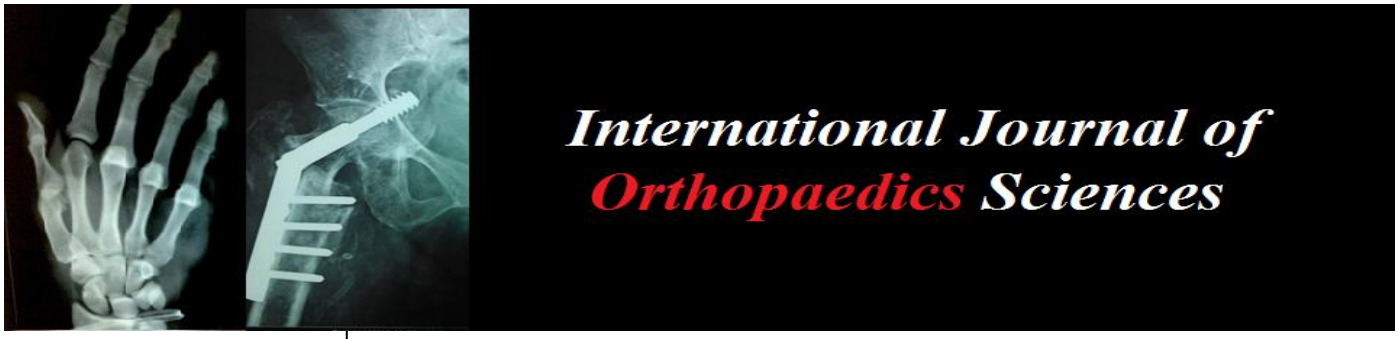

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Reconstruction of ruptured archilles tendon using peroneus brevis tendon transfer to OS calcis

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Abstract
Background: Increase in the incidence of reruptures after non operative management of ruptured Achilles tendon and advances in operative modalities led to primary surgical management of Achilles tendon ruptures in the majority. The present study was undertaken to elucidate the effectiveness of operative management of ruptured Achilles tendon by reconstructing it with Peroneus brevis tendon transfer and evaluate the benefits and risks of this technique in acute and chronic ruptures.
Method: This study comprised of 37 patients with Achilles tendon rupture which were primarily operated upon at Santhiram Medical College and General Hospital, Nandyal, Kurnool (OT), A.P. between October 2013 and October 2015. All patients were treated by reconstruction of ruptured tendon with peroneus brevis tendon transfer.
Results: Maximum numbers of patients were in the 41-50 year age group (49%). Most of the patients sustained injuries on their right lower extremity (78.3%). Stumbling in the fields (dorsiflexion injury) was the mechanism of injury in the majority (59.4%), while it was fall at bathroom in the aged population. Acute ruptures were 22 and chronic ruptures were 15 patients. The average follow-up was 11.3 months (6-12 months). Functional scoring was done Achilles tendon Total Rupture Score (ATRS). We could achieve functionally excellent result in both acute and chronic ruptured patients.
Conclusion: Based on these findings, it can be concluded that reconstruction of ruptured Achilles tendon can be successfully done by peroneus brevis tendon transfer with achievement of excellent functional outcome and plantar flexion in both acute and chronic ruptures with very minimal complications.

Keywords: Achilles tendon ruptures, Peroneus brevis tendon transfer, total rupture score

