



STUMP PASSAGE THROUGH THE CALCANEAL TUNNEL - A MODIFICATION OF BOSWORTH TECHNIQUE IN CHRONIC TENDOACHILLES RUPTURES.

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ABSTRACT **Purpose:** Achilles tendon being one of the strongest tendon of our body, is more prone for injuries by various means. In the past few years, the number of cases has raised drastically due to the active participation of young athletes in various sports activities. This has brought the attention of various researchers towards this tendon and various innovative methods for the repair of the same are being devised. **Materials and Methods:** This Prospective observational study was done on 30 patients who presented between 2015 and 2019, to the Out Patient Department (OPD) of department of Orthopaedics at MMIMSR, Mullana. Patients were diagnosed on the basis of detailed history and physical examination. Postoperatively, patients were followed up at 2 weeks, 4 weeks and 6months and evaluated on the basis of ankle plantar flexion and American Ankle Hind Foot Scale. **Results:** In our study conducted on 30 patients, The mean age of the patients was 47.96 years, with a Standard Deviation (SD) of ± 12.27 years. The mean ankle Plantar flexion at 2 weeks post op was 22.76 degrees, at 4 weeks post op was 33.03 degrees and at 6 months post op was 42.23 degrees. The mean Ankle Hind foot Scale (AHS) at Day 0 was 75.73, at 2 weeks post op was 79.2, at 4 weeks post op was 84.93 and at 6 months post op was 89.26. p-value was highly significant (0.0000001). **Conclusion:** This procedure is ideally suitable for Zone-1 tears without a distal stump and in cases with large gaps between the ruptured ends. With correct patient selection and meticulous adherence to basics, Modified Bosworth technique offers an excellent alternative to tedious and extensive procedures like V-Y plasty or tendon graft augmentation procedures.

KEYWORDS : Zone-1 repair, Modified Bosworth technique, Chronic TA ruptures, Calcaneal tunnel.

INTRODUCTION

Tendoachilles is considered the most frequent injury susceptible tendon in the lower limb⁽¹⁾ ranging to a rough incidence of 18 per 1,00,000 population⁽²⁾. Achilles tendon is one of the strongest tendon of human body, which unites the muscles of the calf to the calcaneum⁽³⁾. Achilles tendon nomenclature was given to it from the ancient Greek hero of the Trojan War, Achilles⁽⁴⁾.

The Achilles tendon is divided into 3 Zones. Zone 1 is up to 2cms above the insertion. The Zone 2 of the Achilles tendon is the area that is about 2-6 cms above the calcaneal insertion (THE WATERSHED ZONE). The neglected ruptures of this area develops a distal stump that undergoes attrition and becomes unsuitable for repair⁽⁵⁾. The Achilles tendon rupture is considered to be chronic if the injury is past 4-6weeks of duration⁽⁶⁾. In cases of neglected ruptures or chronic ruptures, usually the ends of the ruptured tendon would have retracted and this area has a very poor blood supply⁽⁹⁾.

Many surgical techniques have been described that usually needs additional support (augmentation) or reinforcement by using turndown plasty, transfer of tendons, using tendons as grafts, or any synthetic substances^(10,14). In the literature it has been discussed that One or more tendon strips like Achilles tendon fascia, the fascia lata and strips of tendons of the flexor hallucis longus, posterior tibial tendons, peroneus brevis, plantaris muscle, flexor digitorum longus are some of the grafts utilized for the repair of chronic tendoachilles rupture. There is only one study conducted on chronic TA repair by modified Bosworth technique of passing the tendon raphe through the calcaneum and suturing it back to the proximal stump. We conducted the study to observe the outcome of the modified Bosworth technique in chronic TA rupture patients.

MATERIALS AND METHODS

This prospective study was commenced after obtaining approval from the Institutional Ethics Committee. There were no ethical objections. Informed and written consent was taken from the participants before conducting the study. Certificate from the institutional Ethical Committee was obtained before beginning enrolment of the patients for the study. This Observational study was done on 30 patients who presented between 2015 and 2019, to the Out Patient Department (OPD) of department of Orthopaedics at MMIMSR, Mullana, Ambala District, with the presenting symptoms of difficulty in walking and climbing stairs, inability to do plantar flexion, inability to squat etc.

Diagnosis

Patients were diagnosed on the basis of detailed history and physical examination, which mainly included palpation of the gap between the two ruptured ends of the tendon (Fig.1), Thompson test, Toe rise test etc. Detailed history and local examination, basic investigations were done and patients were informed about the condition and were informed about various treatment modalities, which included the surgical repair.



