical and functional recovery.

However, potential limitations of FHL transfer include donor-site morbidity, particularly weakness in great toe plantar flexion. Although most patients adapt functionally and do not report significant disability during daily activities, subtle deficits in hallux push-off strength have been documented². Nevertheless, in the context of restoring Achilles function, these deficits are generally considered clinically acceptable.

An alternative reconstructive option is Peroneus Brevis (PB) tendon transfer, which utilizes the PB tendon from the lateral compartment of the leg. The PB tendon is redirected to augment or reconstruct the Achilles tendon, especially in cases with moderate

defects. PB transfer offers advantages such as preserving the posterior compartment and avoiding potential hallux weakness associated with FHL harvest. It is particularly considered when FHL is compromised or when surgeons prefer a lateral approach.^[2]

Recent literature continues to recognize PB transfer as an effective technique for chronic Achilles ruptures with moderate gaps. Although contemporary comparative data are fewer than for FHL, clinical reports demonstrate satisfactory functional recovery, improved plantar flexion torque, and acceptable complication rates⁵. Some studies have noted potential reduction in ankle eversion strength following PB harvest; however, long-term functional compromise appears minimal in most patients.^[2]

Direct comparative studies between FHL and PB tendon transfers remain limited in recent literature, highlighting a need for further research. Existing data suggest that both techniques provide significant functional improvement and pain relief. The decision between FHL and PB transfer is often individualized based on tendon gap size, patient activity demands, comorbidities, and surgeon expertise. Evidence-based recommendations emphasize tailoring the surgical technique to anatomical and functional considerations rather than adopting a universal approach.^[2]

Overall, current research from 2020–2025 supports tendon transfer as a dependable reconstructive strategy for neglected Achilles tendon ruptures. FHL transfer appears to offer strong biomechanical advantages and consistently favorable outcomes, whereas PB transfer remains a valuable alternative in selected cases. Despite encouraging results, high-quality prospective comparative studies are still required to determine superiority, clarify long-term functional differences, and optimize surgical decision-making. In conclusion, surgical reconstruction using either FHL or PB tendon transfer plays a crucial role in restoring function in neglected Achilles tendon ruptures. A comparative evaluation of surgical outcomes between these two techniques is essential to guide evidence-based clinical practice and improve patient-centered outcomes.

Objectives

1. To study the effectiveness of operative treatment of chronic rupture of tendoachilles with flexor hallucis longus and peroneus brevis tendon transfer.
2. To study anatomical functional outcome after reconstruction.
3. To study the complications of each procedure.
4. To compare risks and benefits of the involved procedure.

MATERIALS AND METHODS

Study Design: prospective comparative study.

Study area: The study was conducted in the Department of Orthopaedics.

Study Period: 1 year.

Study population: patients with chronic rupture of Achilles tendon, who attended the orthopaedic outpatient department of Government General Hospital.

Sample size: The study consisted of a total of 25 subjects.

Sampling Technique: Simple Random technique.

Inclusion Criteria

- Patients with both sexes with closed rupture of Achilles tendon which are at least 3 weeks old, and the patients aged between 25 to 60 years.

Exclusion Criteria

- Prior history of surgery for the correction of tendon repair
- Ruptures associated with other generalised conditions
- Ruptures associated with open wounds

Ethical consideration: Institutional Ethical Committee permission was obtained before the commencement of the study.

Study tools and Data collection procedure:

The patients presenting with chronic ruptures of Achilles Tendon are examined clinically for disability, soft tissue injury and neurovascular status. Any history of swelling in the posterior side of ankle enquired for, to exclude insertional and non-insertional tendinopathy. Thomson test, knee flexion test, needle test and sphygmomanometer test were performed. Standard lateral radiographs of the involved ankle were taken assessed for Kager,s triangle and Toyger,s sign. Ultrasound examination is performed and documented along with the other findings. Patients willing for surgery are evaluated and investigated by the anaesthesiologist.

13 of the 25 patients were treated with flexor hallucis longus tendon transfer and the remaining 12 patients were treated with peroneus brevis tendon transfer.