Introduction
Injuries of the Achilles tendon are relatively common in middle-aged athletes [1-4]. Tendinitis, tendinosis and peritendinitis accounted for 11% of lower extremity complaints at a large runners' clinic, and Achilles tendon ruptures have been estimated to the third most frequent tendon rupture [5]. Most often, these patients present late to the clinic after few weeks after the rupture.
Most commonly, the mechanisms of Achilles tendon rupture are pushing off with the weight bearing forefoot while extending the knee, sudden unexpected dorsiflexion of the ankle, and violent dorsiflexion of the plantar flexed foot, as in a fall from a height or in sports [5]. Additional factors implicated in ruptures include repetitive microtrauma [6], inhibitor mechanism malfunction [7], hypoxic and mucoid degeneration [8], decreased perfusion resulting in degenerative chances [9] and systemically administered or locally infiltrated corticosteroids [10].
Especially, in rural India the common habit of farmers is to walk in field bare footed on uneven plane which also leads to higher incidence in disruption of the Achilles tendon.
Treatment Options for Achilles tendon rupture varies widely in literature including conservative management with cast immobilization, and surgical like end to end repair, percutaneous repair, augmentation with other tendons, reconstruction with tendon transfers, Bone-Marrow-Cell Transplantation Therapy and combination-of these procedures.
Operative management of Achilles tendon is feared due to its associated complications like wound dehiscence, infection and functional disability. It is in this scenario that there is a definite need to document the outcome which will help in proper selection.
The purpose of this dissertation is evaluating functional and objective outcome after reconstruction of ruptured Achilles tendon with peroneus brevis tendon transfer to os calcis.

Current study designed to analyze the effectiveness of operative reconstruction of ruptured Achilles I tendon by peroneus brevis tendon transfer.

Material and Methods

The present prospective study comprised of patients of either sex having ruptured Achilles tendon who attended the Orthopedic OPD or Emergency wing of Santhiram Medical College and General Hospital, Nandyal, Kurnool (Dt), A.P. and were primarily treated by surgical means between October 2013 and October 2015.

Inclusion Criteria

Patients with ruptured tendo-achilles due to indirect violence both fresh and old above 35 years of age.

Exclusion Criteria

- Prior history of surgery for the correction of ruptured Achilles tendon.
- All ruptures below 35 years of age.
- Ruptures associated with other generalized diseases.
- Direct violence.

The patients presenting with disability deformity near the ankle loint, after general condition was stabilized, were administered analgesia as needed, examined clinically for disability, deformity, soft tissue injury and neurovascular status. Calf-squeeze test, Knee-flexion test, Needle test, and Sphygmomanometer test are performed. Standard lateral radiographs of the in Volved ankle were taken and assessed for kagers trlanqle and toygars sign. Ultrasound examination is performed and documented along with findings.

Patients not willing for surgery were treated by and below knee slab application in gravity equinus. They were discharged with advice for regular follow-up. Patient willing for surgery were evaluated and investigated by the anesthesiologist.

Operative procedure is performed in the operating theatre, under spinal or epidural anesthesia, under prone position, under pneumatic tourniquet control and under aseptic precautions. Thorough preparation and draping of the involved leg is performed. Posterior- lateral incision over the distal aspect of the leg is used. The length of the incision is eight to twelve centimeters depending upon the exposure necessary to see the lesion to execute the reconstruction.

The tendon sheath was opened at the site of the rupture and the characteristics of the rupture ends are assessed. A second incision is made from the inferior aspect of lateral malleoli to the base of the fifth metatarsal. Peroneus brevis tendon is incised from the base and the tendon is retracted into the lateral compartment of the leg. The distal stump of the Achilles tendon is excised and the proximal frayed ends of the tendon are freshened and peroneus brevis tendon is sutured to this proximal stump with pulvershaft technique and the distal portion of the peroneus brevis tendon is prepared for bunnels stitch. The top of tuberosity of the calcaneus is pared and a hole is drilled in the calcaneum from dorsal aspect to plantar aspect and the peroneus brevis tendon prepared with bunnel stitch is passed through the tunnel and fixed on the heel in plantar aspect under tension as per the method of Cole. The tunnel drilled in Os Calcis is fashioned such that the transferred tendon do not interfere with wound closure and at the same time it is not too anterior which may decrease the length of lever arm of reconstructed Achilles tendon. The bone which was obtained from the posterior aspect of the calcaneum is packed in the tunnel further reinforcing the tendon fixation. Tourniquet released and haemostatis is achieved and wound closed in layers with corrigated drain. The leg is immobilized with below knee anterior slab with foot in gravity equines position.

