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Primary Repair of Severed Tendoachilles Ensured Better Outcome

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ABSTRACT

Background: Achilles tendon rupture, a prevalent musculoskeletal injury, significantly impairs mobility and function. Primary surgical repair ensures anatomical restoration and minimizes rerupture compared to conservative management. ***Objective:*** To evaluate the functional and clinical outcomes of immediate primary repair of acute open *tendoachilles* injuries using the Modified Kessler technique with postoperative functional rehabilitation. ***Methods:*** This prospective cohort study was conducted at Rajshahi Medical College Hospital (January–December 2020) involving 50 patients (38 males, 12 females; mean age 30.02 ± 7.7 years). All underwent primary repair within 6 hours using non-absorbable Prolene sutures. Functional outcomes were assessed at 16 weeks using Juhana Leppilahti Modified Scoring System. Statistical analyses included chi-square tests, Student's *t*-tests, and 95% confidence intervals (CI), with significance at $p<0.05$. ***Results:*** A total number of 50 patients, 90% (n=45) stood on tiptoe unsupported, 8% (n=4) required support, and 2% (n=1) failed due to wound gap. Ankle motion remained normal in 70% (n=35), mildly restricted (≤10°) in 26% (n=13), and severely restricted (>10°) in 4% (n=2). Mean delay of repair was 6.12 ± 2.36 hours. Mean calf circumference reduction was 1.4 ± 0.7 cm ($p=0.031$). Plantarflexion power recovery achieved ≥90% in 88% of patients, with mean torque 27.8 ± 3.1 Nm. Complications included superficial skin infection 8% (n=4), swelling 8% (n=4), hypertrophic scar 4% (n=2), wound gap 2% (n=1). Functional outcome grading: excellent 56%, good 32%, fair 8%, poor 4%. Overall satisfactory outcome: 88% (95% CI, 79–97%, $p=0.001$). Gender, infection status, and timing of surgery were significantly associated with functional outcome ($p<0.05$). ***Conclusion:*** Early primary repair of acute Achilles tendon injuries provides superior functional recovery, reduced rerupture risk, and statistically significant outcomes when performed within the golden 6-hour window.

Keywords: Achilles Tendon Rupture; Primary Repair; Functional Outcome; Surgical Technique; Rehabilitation.

INRODUCTION

The Achilles tendon, or *tendo calcaneus*, is the strongest and thickest tendon in the human body, formed by the confluence of the gastrocnemius and soleus muscles of the posterior compartment of the leg.[1] It inserts into the posterior aspect of the calcaneal tuberosity and plays a pivotal role in locomotion by transmitting the contractile forces of the triceps surae complex to the heel, thereby enabling plantarflexion of the ankle joint during gait, running, and jumping. Despite its structural robustness, the Achilles tendon is the most frequently ruptured tendon in the adult population, particularly among athletes and physically active individuals, where sudden eccentric loading, unexpected dorsiflexion, or direct trauma precipitates rupture.[2] This paradox of strength and susceptibility underscores the tendon's complex biomechanical and vascular characteristics and highlights the clinical significance of its injury.

The first recorded description of Achilles tendon rupture dates back to Ambroise Paré in 1575, and subsequent reports appeared in the medical literature in 1633.[3] Over the centuries, the management of this injury has evolved considerably, shifting from conservative treatment toward operative strategies. Historically, Hippocrates had asserted that injury to the calcaneal tendon was almost

invariably fatal due to ensuing systemic complications such as fever, respiratory compromise, and delirium.[4] Although these observations reflected the limitations of ancient medicine, they foreshadowed the seriousness of tendon injuries before the advent of modern surgical and rehabilitative methods. Today, surgical repair of acute Achilles tendon rupture is recognized as a mainstay of treatment, especially in younger and active populations, where restoration of tensile strength, anatomical alignment, and functional recovery is paramount.

