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Research Article

Achilles Tendon Trephination Versus Peroneus Brevis Tendon Transfer in Total Avulsion Injuries in a Tertiary Hospital

MBA Okpan Ozinko[1*], Samuel E Urom[2], Izuchkwu Arinze[2]

[1]Division of Burns and Plastic Surgery, Department of Surgery, University of Calabar, Nigeria

[2]Department of Orthopaedics and Traumatology, University Oo Calabar, Nigeria

***Correspondence author:** MBA Okpan Ozinko, Division of Burns and Plastic Surgery, Department of Surgery, University of Calabar, Nigeria; Email: ozinkomba@yahoo.com

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Abstract

Introduction: Complete avulsion of Achilles tendon is common and treatment is challenging which can be trephination with suturing anchoring technique or peroneus brevis tendon transfer. The aim of the study was to evaluate the functional outcomes of ankles following Achilles tendon repair by comparing trephination with peroneus brevis tendon transfer in total avulsion injury.

Methods: A single center prospective randomized study that consisted of 31 patients with Achilles tendon injuries who presented between April, 2019 and December, 2021 on account of complete avulsion injury of the Achilles tendon. Thirty-one (31) patients were randomized into two groups: Group A consisted of 16 patients who had trephination with suture anchoring technique while group B, consisted of 15 patients who had peroneus brevis tendon transfer. Achilles tendon injuries transected at least 10 mm above the calcaneus were excluded and repaired with conventional techniques. The inclusion criteria involved those patients that had complete avulsion injury. The socio-demographic data such as sex, age, occupation, mechanism of injury was documented. The outcome parameters were Endurance test and Proprioceptive evaluation.

Results: Eighteen patients (58.1%) had right heel injuries while 13 patients (41.9%) had left leg injuries. About 16[51.6%] patients had trephination while 15[48.4%] patients had peroneus brevis tendon transfer. The age range was 3.2 and 8 years, with a mean age of 5.7years and a follow-up period of 10.4 and 14.8 months. All patients had open wounds. Seventeen males [63.6%] and fourteen females [36.4%] paediatric age group were studied. Complications were re-rupture in 1 patient with tendon transfer (3.2%), superficial surgical site infection in 3 patients (9.7%) and two sural nerve damage in peroneus brevis transfer (6.5%), stiff ankle joint 2 patients (6.2%) and post operative ankle pains up to 2 years was (1) 3.2%. The probability of damaging sural nerve was higher in peroneus brevis transfer as shown in Table 2, Achilles tendon rupture 1(3.2%) and stiff ankle joint in trephination 1 (3.2%). There was no significant statistical difference between the groups with p-value ≥ 0.06. Endurance test and proprioceptive evaluations were satisfactory at 8-10 weeks post- surgery.

Conclusion: Achilles tendon trephination was simpler with less structural injury compared with peroneus brevis tendon transfer in total Achilles tendon transfer.

Keywords: Achilles Tendon Repair; Peroneal Brevis Transfer; Total Avulsion Injury; Tendon Repair Outcomes

Level of Evidence: Level VII

Introduction

Achilles tendon injury has its name from Greek mythology hero whose lone weakness was in the heel [1]. It is the largest and strongest tendon in the body. The union of soleus and gastrocnemius tendons forms the Achilles tendon with a common insertion onto the calcaneus. It is about 6 cm long and 5 millimeters thick. Achilles tendon is very important in walking, running and