Mobilization of toes and knee advised. Dressing and removal of drain is performed on second post-operative day and slab reapplied. Clinical examination done after six weeks and slab is removed. After removal of slab passive and active dorsiflexion and plantar flexion movements of ankle practiced and weight bearing allowed with walker. Patient is allowed to walk with full weight bearing gradually.

Outcome Studies

Patients were evaluated functionally according to Achilles tendon. Total Rupture Score (ATRS). Objectively patients were assessed their calf girth, power of plantar flexion, abduction and eversion assessed by a standard dynamometer and compared to opposite normal limb at 3 months, 6 months and one year as time permitted in my curriculum.

Results

In our study, we evaluated 37 patients with Achilles tendon rupture treated by reconstruction using peroneus brevis tendon transfer. The patients were from all age groups excluding those lesser than 35 years. Out of the 37 patients, there were 5(13.5%) patients in the 35-40 yrs. age group, 18(49%) in 41-50 yrs. age group, 12(32%) in 51-60 yrs. age group, and 2(5%) in the above 60 years age group. Male patients being 23(62.1%) constituted the majority, with female patients being 14(37.8%).

Right sided injury was noted in 29(78.3%) of the patients and left sided in 8(21.6%). Acute ruptures were 22(59.4%) patients and chronic ruptures were 15(40.5%) patients. Time interval between rupture and operation in our study was within a week in two patients, within a month in twenty patients, within two months in eleven patients, within 3 months in two patients, and two patients with in four months.

The mechanism of injury was fall at home in bathroom 9(24.3%) patients, fallen from stairs in 4(10.8%), stumbling in the fields in 22(59.4%) and no history of specific trauma prior to the onset of. symptoms but had gradual Onset of pain and difficulty in walking in. 2(5.4%).

Previous history of pain around ankle joint and heel was noted in 31(83.7%) of the patients and they had received treatment for the same.

All had major weakness of active plantar flexion and limp. Gap was palpable in 33(89.1 %) and was not palpable in 4(10.8%) patients. Duration of symptoms ranged from 2 days to 4 months. Fissures in foot were noted in almost all of the patients and operative management was done after keen attention to them.

Out of 37 patients 6(16.2%) had history of hypertension, 3(8.1%) had diabetes mellitus and one (3.7%) was positive for HBs Ag.

All of them were treated with reconstruction of ruptured

Achilles tendon with peroneus brevis tendon transfer and non-weight bearing in below the knee slab in gravity equines for six weeks was applied. The average follow-up was 11.3 months with the least follow-up included being 6 months and the longest follow-up being 12 months.

On an average Achilles tendon total rupture score in acute ruptures was 98.4%, 99.7%, and 99.9% at three months, six months and twelve months. In chronic ruptures Achilles tendon total rupture score was 95.4%, 99.7%, and 99.9% at three months, six months and twelve months.

Power of plantar flexion in acute ruptures in 22 patients at three and six months averaged to 97.8% and 99.5% and in 12 patients who returned at twelve months follow up averaged to 100% with comparison to normal limb from the date of operation. And Power of plantar flexion in chronic ruptures in 15 patients averaged to 72.8%, 89.9% and 96.5% at three, six and twelve months

With comparison to normal limb from the date of operation. In our study power of plantar flexion averaged to 87.7%, 95.9% and 98.2% at three, six and twelve months with comparison to normal limb from the date of operation.

Calf circumference was reduced by as much as three centimeters. On an average calf circumference was reduced by 0.7 centimeters. At the end of six months post-operative time period both acute and chronic rupture patients were able to stand on tip toes.

Power of eversion and abduction in acute ruptures in 22 patients at three and six months averaged to 77.4% and 79.4% and in 12 patients who returned at twelve months follow up averaged to 79.5% with comparison to normal limb from the date of operation. And Power of eversion and abduction in chronic ruptures in 15 patients averaged to 76.7%, 78.7% and 79.5% at three, six and twelve months with comparison to normal limb from the date of operation.