Figure 1- Pre-operative Evaluation Of The Visible Gap Between The 2 Ruptured Ends Of The Tendoachilles

Inclusion criteria

- 1) Age above 16 years.
- 2) Tendo achilles rupture of more than 6 weeks duration.
- 3) Patients who gave Consent for surgery.
- 4) Patient with good local skin condition over the operative site.

Exclusion criteria

- 1) Age <15 years.
- 2) Tendo achilles rupture of less than 6 weeks duration.
- 3) Patients who donot give Consent for surgery.
- 4) Patient with poor local skin condition over the operative site.
- 5) Previously operated cases.

Pre-operative evaluation

During Clinical Examination, Thompson test was done in all the participants of the study. Plain X-rays and Ultrasonography were done to reveal the gap between the two-ruptured ends of the tendon, any irregularity in the borders of Kager's triangle and to rule out the presence of calcification in the distal portion. Preoperative counselling of the patient and his/her relatives regarding the method of treatment and prognosis was done and consent for operation was taken. Patients were immunized against Tetanus. Local preparation of the part was done by shaving and appropriate broad spectrum antibiotic was given a night before the operation and was continued thereafter intra and postoperatively.

Operative technique

Anaesthesia: Spinal/ Epidural.

Position and Preparation:

The patient was made to lie down in prone position over the operating table. Next step was to inflate the lower limb tourniquet, after exsanguination. The back of the leg over the affected side was prepared with aqueous iodine based solution from popliteal fossa till the heel and covered with sterile drapes. A Dose of intravenous antibiotic was given prior to skin incision.

Skin Incision And Exposure of Achilles tendon:

A straight long midline incision extending proximally about 10–12 cms below the knee joint was put and that incision was continued distally, distal to the site of insertion of the Achilles tendon up to the heel. The length of the incision was about 15–20 cms.

Tendon Repair and Closure:

After performing the skin incision, two important structures viz., the short saphenous vein and the sural nerve were secured and isolated. The Tendoachilles paratenon was isolated and saved, for closure over the repair, to avoid adhesions. Then a wide strip of Achilles tendon measuring about 1-1.5 cms was cut and freed of from the central portion of the aponeurosis (Fig.2). The aponeurosis was then left attached (about 1.5-2 cms) proximal to the ruptured end. The strip was passed through the proximal stump for better anchorage and stability. A hole was made in calcaneus from lateral to medial direction (Fig.3) and strip was passed through it, taking care that there is free movement of the tendon raphe inside the bony tunnel (Fig.4). The stump was then sutured back to the main Achilles tendon with ethibond (Fig.5).



Figure 2- A Wide Strip Of Achilles Tendon Measuring About 1-1.5 Cms Cut And Freed Of From The Central Portion Of The Aponeurosis



Figure 3- Hole Made In The Calcaneus From Lateral To Medial Direction



Figure 4- Aponeurosis Strip Passed Through The Calcaneum, Taking Care That There Is Free Movement Of The Tendon Raphe Inside The Bony Tunnel



Figure 5- Aponeurosis Stump Re-sutured To The Proximal End While Maintaining The Ankle In Plantar Flexion Position

While doing closure, negative suction drain was inserted, a proper amount of tension was maintained in the tendon by plantar flexing the ankle and wound closure was done in layers. The precautions that are to be remembered during the surgery were (a) without any subcutaneous dissection, making a skin incision up to the Achilles tendon, (b) paratenon to be preserved & sutured before closure and (c) by doing a tight continuous subcutaneous suturing, to prevent wound dehiscence.

Postoperative protocol:

In the post-op period, a long, non-weight-bearing above knee cast with the ankle in plantar flexion (Equinus) and the knee in 30° flexion was applied for 2 weeks, which was then converted to below knee cast for 2 weeks. Wound dressing with removal of negative suction drain was done through a window created over the cast 2 days after surgery. Patients were discharged on the 5th post op day after 2 post op dressings and the sutures were removed 14 days after surgery on OPD follow up basis.

Rehabilitation Protocol:**Phase I: 1-2 Weeks**

- Was in a Long-Leg Cast with knee in flexion and foot in Equinus.
- Non-weight bearing when walking, But Can put the foot down on the floor when standing.
- Was using crutches for 6 weeks.

Phase II: 3-6 Weeks

- The Above knee cast was converted into below knee cast after 2 weeks and was removed after 4 weeks.
- Partial Weight Bearing in walker boots- in Plantar Flexion position – one wedge was removed every 3 weeks.

Phase III: 7-10 Weeks

- Weight Bearing in walker boots: Wedges were gone at 10 weeks.
- Swelling control with elevation of the lower limb and other modalities as required.
- Active Range Of Movements at the ankle: Plantar flexion, Inversion or Eversion, Dorsiflexion (Fig.6) up to the first point of resistance.
- Manual mobilization of foot as required.
- Continued core, hip and knee strengthening exercises (exercises were done with the brace on).
- Control hyperextension of knee joint (to compensate for the lack of Dorsiflexion at the ankle, the knee hyperextends).