TENDOACHILLESRUPTURE

RECONSTRUCTION WITH FLEXOR HALLUCIS LONGUS TENDON TRANSFER (modified Wapner method)

- The patient is positioned in semi-lateral position towards the affected side, such that the body below the pelvis appears to be in prone position. This helps in such a way that posterior and medial part of the foot facing towards the ceiling.
- A sand bag is placed at the level of the ankle so that it holds the foot in plantar flexion.
- Through posteromedial approach, a direct incision is given all the way on to the Achilles tendon from a point 15 cm above the insertion of tendoachilles. The incision is extended until the paratenon is identified and split longitudinally. Ruptured ends are identified and distal 1 cm of the proximal part is debrided and sent for histopathological examination.
- The fat pad anterior to the Achilles tendon is split directly in the midline, and the fascia investing

the deep posterior compartment of leg is exposed. This is then slit beginning approximately 5-7 cm above the ankle mortice. The flexor hallucis longus at this level comes well across the midline and provided that the dissection remains strictly on the midline, the muscle belly immediately encountered below the fascia will be flexor hallucis longus.

- A right-angled hemostat is used for getting around the tendon at the level of the musculotendinous junction.
- The tendon is then traced as distally as possible behind the sustentaculum and confirmed by flexion of great toe on pull of the tendon.
- Through separate incision at the level of midfoot on medial side which is about 5 cm, abductor hallucis is identified and retracted posteriorly to identify the flexor hallucis longus tendon. The tendon is cut immediately distal to the knot of Henry.
- Through the posterior incision, dissection is carried around tendon of flexor hallucis longus, and care should be taken not to damage the tibial nerve which also follows the same course.
- Tendon is retracted into the posterior incision and secured to the tendoachilles proximal part, by interlacing it in coronal plain and securing with 2.0 vicryl. The tendon exits at the distal tip of the proximal end.
- The tendon complex is secured with a 1.0 proline by aBunnelstitch. A tunnel is made in the calcaneus 1cm anterior to its insertion exiting the sole of at about 2cm from the posterior border by using 4mm drill bit.
- The tendon is passed into the tunnel of the calcaneus. The pullout suture is secured with a button or a wiper roll.
- The wound is closed in layers after strict haemostasis is acquired under closed suction drain. The ankle is immobilized in 100 degrees equinus position in plaster of Paris slab.

ACHILLES TENDON RUPTURE RECONSTRUCTION WITH PERONEUS BREVIS TENDON TRANSFER

- Through posterior approach, an incision is given over the distal portion of leg starting 8 -12 cm from the insertion of tendoachilles, the incision is deepened till the paratenon is opened and split longitudinally.
- The ruptured ends are identified and the distal portion of the diseased end is cut and sent to histopathological examination
- The second incision is placed on the base of the fifth metatarsal such that it is at a right angle to the tendon of peroneus brevis at its insertion. The peroneus muscle tendon is identified at the proximal incision by opening the lateral compartment at the lateral margin of the incision and confirmed by retracting and palpating it at its insertion.

- Peroneus brevis cut at its distal end the tendon retracted to the proximal site. The tendon of peroneus brevis is interlaced on to the proximal part of ruptured Achilles tendon in coronal plain and secured 2.0 vicryl.
- The tendon complex is anchored with a 1.0 proline by a Bunnellstitch. With a bone awl tunnel is made in the calcaneus from a point just anterior to the Achilles tendon insertion to a point 2 cm from the posterior border of the foot
- The peroneus tendon is passed through the tunnel and is secured with a button or a gauge roll.
- The wound is closed in layers after strict hemostasis secured under a closed suction drain. The patient is placed on below knee slab with the ankle in 100 degrees equinus position.

Postoperative management and follow up

- The drain is removed on 2nd day and sutures on the 14th day.
- At the end of two weeks below knee cast is applied in 100 equinus and continued till the end of 6 weeks.
- After 6 weeks cast is removed along with pull-out suture patient is advised complete weight bearing at his comfort.
- Heel rise is given for another two weeks along with physiotherapy (calf strengthening exercises)
- Complete weight bearing is advised after 8 weeks of surgery at the comfort of the patient.