We had one (2.7%) case with superficial wound infection and one (2.7%) case with numbness over sural nerve innervations.

Case number eleven had superficial wound infection which required antibiotics, debridement and subsequent split thickness skin grafting. Jille same patient was even positive for Hepatitis B surface antigen. Case number twenty had numbness in sural nerve innervations which subsequently improved by sixth post-operative month. However, the patient had not complained of it.

Table 1: Age Incidence

Age group	Number of patients	percentage
35-40	5	13.5
41-50	18	49
51-60	12	32
>60	2	5
Total	37	100

Table 2: Sex Incidence

Sex	Number of patients	percentage
M	23	62.1
F	14	37.8
Total	37	100

Table 3: Side of rupture

Side of injury	Number of patients	Percentage
Right	29	78.3
Left	8	21.6
Total	37	100

Table 4: Type of Rupture

Type	Number of patients	Percentage
Acute	22	59.4
Chronic	15	40.5
Total	37	100

Table 5: Mechanism of injury

Mechanism of injury	number of ruptures	Percentage
Fall from stairs	4	10.8
Fall at bathroom	9	24.3
Dorsiflexion injury at fields	22	59.4
No specific trauma history	2	5.4
Total	37	100

Table 6: Functional result at follow up of 22 acute ruptures (ATRS**)**

Time intervals	Number of patients	ATRS
Three months	22	98.4
Six months	22	99.7
Twelve months	12	99.9

Table 7: Functional result at follow up of 15 chronic ruptures (ATRS)

Time interval	Number of patiens	ATRS
Three months	15	95.4
Six months	15	99.7
Welve months	15	99.9

Table 8: Power of plantar flexion with comparison to normal limb

Time interval	Number of acute ruptures	Power of plantar flexion for acute ruptures	Number of chronic rptures	Power of plantar flexion for chronic ruptures
3 months	22	97.8	15	72.8
6 months	22	99.5	15	89.9
12 months	12	100	15	96.5

Table 9: Power of abduction and eversion with comparison to normal limb

Time interval	Number of acute ruptures	Power of abduction & eversion for acute ruptures	Number of chronic ruptures	Power of abduction & eversion for chronic ruptures
3 months	22	97.8	15	72.8
6 months	22	99.5	15	89.9
12 months	12	100	15	96.5

Discussion

The goal of treatment for rupture of Achilles tendon is to obtain sufficient active plantar flexion power in allowing return to activities, while minimizing the risk for future reruptures. The first used was nonoperative treatment by plaster cast immobilization, which has resulted in increased re rupture rates and other complications.

Inglis *et al*. [11] had an incidence of 29 percent and Jacobs *et al*. [12] reported a rate of 22 percent. This treatment has been applied for many years, but vast data from well documented studies have shown that the goal set out was far from being realized with conservative treatment. Many different operative methods have been advocated. Since all of these methods gave good results, non-surgical treatment was not advocated commonly. In the recent decade, most of the studies are based on operative management, decreasing the post-operative complications and subsequently improving the functional outcome.

It is in this scenario that the present study was undertaken in which we evaluated 37 patients with Achilles tendon rupture reconstructed using peroneus brevis tendon transfer.

The peroneus brevis tendon was popularized by P'erez Teuffer [13]. He harvested this tendon from its attachment at the base of the fifth metatarsal and passed it through a transosseous drill hole in the calcaneus.' The tendon was then passed back on itself and sutured over the Achilles tendon. This procedure was used in thirty patients, all of whom had an acute tendon rupture, and twenty-eight of them were able to return to their original level of sports, activity. This procedure has subsequently been used for chronic tears.