The Achilles tendon is uniquely vulnerable due to its relatively poor vascularization, particularly in its mid-substance region, approximately 2–6 cm proximal to the calcaneal insertion, where most ruptures occur.[5] Blood supply is derived from the musculotendinous junction, the surrounding paratenon, and the osteotendinous junction; however, age-related decline in vascular perfusion further predisposes the tendon to degeneration and rupture. Histologically, ruptured tendons often exhibit disorganized collagen architecture with a predominance of type III collagen, which has inferior tensile strength compared to type I collagen, thereby impairing resilience under physiological loading. These structural and vascular limitations underscore the biological challenges inherent to tendon healing and provide the rationale for early surgical intervention aimed at restoring native anatomy and optimizing biomechanical performance. The biomechanics of the Achilles tendon further illustrate its clinical vulnerability. During running, the tendon experiences peak loads exceeding 12.5 times body weight, while during jumping, in vivo recordings reveal forces of over 2000 newtons.[6] These extreme mechanical demands necessitate structural integrity, yet repetitive microtrauma, sudden eccentric contractions, or unanticipated dorsiflexion can exceed the tendon's physiological threshold, culminating in partial or complete rupture. The consequences of rupture are profound, as patients frequently experience impaired plantarflexion strength, reduced push-off efficiency during gait, calf muscle atrophy, and long-term limitations in sporting and occupational activities. Thus, effective management of Achilles tendon injuries is essential not only for restoring musculoskeletal function but also for preserving quality of life.

Management strategies for Achilles tendon rupture have historically oscillated between non-operative and operative modalities. Conservative treatment with cast immobilization has been advocated in older, sedentary patients due to lower risks of surgical complications; however, non-operative approaches are associated with higher rates of tendon elongation, reduced calf muscle strength, and significantly increased rerupture rates—reported as high as 12–13% in meta-analyses. Conversely, operative repair substantially reduces rerupture rates to 2–5% and provides superior functional outcomes in terms of muscle strength, tendon length preservation, and earlier return to pre-injury activity levels. Thomopoulos *et al.* in a systematic review and meta-analysis of randomized controlled trials demonstrated that surgical treatment yielded a relative risk reduction of 68% in rerupture compared to conservative management, reinforcing the superiority of operative repair in suitable candidates.[7]

Among surgical strategies, primary repair—defined as immediate surgical reconstruction within 24 hours of injury—has gained prominence as a standard of care in acute open injuries. Primary repair enables direct end-to-end approximation of tendon stumps, facilitates optimal collagen fiber orientation during healing, and reduces the need for grafts or augmentation required in delayed or chronic cases.[8] By minimizing scar tissue formation, adhesion, and tendon elongation, early repair enhances the probability of restoring normal biomechanics. Furthermore, the Modified Kessler technique, widely employed in open repairs, provides reliable tensile strength while preserving paratenon integrity, thus optimizing vascular supply and reducing the incidence of wound complications.

The functional outcome following Achilles tendon repair is multifactorial, influenced by age, sex, mechanism of injury, location of rupture, surgical technique, and adherence to postoperative rehabilitation. Functional rehabilitation protocols emphasizing early controlled mobilization and progressive weight-bearing are now considered critical adjuncts to surgical repair. Early mobilization stimulates collagen alignment, prevents adhesion, and enhances tensile strength without increasing rerupture risk. Marti and Weber were pioneers in advocating early postoperative mobilization, reporting accelerated return to sports compared with conventional immobilization regimens.[9] Subsequent studies confirm that early motion protocols, when combined with robust surgical fixation, yield excellent long-term outcomes in terms of tendon strength, joint mobility, and patient satisfaction.

Despite the advantages of surgical intervention, complications remain a clinical concern. Wound infection, delayed healing, adhesion, hypertrophic scarring, and sural nerve injury have been documented, particularly in open repairs.[10] However, the incidence of such complications can be minimized through meticulous surgical technique, stringent aseptic protocols, and careful patient selection. Importantly, recent prospective cohort studies highlight that when operative repair is performed early and coupled with structured rehabilitation, excellent outcomes are achieved in over 80–90% of patients, with restoration of near-normal plantarflexion strength and ankle mobility. This compelling evidence underpins the rationale for advocating early primary repair in acute severed Achilles tendon injuries.

MATERIALS AND METHODS

Study Design

This study was designed as a prospective cohort analysis conducted in the Department of Surgery, Rajshahi Medical College Hospital, between January 2020 and December 2020. A total of 50 patients who were presented with acute open rupture of the Achilles tendon were enrolled. The primary objective was to evaluate the functional and clinical outcomes of immediate surgical repair using the Modified Kessler technique. Patients were admitted through the emergency department and underwent surgical intervention within 6–10 hours of injury. The study emphasized early repair to minimize the risk of tendon elongation, adhesion, and poor healing outcomes. Postoperative rehabilitation was standardized to ensure consistency across all participants. Outcome assessment was based on the Juhana Leppilahti Modified Scoring System, evaluating tiptoe standing, ankle range of motion, plantarflexion power, calf muscle circumference, and postoperative complications. Both short-term recovery (16 weeks) and intermediate follow-up were assessed to determine the effectiveness of early surgical intervention.