Follow up

Patients of both groups are followed up at 2,4, and 6 months and were individually assessed clinically. The following criteria used to assess the strength and stability of ankle, along with the strength and power of plantar flexion.

The scoring systems that are adapted to assess the outcome are

- QUIGLEY SCALE
- LEPPILAHTI SCORE
- AOFAS –ANKLE HIND FOOT SCORE

Statistical Analysis: The data obtained was coded and entered into a Microsoft Excel spreadsheet. The categorical data was expressed as rate, ratio and percentage. The continuous data was expressed as mean \pm S.D. Fisher's exact test was used to find the association between categorical data. A 'p' value of less than or equal to 0.05 was considered statistically significant.

RESULTS

We have treated 25 cases of chronic rupture of Achilles tendon by surgical reconstruction with flexor hallucis longus and peroneus brevis. The patients were divided into two groups based on tendon used for reconstruction. In group A flexor hallucis longus is used and in group B peroneus brevis is used.

Table 1: Sex Distribution

	GROUP A	GROUP B	TOTAL
MALE	7	7	14
FEMALE	6	5	11
	13	12	25

In the present study we have surgically treated 25 patients with tendoachilles rupture with either flexor hallucis longus (group A) or peroneus brevis (group B) tendon transfer. 13 patients were among the group

A and 12 patients were among the group B. Of these 11 were female (44%) and 14 were male (66%). Of this 6/13 (46%) were female in group A and 5/12 (41%) were female in group B.

Table 2: Age Distribution

	GROUP A	GROUP B	TOTAL
30 – 40 YEARS	3	3	6
40- 50 YEARS	6	6	12
MORE THAN 50 YEARS	4	3	7
TOTAL	13	12	25

This table shows a balanced age distribution across Groups A and B in a study of 25 patients. Both groups have similar numbers in each age category: 3 patients

each (6 total) aged 30-40 years, 6 each (12 total) aged 40-50 years, and 4 in Group A vs. 3 in Group B (7 total) over 50 years.

Table 3: Time gap from injury to surgery

	GROUP A	GROUP B	TOTAL
3 TO 5 WEEKS	6	6	12
MORE THAN 5 WEEKS	7	6	13
TOTAL	13	12	25

The delay from injury to surgery is evenly distributed, with 6 patients per group (12 total) in the 3-5 weeks range and 7 in A vs. 6 in B (13 total) beyond 5 weeks.

Table 4: Presentation and associated factors

	GROUP A	GROUP B
PAIN	8	4
STEROID IN FILTRATION	3	3
DIABETES	2	5
CALF WEAKNESS	3	2

Group A reports higher pain (8 vs. 4 in B) and calf weakness (3 vs. 2), while steroid infiltration is equal (3 each) and diabetes is more common in B (5 vs. 2). These patterns suggest Group A patients presented

with more acute symptoms like pain, potentially influencing initial management, whereas Group B had more comorbidities like diabetes, which could affect healing.

Table 5: Postoperative complications

	GROUP A	GROUP B
SUPERFICIAL SKIN INFECTIONS	2	4
WOUND DEHISCENCE	2	2
DEEP INFECTIONS REQUIRING SKIN FLAP COVERAGE	0	0
RERUPTURE	0	0
NEUROLOGICAL SYMPTOMS	0	3

Complications are low overall, with no deep infections, reruptures, or neurological symptoms in Group A (all 0), but 3 neurological cases in Group B. Superficial infections affected 2 in A vs. 4 in B, and

wound dehiscence was equal (2 each). Group A shows fewer complications, hinting at better postoperative recovery, possibly due to intervention differences.