Turco and Spinella [14] augmented an end-to-end repair of the Achilles tendon with a modification of P'erez Teuffer's technique, by passing the tendon of the peroneus brevis through the distal stump rather than through the calcaneus. Excellent results were reported, but the outcome measures were not identified.

Miskulin *et a1*. [15]. also passed peroneus brevis through the distal Achilles tendon stump and used plantaris tendon as suture material. In their series of five patients, all patients had an improvement in peak plantar flexion torque (range, 21% to 410%) and no complications were reported at one year after the operation.

McClelland and Maffulli [16] approached the Achilles tendon medially, and pulled the stump of the peroneus brevis through the inferior peroneal retinaculum, hence retaining its blood supply from the intermuscular septum. The tendon of the peroneus brevis was then woven through small coronal incisions in the distal stump of the Achilles tendon and again through similar incisions in the proximal stump. If the plantaris muscle was present, its tendon was used to augment the repair. Some investigators reported concerns that this technique could result in eversion weakness of the ankle [17, 18]. However, the peroneus longus muscle has more than twice the eversion strength of the peroneus brevis.

Theoretically, if the tendon of the peroneus brevis is placed distally in a lateral-to-medial direction, it does not duplicate the medial pull of an intact.

Achilles tendon [18]. However, the practical implications of these mechanical studies are unclear, and reconstruction with use of the tendon of the peroneus brevis has been reported to be functionally successful. Based on this concept we had made a drill hole in the midline in posterior aspect of calcaneum and anchored the peroneus brevis tendon in it. So that the pull of Achilles tendon is maintained.

Pintore *et al*. [19] compared the results of treatment of acute ruptures with direct end-to-end anastomosis with the results of treatment of chronic ruptures with peroneus brevis transfer. At the time of follow-up, at a mean of fifty-three months, they found the patients who had had a chronic rupture to be satisfied with the result of the procedure despite experiencing a -higher postoperative complication rate and greater loss of strength and calf circumference compared with their counterparts who had had an acute rupture.

Present study involved 37 Achilles tendon ruptures from above 35 years of age group with maximum ruptures involved in fourth and fifth decade. It was the same findings as seen in various other studies [1-4].

The mechanism of injury was fall at home in bathroom 9 (24.3%) patients, fallen from stairs in 4 (10.8%), stumbling in the fields in 22(59.4%) and no history of specific trauma prior to the onset of symptoms but had gradual onset of pain and difficulty in walking in 2(5.4%), were as in western countries most often the mechanism of injury has been shown to be associated with sports. In our country there is a need to educate farmers and stressing to take proper precautionary measures as used in foreign countries like wearing long boots working in fields rather than working barefooted.

Fortunately, the incidence of open Achilles tendon rupture is low in most of the studies despite high preponderance of increasing incidence of violence and road traffic accidents.

In view of raising incidence of ruptures of Achilles tendon, the incidence of delay in presentation is also increasinq [20]. In our study we had nearly 40.5 percent of the cases presenting greater than four weeks of time interval. Right sided injury was noted in 29(78.3%) of the patients and left sided in 8(21.6%). Acute ruptures were 22(59.4%) patients and chronic ruptures were 15(40.5%) patients.

Time interval between rupture and operation in present study was within a week in two patients, within a month in twenty patients, within two months in eleven patients, within 3 months in two patients, and two patients within four months.

In this study we have used peroneus brevis tendon for reconstruction. The tendon is pulled proximally through the lateral rmuscular septum from its insertion, than the tendon is woven to proximal aspect of Achilles tendon by making a coronal split in it. The distal Achilles tendon stump is excised and the attachment site on calcaneus is freshened until fresh cancellous bone is seen.

This will allow removing of pathology as most of our patients had previous history of pain surrounding Achilles tendon insertion site like bursitis, tendinitis. This will allow removing pathological tissues, spurs or osteophytes which would have formed due to early events.