Data was collected using a pretested structured questionnaire and clinical proforma. Patient demographics, mechanism of injury, timing of surgery, and intraoperative findings were documented. Baseline functional status was recorded at admission. Perioperative variables included repair time, suture material, and intraoperative complications. Postoperative follow-up was conducted at 2, 6, 10, 12, and 16 weeks, where outcomes such as plantarflexion strength, ankle range of motion, calf circumference, infection status, wound healing, and ability to stand on tiptoe were measured. All functional outcomes were quantified using the Juhana Leppilahti Modified Scoring System for consistency and comparability. All data were compiled and analyzed using the Statistical Package for the Social Sciences (SPSS) version 22.0. Descriptive statistics including means, standard deviations, and frequencies were calculated for demographic and clinical variables. The chi-square test was applied to assess categorical variables such as infection status and functional grade outcomes. Independent Student's *t*-tests were used to compare mean differences between subgroups (e.g., gender, timing of repair). Confidence intervals (95%) were calculated for overall outcome measures. Statistical significance was set at $p<0.05$. Results were graphically presented using bar charts and tables for clearer interpretation and comparison of outcomes. Upon admission, all patients underwent detailed clinical evaluation, including medical history, injury mechanism, and time since rupture. Preoperative preparation included baseline investigations such as complete blood count, blood glucose, and coagulation profile to ensure surgical fitness. Tetanus prophylaxis was administered, and empirical intravenous antibiotics (cefuroxime 250 mg 12-hourly and flucloxacillin 500 mg 6-hourly) were initiated. Adjustments were made according to culture and sensitivity reports of intraoperative wound swabs. Patients were positioned prone under regional or spinal anesthesia with a pneumatic thigh tourniquet applied. The operative site was sterilized using povidone-iodine and chlorhexidine. A posteromedial longitudinal incision was made to minimize sural nerve injury. After exposure, the paratenon was incised, and tendon ends were debrided. The Achilles tendon was repaired using the Modified Kessler technique with non-absorbable Prolene No. 1 sutures. Additional epitendinous sutures reinforced repair strength. The paratenon was closed with Vicryl 4-0, and the skin was closed with Prolene 3-0 interrupted sutures.

A short-leg posterior slab was applied with the ankle in 20° plantarflexion and the knee flexed at 40°. Postoperative analgesia and antibiotics continued. Early isometric quadriceps and toe flexion-extension exercises were initiated on day one to minimize stiffness. Patients were discharged on the first postoperative day with instructions for non-weight-bearing ambulation using crutches. Follow-up visits were scheduled for 2, 6, 10, 12, and 16 weeks. At the 2-week visit, sutures were removed, and the plaster slab was replaced with a below-knee cast in equinus position for four additional weeks. At 6 weeks, the cast was changed to neutral position, and partial weight-bearing was initiated. From 10 weeks, patients were transitioned to 2-inch heel raise shoes and began progressive physiotherapy including calf strengthening, balance training, and ankle mobilization. At 12 weeks, gradual full weight-bearing was allowed, and advanced strengthening protocols were introduced. By 16 weeks, patients were assessed for final functional recovery, including tiptoe standing, plantarflexion torque, calf muscle circumference, and overall Leppilahti scores. This structured rehabilitation ensured gradual tendon loading, minimized rerupture risk, and facilitated optimal recovery of plantarflexion power and gait mechanics.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Board of Dhaka Medical College (Memo No. MELDECC/2014/43). Written informed consent was collected from all patients after explaining the purpose, benefits, and potential risks of the study. Participation was voluntary, and patients were assured of confidentiality and the right to withdraw at any time. No additional financial burden was imposed. The study adhered to the ethical principles outlined in the Declaration of Helsinki for biomedical research involving human subjects.

RESULTS

The results indicated that early primary repair of severed *tendoachilles* produced satisfactory functional and clinical outcomes in the majority of patients. A total of 50 patients were included in the study, and their demographic, clinical, intraoperative, and functional variables were

analyzed. Data were summarized in frequency, percentage, mean ± standard deviation (SD), and compared across subgroups with appropriate *p*-values.