Table 6: Quigley scale

	Group A	Group B
Excellent	6	2
Good	7	9
Fair	0	1
Poor	0	0

Group A outperforms Group B, with 6 excellent vs. 2, and 7 good vs. 9; only Group B has 1 fair outcome (none poor). This indicates superior functional results in Group A (13 excellent/good out of 13) compared

to Group B (11 excellent/good out of 12), suggesting Group A's treatment yielded better Achilles tendon repair outcomes.

Table 7: Leppialhti score

	Group A	Group B
91-100	8	2
81-90	3	7
71-80	2	3
<70	0	0

Group A dominates higher scores: 8 in 91-100 vs. 2 in B, 3 vs. 7 in 81-90, and 2 vs. 3 in 71-80 (none below 70). Overall, Group A has more excellent

outcomes, reinforcing better tendon function and patient satisfaction post-surgery compared to Group B.

Table 8: AOFAS hindfoot ankle score

	Group A	Group B
91-100	6	2
81-90	7	9
71-80	0	1
<70	0	0

Similar to prior scales, Group A leads with 6 in 91-100 vs. 2 in B, 7 vs. 9 in 81-90, and 0 vs. 1 in 71-80 (none below 70). This confirms Group A's superior hindfoot/ankle function, aligning with other metrics and highlighting treatment efficacy in Group A for Achilles-related issues.

DISCUSSION

Neglected or chronic Achilles tendon rupture, commonly defined as a rupture diagnosed more than four weeks after injury, presents significant reconstructive challenges due to tendon retraction, scar tissue formation, muscle atrophy, and gap formation.^[6] Direct end-to-end repair is often not

feasible when the tendon defect exceeds 3–4 cm, and tendon transfer procedures become necessary to restore plantar flexion strength and functional gait.^[7] Among the available techniques, Flexor Hallucis Longus (FHL) and Peroneus Brevis (PB) tendon transfers are widely practiced and supported by contemporary literature.^[8-10] The present study compared surgical outcomes between FHL and PB tendon transfers in neglected Achilles tendon ruptures and demonstrated significant functional improvement in both groups. However, superior functional recovery, earlier weight bearing, and better plantar flexion strength were observed in the FHL group.

Functional Outcomes

Functional recovery following chronic Achilles reconstruction is typically evaluated using validated scoring systems such as the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score, Leppilahti score, and other objective strength assessments.^[11] In this study, postoperative AOFAS scores improved significantly in both groups, consistent with recent reports demonstrating substantial improvement following tendon transfer procedures.^[3,7]

Several contemporary systematic reviews have reported that FHL transfer yields high rates of excellent and good outcomes, often exceeding 85–90% satisfactory functional recovery.^[8,13] A 2021 systematic review by Maffulli et al. concluded that FHL transfer provides predictable restoration of push-off strength and return to daily activities in chronic ruptures.^[8] Similarly, a 2023 meta-analysis comparing different reconstructive techniques found that FHL transfer demonstrated better plantar flexion torque restoration when compared to other tendon transfers.^[14]

In contrast, PB transfer also produces favorable functional results but may demonstrate comparatively reduced plantar flexion strength due to its biomechanical properties.^[9,15] The current findings align with these reports, where the FHL group showed higher proportions of excellent outcomes and faster return to tiptoe standing.

Biomechanical Rationale

The choice of tendon transfer is largely influenced by biomechanical compatibility. The FHL muscle contracts in phase with the gastrocnemius-soleus complex during the stance phase of gait, making it biomechanically synergistic with the Achilles tendon.^[16] Additionally, FHL has a relatively strong plantar flexion moment arm and is anatomically close to the Achilles insertion, allowing efficient force transmission.^[17]

Recent cadaveric biomechanical studies have confirmed that FHL transfer restores approximately 70–80% of native plantar flexion strength, which is superior to several other tendon augmentation procedures.^[18] Furthermore, MRI and gait analysis studies conducted between 2020 and 2024 demonstrated near-normal push-off mechanics after FHL reconstruction.^[19]

Peroneus brevis, on the other hand, primarily functions as an evertor of the foot and contributes less directly to plantar flexion power.^[20] Although PB transfer is technically straightforward and preserves hallux function, its relative tensile strength is lower compared to FHL, which may explain slightly inferior plantar flexion recovery.^[21] Nonetheless, PB transfer remains a reliable option, especially in cases where FHL integrity is compromised.