A drill hole is made in posterior aspect in such a way that the pull of Achilles tendon is recreated when the reconstructed tendon is anchored in it, avoiding the change in direction of pull which can be noted theoretically. By removing the distal stump of Achilles tendon the bulk will be reduced which subsequently reduces tension over the operative wound at closure, more often we have found the tendon to be frayed and degenerated. By removing it directly decreases postoperative complications like wound dehiscence and wound related issues and hence encouraging early wound healing.

Note is made of that operative experience also counts for decreasing the incidence of post-operative complications, especially wound related complications as the importance of experience was emphasized by Inglis *et a1*. [7]. Opening the skin, subcutaneous with or without fascia in a single layer and retaining the sural neurovascular bundle will help good

healing of the wound by providing adequate circulation Post-operative immobilization was previously advised for 12 weeks with first six weeks in a below knee cast in gravity equines and next six weeks in an below knee walking cast following operative management of ruptured Achilles tendon but recent studies showed no added advantage of such lengthy immobilization [21-24] and hence range of motion exercises and gradual active exercises were allowed with the affected extremity after 6 weeks based in present study and found no pain or reruptures.

The most common complications reported after operative treatment of Achilles tendon rupture are superficial infections, deep infections, fistula, necrosis of skin, tendon or both, wound dehiscence, delayed wound healing and reruptures. In present study there was one (2.7%) case with superficial infection and one (2.7%) case with numbness over sural nerve innervations. On the whole, there were complications in two (5.4%) cases. The case number eleven which had superficial infection was noncompliance patient and was not keeping the cast in healthy conditions.

In present study no correlation between decrease in calf circumference and improvement of power of plantar flexion was found. This was the same noted in other studies and probably this can be due to altered configuration of triceps surae rnuscle [25].

The average follow-up was 11.3 months with the least follow-up included being 6 months and the longest follow-up being 12 months.

On an average. Achilles tendon total rupture score in acute ruptures was 98.4%, 99.7%, and 99.9% at three months, six months and twelve months. In chronic ruptures Achilles tendon total rupture score was 95.4%, 99.7%, and 99.9% at three months, six months and twelve months.

Power of plantar flexion in acute ruptures in 22 patients at three and six months averaged to 97.8% and 99.5% and in 12 patients who returned at twelve months follow up averaged to 100% with comparison to normal limb from the date of operation. And Power of plantar flexion in chronic ruptures in 15 patients averaged to 72.8%, 89.9% and 96.5% at three, six and twelve months with comparison to normal limb from the date of operation.

In present study power of plantar flexion averaged to 87.7%, 95.9% and 98.2% at three, six and twelve months with comparison to normal limb from the date of operation.

Power of eversion and abduction in acute ruptures in 22 patients at three and six months averaged to 77.4% and 79.4% and in 12 patients who returned at twelve months follow up averaged to 79.5% with comparison to normal limb from the date of operation, and power of eversion and abduction in chronic ruptures in 15 patients averaged to 76.7%, 78.7% and 79.5% at three, six and twelve months with comparison to normal limb from the date of operation.

In present study patients who had a chronic rupture to be more satisfied with the result of the procedure as compared to acute ruptures (as per ATRS findings) despite experiencing mild loss of plantar flexion power compared with their counterparts who had had an acute rupture.

Conclusion

With multiple variables influencing the results of treatment of Achilles tendon ruptures, definitive conclusions about such treatment and factors affecting the outcome are difficult to reach. Optimal restoration of biomechanical relationship of Achilles tendon with the help of peroneus brevis tendon transfer can lead to improved early functional outcome with decreased chances of early disability even in chronic ruptures and this can be achieved by surgical means.Peroneus brevis tendon transfer is an inexpensive and efficient means of reconstruction of ruptured Achilles tendon in both acute and chronic ruptures in both adults and elderly aged patients. Proper analysis, patient factors, biomechanical restoration of Achilles tendon with peroneus brevis tendon transfer and a well-structured post-operative rehabilitation protocol are the pre- requisites for consistently good results in both acute and chronic Achilies tendon ruptures.

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