jumping. It connects the heel bone to the calf muscles at the back of the ankle. Structurally, it consists of fibrous tissues with poor blood supply, thus, it is prone to rupture. Overstretching or straining could lead to partial or complete tear [2]. The tendon could suffer from avulsion injury in children who may put their heels in between bicycle spokes and it could lead to complete or partial avulsion of the Achilles tendon [3]. In most cases, the Achilles tendon may be repaired by common techniques such as modified Kesler's technique, pulvertaft, etc. Achilles tendon injury takes some time to heal with loss of working hours. Treatment will depend on the severity of the injury, gap > 2 cm and the fracture of calcaneum. Treatment could be surgical repair with non-absorbable sutures, preferably nylon. The repair is protected by several weeks in a cast or boot. Then physical therapy and exercises may begin as soon as the surgical incision is healed [4]. In complete Achilles tendon avulsion injury from the calcaneum, trephination of the calcaneum and anchoring of the tendon could be the choice of treatment [5]. In the hand of some surgeons, peroneus brevis tendon transfers could be used. The challenge of Achilles tendon repair is when there is complete avulsion from the calcaneus which leaves us with the option of peroneus brevis transfer or trephination of the calcaneus with anchoring with or without tendon graft [6]. The study is to evaluate the use of peroneus brevis tendon transfer and the trephination with anchoring of the tendon in complete tendon avulsion injuries. Achilles tendon injury has become a common occurrence in the Accident and Emergency Department of the tertiary Hospital. Globally, the incidence is moving away from open avulsion injury of the heel in the developing countries to closed Achilles tendon rupture in developed countries [7]. The use of motor bikes as a common means of transportation where children below the age of 8 years are transported in the remote villages poses a challenge as they sit astride with their legs hanging by the sides of the motor bikes. The dangling heel may accidentally go in-between the spokes which led to avulsion injury of the Achilles tendon. In adults, violent and strong muscle contraction of the calf muscles also led to close avulsion injury at the calf, usually at the tendino-muscular junction thereby manifesting with painful swelling and weakness of the calf muscles [8].

In open avulsion injury, it could be partial or complete transection of the tendon. In partial transection, movement may be attempted but with severe pain whereas in complete laceration of tendons there was inability to walk. Closed tendon injuries were seen in violent sporting activities and in military parade where the tendons snap from the muscle attachment [9].

In the acute phase, there was associated painful swelling and difficulty in walking in closed injury while in open avulsion injury a wound would be seen with partial or complete tendon transection. Patients could not plantarflex the foot. In some cases, the tendon avulsed off the calcaneal attachment which might result in trephination and anchoring the avulsed tendon on to the calcaneus with non- absorbable sutures and then soft tissue cover. Other cases were treated with peroneal tendon transfer with significant outcome. A meta-analysis by Khan, et al., concluded that surgical treatment has a lower risk of re-rupture and allowed early mobilization with shorter time [10].

This procedure was not free from complications such as surgical site infection, abnormal scars, rupture, chronic ankle pain, etc. Prevention of injury and complications of surgery were very paramount in the care of the patients.

Trephination dated back to antiquity where burr hole was drilled in the skull in the treatment of depressed skull fracture or in the treatment of brain haematoma. In 1884, frontal sinus trephination for the treatment of frontal sinus disease was described by a physician Alexander Ogston [11]. Later the trephination was used in the treatment of rotator cuff avulsion. In recent years, the use of trephination anchoring technique was adopted in the treatment of Achilles tendon complete avulsion from the calcaneus which served as an alternative procedure to peroneus brevis transfer. Trephination involved the drilling of hole through the calcaneus and anchoring the Achilles tendon on to the bone with non- absorbable sutures. Trephination may not require fixing the tendon with interference screw but to drill the calcaneus and anchor the tendon with nonabsorbable nylon suture.

Peroneus Brevis transfer for rupture of the Achilles tendon was popularized by Perez-Teuffer [12]. In the original technique, the harvested peroneus brevis tendon was passed through a transosseous drill hole in the calcaneus. Subsequently, Turco and Spinella modified the technique by passing the peroneus brevis tendon through the distal stump of the Achilles tendon [13]. The peroneus brevis tendon is then woven through the ends of the ruptured Achilles tendon, passing through small coronal incisions in the distal stump and then through some incisions in the proximal stump [14]. The comparison of the surgical outcomes of peroneus brevis tendon transfer and trephination of calcaneum with anchoring suture technique in the treatment of complete avulsion injury has become pertinent since such study has not been conducted.