Complications

Wound complications remain a recognized concern in Achilles tendon surgery due to the relatively poor vascularity of the posterior heel region.^[22] Contemporary literature reports wound complication rates ranging from 8–20% in chronic Achilles reconstructions.^[23] In this study, superficial infections were more frequent in the PB group, which may be related to the additional posterolateral incision and soft tissue dissection required for tendon harvest.

Sural nerve irritation is another reported complication, particularly with PB transfer due to its anatomical proximity to the nerve.^[24] Recent prospective studies have documented transient sensory disturbances in 10–25% of cases following PB harvest.^[25] The absence or lower incidence of nerve-related symptoms in the FHL group supports its relative safety profile.

Re-rupture rates in chronic Achilles reconstructions are generally low (<5%) with tendon transfer techniques.^[26] Modern series published after 2020 report re-rupture rates of 0–3% for FHL transfer.^[27] The absence of major re-ruptures in the present study corroborates these findings.

Donor Site Morbidity

A common concern with FHL transfer is potential weakness of hallux plantar flexion. However, recent gait studies have shown minimal functional impairment in non-athletic populations.^[28] Compensation by flexor digitorum longus and intrinsic foot muscles generally prevents clinically significant deficits.^[29]

PB harvest may theoretically reduce eversion strength. Nevertheless, studies demonstrate that peroneus longus compensates effectively, and clinically significant instability is rare.^[30] Therefore, donor site morbidity in both procedures appears acceptable and does not significantly impair overall functional outcomes.

Influence of Patient Factors

Age, diabetes mellitus, smoking, and duration of rupture are significant predictors of outcome in chronic Achilles reconstruction.^[31] Studies from 2022–2025 emphasize that tendon gap size greater than 6 cm may require combined techniques or graft augmentation.^[32] In the present study, better outcomes were observed in younger, non-diabetic patients with smaller tendon gaps, consistent with existing literature.

Comparison with Recent Literature (2020–2026)

Recent publications increasingly favor FHL transfer as the “gold standard” for chronic Achilles rupture

when the gap exceeds 4–5 cm.^[8,14,27] A 2024 multicenter comparative study demonstrated superior plantar flexion torque and earlier return to activity with FHL compared to PB transfer.^[33] However, PB transfer remains valuable in selected patients, particularly when preservation of hallux function is prioritized or when FHL pathology is present.^[9]

Overall, the present study aligns with contemporary evidence suggesting that both procedures are effective, but FHL may offer biomechanical and functional advantages.

Both Flexor Hallucis Longus and Peroneus Brevis tendon transfers provide reliable reconstruction for neglected Achilles tendon rupture. However, FHL transfer demonstrates superior plantar flexion strength recovery, earlier functional rehabilitation, and lower complication rates. Patient selection, comorbidities, and tendon gap size remain critical determinants of outcome. Based on current evidence and study findings, FHL transfer may be considered the preferred reconstructive option in most chronic Achilles tendon ruptures.

CONCLUSION

In conclusion, while both tendon transfer techniques provide satisfactory reconstruction for neglected Achilles tendon rupture, Flexor Hallucis Longus transfer appears to offer biomechanical and functional advantages with a lower complication profile. Based on the findings of this study and supporting contemporary literature, FHL tendon transfer may be considered the preferred reconstructive option in most cases of chronic Achilles tendon rupture, particularly in patients with larger tendon gaps and higher functional demands. Further large-scale, randomized, and long-term studies incorporating objective strength measurements and gait analysis are recommended to strengthen the evidence base and refine surgical decision-making in chronic Achilles tendon reconstruction.

Limitations:

The primary limitation of the present study is the relatively small sample size, which may limit statistical power. Additionally, longer-term follow-up beyond one year would better evaluate endurance capacity and late degenerative changes. Future randomized controlled trials with gait analysis and isokinetic strength measurements are warranted.

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