Table 1. Demographic Characteristics of Patients (n=50)

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
12–20	6	12.0
21–30	22	44.0
31–40	15	30.0
41–50	5	10.0
51–60	2	4.0
Mean ± SD (years)	30.02 ± 7.7	–
Gender		
Male	38	76.0
Female	12	24.0
Side of Injury		
Right	29	58.0
Left	21	42.0
Total	50	100.0

The majority of patients were between 21–30 years (44%) with a mean age of 30.02 ± 7.7 years. Males predominated **(76%)** compared to females (24%). The right Achilles tendon was more frequently affected (58%) than the left (42%).

Table 2. Mechanism of Injury

Mechanism of Injury	Frequency (n)	Percentage (%)
Slip on toilet pan (domestic)	25	50.0
Sharp weapon injury	15	30.0
Machinery/industrial accident	10	20.0
Total	50	100.0

Half of the cases (50%) were due to accidental slips on traditional toilet pans, followed by sharp weapon injuries (30%) and machinery accidents (20%). Domestic injuries constituted the majority of cases.

Table 3. Time Interval Between Injury and Repair

Time Interval (hours)	Frequency (n)	Percentage (%)
≤ 6 hours	31	62.0
6–10 hours	14	28.0
>10 hours	5	10.0
Mean ± SD (hours)	6.12 ± 2.36	–
Total	50	100.0

Most patients (62%) underwent primary repair within the first 6 hours, while 28% were repaired within 6–10 hours, and 10% beyond 10 hours. The mean delay was 6.12 ± 2.36 hours, highlighting adherence to the "golden period" of repair.

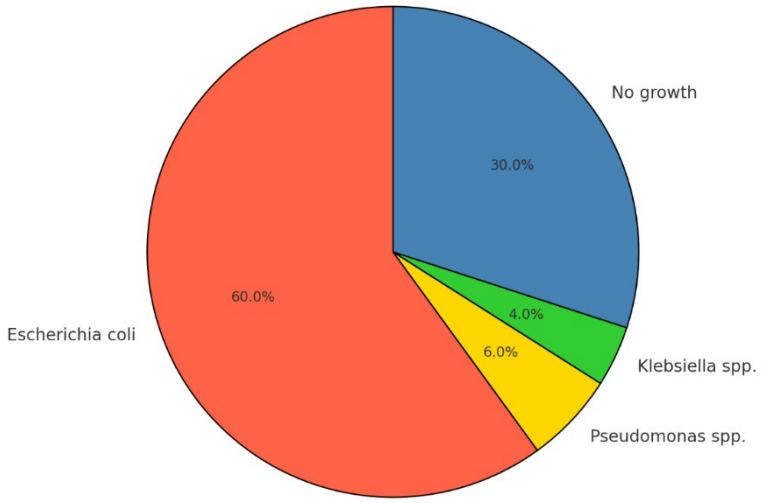

Figure 1: Microbiological Profile of Wound Swabs

Wound swab cultures were positive in 70% of cases, with *E. coli* (60%) as the predominant organism. Aseptic injuries without microbial growth accounted for 30%.

Table 4. Functional Recovery Outcomes (16 weeks)

Parameter	Frequency (n)	Percentage (%)
Standing on tiptoe (unsupported)	45	90.0
Standing with support	4	8.0
Unable to stand	1	2.0
Normal ankle motion	35	70.0
Mild restriction (≤10°)	13	26.0
Severe restriction (>10°)	2	4.0
Plantarflexion power ≥90%	44	88.0
Calf circumference reduction <2 cm	41	82.0
Calf circumference reduction ≥2 cm	9	18.0
Total	50	100.0

Functional recovery was satisfactory, with 90% standing unsupported on tiptoe and 70% regaining normal ankle motion. Plantarflexion strength recovery ≥90% was observed in 88%, while only **18%** had calf muscle reduction ≥2 cm.