Methodology

A retrospective randomized study that consisted of 31 patients: (17 Males (54.8%) and 14 females (45.2%) who presented to our hospital between April, 2019 and December, 2021 on account of complete avulsion injury of the Achilles tendon. No patient had closed rupture of the tendon since the cohort consisted of paediatric subjects. Patients were evaluated clinically and intra-operatively and randomly placed into two groups: A and B. Group A consisted of 16 patients who had trephination with anchoring while group B, consisted of 15 patients had peroneus brevis transfer. All the patients were numbered and the even numbered patients were assigned group A while odd numbered patients assigned group B. Other Achilles tendon injuries that were transected at least 20 mm above the calcaneus were excluded from the study and were repaired by the conventional tendon repair techniques. All adult cases were also excluded. All patients had X-ray of the leg and foot to rule out any fracture. Trephination with anchoring, with or without tendon graft, was easier than peroneal brevis transfer. The inclusion criteria involved those that we had difficulty in fixing the tendons to the calcaneus. Some patients had simple wound closure while others needed a flap to cover the tendons, such as reverse soleus flap or short saphenous reverse island flap.

The peroneus brevis tendon sheath was identified and a small incision made over the base of the 5th metatarsal bone and the peroneus brevis tendon was identified and detached. It was then attached to the calcaneus by drilling the bone and fixing it with nonabsorbable nylon suture. Post-operative Plaster of Paris backslap for the initial immobilization and elevation of the limb on a Braun frame was instituted. Regular neurovascular assessments were performed to avoid compartment syndrome. Endurance test and proprioception evaluation were done. Early physiotherapy was commenced after a fortnight as the pain was reducing. The outcome parameters included Endurance test and proprioceptive evaluation with active angle reproduction test of the ankle at 15° of dorsiflexion and 200 of plantar flexion. SPSS version 20 was used to analyze the data.

Results

A total of 31 patients were evaluated and recruited into the study that span between April, 2019 to December, 2021. Eighteen patients (58.1%) had right heel injuries while 13 patients (41.9%) had left leg injuries. About 16[51.6%] patients had trephination with transosseous anchoring suturing while 15[48.4%] patients had peroneus brevis tendon transfer. The age range was 3.2 and 8 years, with a mean age of 5.7years and a follow-up period of 10.4 and 14.8 months, with a mean duration of 12.2 months. All patients had open wounds (Table1) Seventeen males [63.6%] and fourteen females [36.4%] who were paediatric age group were studied. Sixteen patient's relatives expressed their satisfaction as excellent, 14 as good and one as fair. The patient's relative that had peroneal transfer who fell down and had a redo by using trephination expressed fair outcome. In our study, complications were re-rupture in 1 patient with tendon transfer (3.2%), superficial surgical site infection in 3 patients (9.7%) and two sural nerve damage in peroneus brevis transfer (6.5%), stiff ankle joint 2 patients (6.2%) and post operative ankle pains up to 2 years was (1) 3.2%. The probability of damaging sural nerve was higher in peroneus brevis transfer as shown in (Table 1), Achilles tendon rupture 1(3.2%) and stiff ankle joint in trephination 1(3.2%). One patient had linear fracture of the calcaneus and was repaired with interference screw and trephination technique. There was significant statistical difference between the groups with p-value ≥ 0.005 in favour of trephination and anchoring suture technique. Endurance test and proprioceptive evaluation were satisfactory at 8-10 weeks post- surgery. Table 2 has shown the comparison between the two surgical procedures with a note on the advantage of using peroneus brevis tendon transfer in cases where there was complete absence of the calcaneal bone. The rehabilitation protocol adopted is outlined: after surgery, the plaster of Paris backslap was put in place for two weeks after which passive exercises of the ankle was commenced, then followed by active dorsiflexion and plantarflexion. About the 4th and 6th weeks post operative period, minimal weight -bearing commenced with clutches and about 8th week full weight-bearing was instituted. In the absence of fracture of the calcaneus, full weight -bearing could start within 6-7 weeks while in calcaneal fracture 8-10 weeks on average.

S. No	Sex	Age/Yrs	Types of Surgery	Complications	Follow-Up Duration in Months
1	M	5	Trephination/fixation	Nil	13
2	M	7	Peroneus brevis	Nil	14
3	F	8	Trephination/fixation	Joint stiffness	11.8
4	F	6.5	Peroneus brevis	Nil	13.4
5	M	5.9	Trephination/ fixation	Surgical site infection	10.5

6	M	4.4	Peroneus brevis	Nil	11.9
7	F	4.2	Trephination/ fixation	Nil	14.2
8	M	3.9	Peroneus brevis	Sural nerve damage	11.8
9	F	6.8	Trephination/ fixation	Nil	11.5
10	M	3.4	Peroneus brevis Transfer	Rupture after a fall	10.6
11	M	6.6	Trephination / fixation	Nil	10.4
12	M	4.8	Peroneus brevis transfer	nil	9.8
13	M	4.9	Trephination / fixation	nil	11
14	F	5.2	Peroneus brevis transfer	nil	12
15	F	8	Trephination. fixation	nil	11.2
16	M	6.2	Peroneus brevis transfer	nil	10.9
17	F	7.1	Trephination/fixation	nil	10.3
18	M	3.8	Peroneus brevis transfer	Sural nerve damage	8.8
19	M	4.2	Trephination/fixation	nil	10
20	M	6.5	Peroneus brevis transfer	nil	12.4
21	F	6.1	Trephination/ fixation	nil	11.1
22	F	7.4	Peroneus brevis transfer	nil	8.4
23	M	7.0	Trephination/ fixation	nil	7.9
24	F	5.4	Peroneus brevis transfer	nil	9.5
25	M	3.2	Trephination/ fixation	nil	10.5
26	F	5.9	Peroneus brevis transfer	Surgical site infection	5.9
27	F	5.3	Trephination/fixation	nil	6.3
28	M	4.6	Peroneus brevis transfer	Surgical site infection	8.4
29	M	4.9	Trephination/fixation	Stiff joint	9.6
30	F	7.4	Peroneus brevis transfer	Posttraumatic ankle pains >2years	10.3
31	F	8.0	trephination/fixation	nil	11.2
Mean age=5.7 years, Mean duration of follow-up= 10.6 months, Surgical site infection=9.7%, Sural nerve damage =3.2%, Stiff ankle joint=6.4%, posttraumatic ankle pains > 2years					

Table 1: Showing Socio- demographic parameters and surgical outcomes in 31 patients that had trephination and peroneus brevis transfer for complete avulsion injury.

Items	Trephination and Anchoring	Peroneus Brevis Tendon Transfer
Learning curve	Straight and easy	Stiff and difficult
Nerve injury	Not common	Very common
Vascular injury	Not common	Very common
Line of force of Achilles tendon	Straight and vertical	Curvilinear
In the absence of calcaneus	Not indicated	Good indication

Table 2: Comparison between Trephination with anchoring and peroneus brevis tendon transfer.

Discussion

Achilles tendon is the thickest and strongest tendon in the human body yet prone to rupture or laceration. The prevalence was more of the males 17[63.6%] and fourteen females [36.4%] who were of paediatric age group. The result was similar to Barbosa, who reported male preponderance although their population was adult age [14]. He also reported that the right ankle was more involved which also was similar to our study. The right heel was also more affected 18 patients (58.1%) while 13 patients (41.9%) had left leg injuries. The mean distal stump was 1.85cm, varying from 2.30 cm to 2.80 cm while the mean gap between the stumps was 4.6 cm which ranged from 3.5 cm to 6.5 cm. Open avulsion injury is more common in the West African sub-region because

the under-five year old children that are carried by their parents on motor cycle frequently put their heels in-between the spokes as their legs dangle while they rode. It is worth noting that closed Achilles tendon rupture was not seen among the cohort unlike the Caucasian population where it is common due to sporting and in military parade [15].

Following the injury, there could be open or closed wound as well as partial or complete tendon laceration. In partial laceration, the tendon is still in-continuity and patient could attempt to walk but with severe pains. However, in complete avulsion patient cannot walk. There was pain, inability to walk and open wound. Bedside clinical evaluation using Simmond's and Thompson's tests, there was loss of plantar flexion [16].

Radiological investigation may reveal fracture of the calcaneus or fracture- dislocation of the ankle joint. In closed rupture of Achilles tendon, magnetic resonance imaging as well as ultrasound could help to delineate the pathology as seen in developed countries.