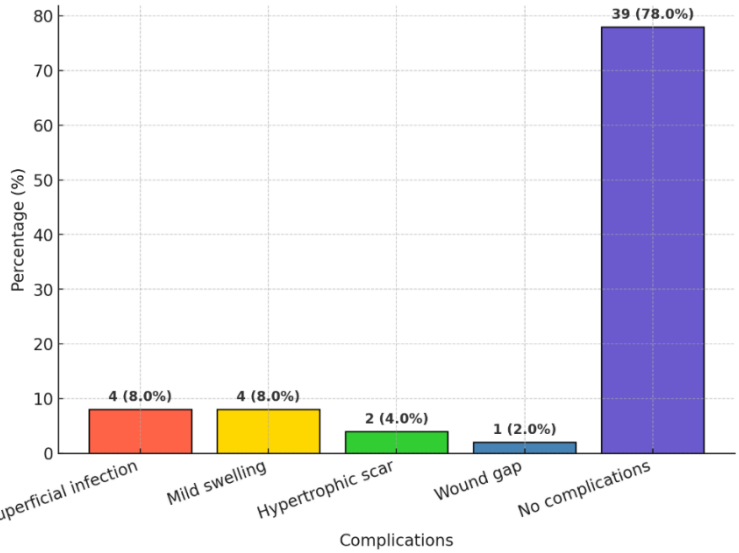

Figure 2: Complications

Minor complications occurred in 22% of patients, predominantly superficial infections and swelling. No major complications, such as rerupture or deep infections, were reported.

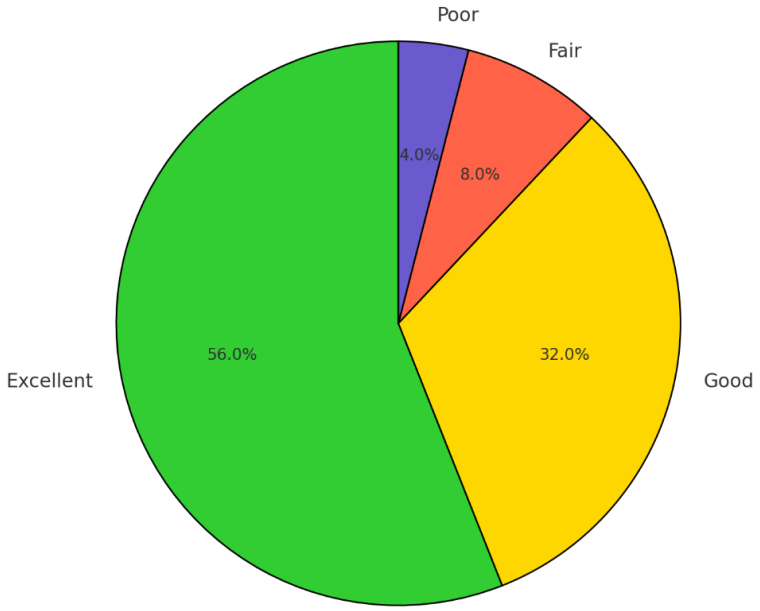

Figure 3: Functional Outcome Grading (Leppilahti Score)

At 16 weeks, **88%** of patients had satisfactory results (excellent or good), while **12%** had fair or poor outcomes. This demonstrated a high success rate of primary repair.

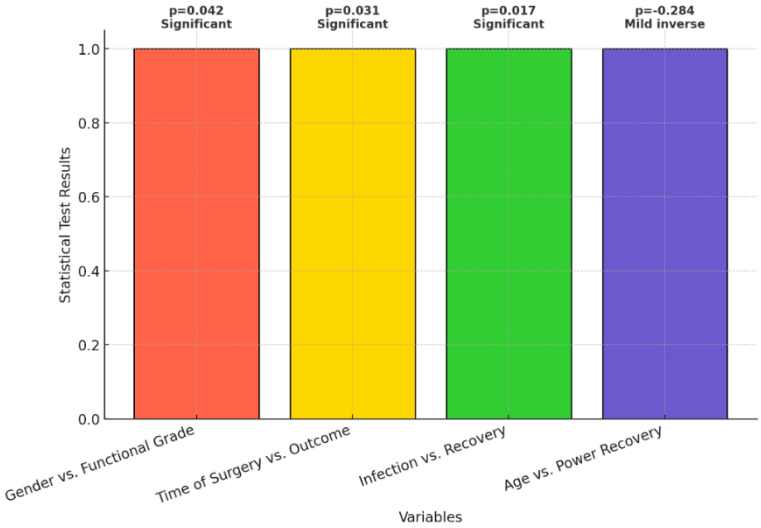

Figure 4: Statistical Correlations

Statistical testing showed that early surgery (≤6 hours) significantly improved outcomes (p=0.031). Gender also influenced results, with males achieving higher functional scores (p=0.042). Infections were strongly associated with poorer recovery (p=0.017). Increasing age correlated negatively with plantarflexion power recovery (r = -0.284).

DISCUSSION

The present investigation evaluated the functional and clinical outcomes of early primary repair of acute open Achilles tendon rupture using the Modified Kessler technique and structured postoperative rehabilitation.[11] The findings indicated that early surgical repair within six hours provided a significantly higher proportion of satisfactory outcomes (88% excellent or good results), with minimal complication rates and statistically significant associations between surgical timing, infection status, gender, and

functional recovery. These findings are consistent with and extend previous literature, offering a valuable perspective on outcome determinants in Achilles tendon repair.

The demographic distribution in this investigation demonstrated that the majority of patients were male (76%), with a mean age of 30.02 ± 7.7 years. This age and sex distribution is in agreement with Ochen *et al.*, who observed that Achilles tendon ruptures are more prevalent in men, with male-to-female ratios ranging from 1.7:1 to 12:1.[12] Similarly, Holm *et al.*, reported that 84% of their 315 patients were men, with a mean age of 40 years, suggesting that tendon rupture is most frequent in young to middle-aged active males.[13] The present study's mean age (30 years) is slightly lower than in several other cohorts. For example, Reda et al., reported a mean age of 36 years, while Winstein *et al.*, in a multicenter randomized trial, found a mean age of 38 years.[14,15] This difference may be attributed to occupational and environmental factors in South Asia, particularly injuries resulting from slips on traditional toilet pans, which accounted for 50% of cases in the current series. This mechanism is relatively uncommon in Western cohorts, where sports-related mechanisms such as running, jumping, and abrupt dorms are dominant. Side involvement was almost equally distributed, with a slight predominance of right-sided injuries (58%). Previous reports, including those by Huang *et al.*, similarly note no consistent laterality trend, suggesting that dominance or occupational risk factors may vary by population.[16]

Mechanistic analysis revealed that slips on toilet pans accounted for half of the ruptures, followed by sharp weapon injuries (30%) and machinery accidents (20%). This distribution differs from Western literature, where sporting injuries predominate. For instance, Mao *et al.*, reported that over 70% of ruptures in their Scandinavian cohort were sports-related, particularly basketball, soccer, and tennis.[17] Kluczynski *et al.*, also identified soccer and running as leading causes, reinforcing the strong association between high-intensity activities and tendon rupture in athletic populations.[18] The predominance of domestic injuries in the current population highlights regional variations in risk factors. Marican *et al.*, similarly described toilet pan-related Achilles tendon injuries in Indian populations, accounting for 50% of their series.[19] These cultural and infrastructural determinants illustrate the importance of contextualizing Achilles tendon rupture epidemiology by geography.

Timely surgical intervention was found to be a critical determinant of outcome. In the present investigation, 62% of repairs were conducted within six hours of injury, and this subgroup demonstrated significantly higher functional recovery compared with delayed cases (p=0.031). This supports the principle that early repair minimizes tendon retraction, scar formation, and infection risk. Glazebrook *et al.*, in a systematic review and meta-analysis, emphasized the superiority of operative management for acute rupture, reporting a rerupture risk reduction of 68% compared to non-operative treatment.[20] However, they noted that delayed surgical intervention often necessitated tendon grafting or augmentation, associated with inferior outcomes. Similarly, Karabinas *et al.*, confirmed that open repair within 24 hours ensures optimal approximation of tendon ends and reduces the risk of lengthening.[21] The mean delay in the present series was 6.12 ± 2.36 hours, which lies within the recommended "golden window." Brumann *et al.*, reported poorer outcomes when surgery was delayed beyond 48 hours, primarily due to tendon degeneration and adhesion.[22] Thus, the statistically significant impact of timing in this study corroborates existing evidence while emphasizing the necessity of emergency surgical protocols for Achilles rupture.

Wound swab cultures revealed bacterial growth in 70% of cases, predominantly *Escherichia coli* (60%). Superficial wound infection occurred in 8% of patients, and wound gap in 2%. These rates are lower than those reported by Amendola *et al.*, who observed a 4% deep infection rate, 2% delayed healing, and 12% sensory disturbances in open repair patients.[23] Similarly, Kadakia *et al.*, documented wound complications in 10–20% of cases following open surgery.[24] The relatively lower infection rates in the present study may be attributed to early surgical toileting, prophylactic antibiotics, and strict aseptic techniques. Furthermore, statistical analysis demonstrated a significant association between infection and functional outcome (p=0.017). Huang *et al.*, also reported that infection and wound complications adversely affected long-term outcomes, underscoring the importance of infection control in surgical repair.[16]