It was commoner in men than women, even in the paediatric age group. The peak age is 30-40 years among Caucasians but in our cohort, it was paediatric age group whose age range between 3.4 and 8 years [17]. The risk factor was motor cycle accident in the paediatric aged group while risk factors in adult Caucasian population were sporting, athletics, steroid injection and fluoroquinolone antibiotics [18].

Tendon-to-bone fixation procedure with non- absorbable suture (nylon) called trephination and anchoring was simple procedure and tendon shortening was not recorded in most patients after surgery. Where there was tendon gap above 2.0 cm, tendon elongation and plantaris tendon graft were used to breach the defect. In another study, peroneal tendon transfer had good outcome but was fraught with sural nerve injury and re-rupture compared with trephination with transosseous suture technique which is similar to our study outcome. The tendon of peroneus brevis is well vascularized thereby transferring good blood supply to the Achilles tendon. It is noteworthy that peroneus brevis contributes 28% of the total eversion strength of the ankle. The use of peroneus brevis tendon may cause a strength deficit in the eversion on the ankle but will not affect plantar flexion. Human cadaveric models have been used to assess the mechanical properties at Achilles tendon reconstruction with peroneus brevis and trephination with transosseous suturing and the later had less stiff learning curve.

Complications in the use of peroneus brevis tendon transfer had one sural nerve damage and rupture which were similar to a previous study [19]. Superficial surgical site infection was found in two patients who had trephination procedure. Concerning the return to daily activities and school, patients were able to return to school in 8-10 weeks. He reported a slower return to sports in peroneus brevis tendon transfer patients in adults. He pointed out that the limitation of the local anatomy usually making simpler reconstructive modalities such as primary closure and skin grafting difficult [20]. They used trephination of the exposed calcaneus as a means of salvaging six cases of lower limb exposed bone. He did peroneus brevis tendon transfer which were secured to the calcaneus with an interference screw or suture anchors and they noted good functional outcome. They also reported loss of eversion power although loss of ankle stability did not seem to develop as a consequence [21]. He reported that all patients had no limitation of tip toe stance and active foot eversion range were maintained during daily life activity and during sports.

Analysis of the results of isokinetic test was done and revealed that when comparing the peak torque of plantar flexion of the affected ankle to the non-affected, there was decrease of 28 ± 11% and 36 ± 4% in 30 deg/sec and 120 deg/sec.

Preventive measures could be adopted such as slowly increasing the length and intensity of workouts, avoiding or limiting exercise on uneven surfaces and wearing well fitted shoes [22]. However, our cohort consisted of children who presented with avulsion injury due to insertion of the heel into motor cycle spokes. Prevention in children consists of transporting them in tricycle and the other vehicles in remote villages as well as wearing them protective boots/shoes on mounting motor cycles.

The limitation of the study was that it was a single center study which should be subjected to multi-center study. This study should also be compared with repairs done with conventional methods. Further investigations are required to validate results of the study [23-25].

Conclusion

The study had shown that peroneus brevis tendon transfer and trephination with transosseous suture anchoring technique are good alternatives for complete avulsion of the Achilles tendon, although the latter is easier with less postoperative ankle-foot deformity. A good soft tissue cover is necessary in open injuries with soft tissue loss and the initial immobilization should be followed- up with early physiotherapy. Where wide Achilles tendon gap existed, tendon graft or re-enforcement with peroneus brevis tendon transfer could be the option to breach the gap.

Conflict of Interest

No conflict of interest from co-authors nor from any organization.

Ethical Approval and Consent to Participate

Ethical approval was obtained by the ethical committee of the University of Calabar Teaching Hospital and consent to participate was issued and participants counseled on the importance of the research.

Consent for Publication

Participants gave written informed Consent to publish the data contained within this study.

Availability of Data and Materials

Data is custodied by the author and can be released on trust.

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Trial Registration

No trial registration was done.

Author's Contribution

M.O. Ozinko contributed in the drafting and revising at critical point for intellectual content. He is the corresponding author. S.E. Urom contributed in the acquisition of data and analysis and I. Arinze help in interpretation of data. All co-authors contributed in the final approval of the version to be submitted.

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