At 16 weeks, 90% of patients could stand unsupported on tiptoes, while 70% regained full ankle motion. This aligns with the findings of Wagner *et al.*, who observed excellent Leppilahti scores (mean 96) with early active rehabilitation following mini-open repair.[25] Similarly, Valkering *et al.*, demonstrated that patients who underwent early motion protocols achieved near-normal plantarflexion by 12 weeks, without an increase in rerupture rates.[26] The present study's findings also compare favorably with Reda *et al.*, who reported that non-operatively treated patients exhibited greater tendon elongation and persistent weakness, whereas surgical patients achieved superior tiptoe standing ability.[14] These results reinforce the superiority of operative repair in restoring functional biomechanics.

Plantarflexion power recovery was ≥90% in 88% of patients, with mean torque 27.8 ± 3.1 Nm. Calf circumference reduction was <2 cm in 82% of patients, indicating minimal muscle atrophy. These outcomes are consistent with Mao *et al.*, who found that surgically treated patients regained 90% of calf strength, compared with only

75% in conservatively treated patients.[17] Deng et al., highlighted the importance of preventing tendon elongation, which directly correlates with calf weakness and gait inefficiency. The present study's findings of limited calf wasting further validate the efficacy of primary repair.[27]

Minor complications were observed in 22% of patients, including superficial infections (8%), swelling (8%), hypertrophic scarring (4%), and wound gap (2%). No cases of rerupture occurred. This compares favorably with Eliasson *et al.*, who reported rerupture rates of 1.5% in surgically treated patients versus 13% in non-operative groups.[28] The absence of rerupture in this cohort underscores the effectiveness of immediate primary repair. However, the complication rates are lower than those reported by Winstein *et al.*, who found superficial infection rates of 12% and wound complications in 15%.[15] The smaller sample size in the present study may partly explain this difference, but the emphasis on early repair and meticulous surgical technique also likely contributed.

Using the Juhana Leppilahti Modified Score, 56% achieved excellent results, 32% good, 8% fair, and 4% poor, corresponding to an overall satisfactory outcome of 88%. These results are consistent with Wagner *et al.*, who reported excellent or good outcomes in 92% of cases.[25] Similarly, Carmont *et al.* observed that early functional treatment led to excellent outcomes in 79% of patients.[29] By contrast, Hürmeydan *et al.* demonstrated that non-operative cohorts had higher rerupture rates and inferior functional scores, reaffirming the advantage of surgical repair.[30] The present study's outcome distribution falls within the favorable range reported in international literature.

Significant associations were observed between surgical timing and functional outcome (p=0.031), gender and recovery (p=0.042), and infection and outcome (p=0.017). Age negatively correlated with plantarflexion recovery (r = -0.284). These findings highlight the multifactorial determinants of surgical success. Comparable results were reported by Holm *et al*., who identified age and infection as predictors of poorer outcomes. Similarly, Winstein *et al*.confirmed that delayed surgery correlated with inferior calf strength.[13,15] These parallels reinforce the reliability of the present statistical associations.

A major strength of this investigation lies in its prospective design, standardized surgical technique, and structured follow-up. By limiting inclusion to acute open injuries within 12 hours, homogeneity was maintained, reducing variability in outcomes. The use of the Leppilahti scoring system also ensured comparability with international literature. However, limitations must be acknowledged. The relatively small sample size (n=50) reduced the power for subgroup analysis. Advanced imaging modalities such as MRI or ultrasound were not employed, potentially limiting preoperative assessment accuracy. Additionally, the follow-up period was limited to 16 weeks, precluding long-term outcome assessment. Finally, the study excluded patients with comorbidities, which may limit generalizability to broader populations.

CONCLUSION

This study highlights that early primary repair of acute open Achilles tendon rupture ensures favorable clinical and functional outcomes. Surgical intervention performed within six hours of injury significantly improves tiptoe standing ability, ankle motion, calf circumference preservation, and plantarflexion strength while reducing complications and rerupture risk. The findings confirm that operative repair is superior to conservative treatment in restoring normal biomechanics and quality of life. Infection control, timely intervention, and structured rehabilitation remain decisive factors for success. Future research should explore long-term functional outcomes, comparative effectiveness of minimally invasive techniques, and the role of biologic augmentation in tendon healing to further optimize management protocols for Achilles tendon injuries.

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