Figure 6- Postoperative Dorsiflexion At The Ankle

Phase IV: 10-12 Weeks

- Usually were out of the boots by 10-12 weeks.
- Sitting: Active Plantar Flexion exercises, Dorsiflexion up to tolerance levels.

Phase V: 13-16 Weeks

- Boots off.
- Increase the Weight Bearing tolerance
- ROM exercises:
 - Gentle calf stretching exercises.
 - Manual mobilization of the limb as required
- Calf massage.
- Leg massage.
- Retraining of gait.

Phase VI: 16+ Weeks

- Work or sports activities like running, spot jumps.

Phase VII: 26 Weeks

- Returning back to competitive sports if any.

Evaluation of patients

All the patients were evaluated according to American Ankle Hind Foot Scale (AHFS)⁽¹⁵⁾ and plantar flexion of ankle was measured on the day of presentation i.e., at Day 0 and during the postoperative period at 2 weeks, 4 weeks & 6 months (Fig.7).



FIGURE 7- PLANTAR FLEXION AT 6 MONTHS FOLLOW UP

Statistical analysis

Data were described in terms of range; mean \pm standard deviation (\pm SD), median, frequencies (number of cases) and relative frequencies (percentages) as appropriate. Comparison of quantitative variables between the study groups was done using independent t-test and Mann Whitney U test for independent samples for parametric and non-parametric data respectively. A probability value (p value) less than 0.05 were considered statistically significant. All statistical calculations were done using SPSS (Statistical Package for the Social Science) SPSS 21 version statistical program for Microsoft Windows.

RESULTS

In our study conducted on 30 patients, The mean age of the patients was 47.96 years, with a Standard Deviation (SD) of \pm 12.27 years. There were 19 (66.33%) male patients and 11 (36.67%) female patients. Out of 30, 56.67% (n=17) of the patients had Right-sided TA rupture and 43.33% (n=13) of the patients had left-sided TA rupture. The mode of injury leading to rupture were, Injection of steroid into Achilles tendon in 5 (16.67%) patients, 7 (23.33%) patients had sustained direct injury to the ankle, 5 (16.67%) patients had history of steroid abuse, 3 (10%) patients had sustained sports injury and 10 (33.33%) patients had sustained RTA (Fig.8). The Mean Duration of presentation to the hospital after injury was 8.46 weeks, with a Standard deviation of \pm 2.01 weeks (Table 1). Among the 30 patients, 33.33% of the patients had associated co-morbidities, of which, 3 (10%) patients had Diabetes, 3 (10%) patients had Hypertension and 4 (13.33%) patients had both diabetes and hypertension.

Table 1- Time Of Presentation To Hospital After Injury

Presentation after injury (in weeks)	Number (n,%)
6 weeks	6 (20%)
7 weeks	5 (16.67%)
8 weeks	7 (23.33%)
9 weeks	3 (10%)
10 weeks	4 (13.33%)
12 weeks	5 (16.67%)
Total	30 (100%)

Mean \rightarrow 8.46 weeks
 Median \rightarrow 8 weeks
 SD \rightarrow 2.01 weeks

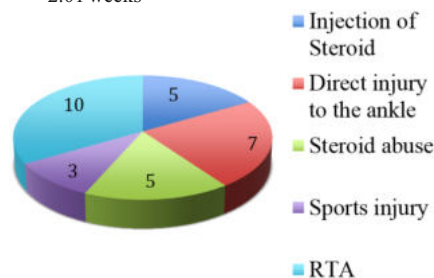


FIGURE 8-MODE OF INJURY

In the post operative period, 10% of the patients had post op complications, of which, 1(3.33%) patient had superficial wound infection- which was treated by debridement and regular Aseptic sterile dressing (ASD), 1 (3.33%) patient had delayed sinus formation which healed after removal of vicryl from the site of sinus and 1 (3.33%) patient had wound dehiscence on the 4th Post operative day, which was managed by re-suturing and delayed suture removal. The mean ankle Plantar flexion at 2 weeks post op was 22.76 degrees, at 4 weeks post op was 33.03 degrees and at 6 months post op was 42.23 degrees. The mean Ankle Hind foot Scale (AHS) at Day 0 was 75.73, at 2 weeks post op was 79.2, at 4 weeks post op was 84.93 and at 6 months post op was 89.26. p-value was highly significant (0.0000001) (Table 2).

TABLE 2- ANKLE HIND FOOT SCALE

Duration	Ankle Hind foot Scale		
	Mean	SD	p-value
Day 0	75.73	4.86	0.0000001
2 weeks	79.2	4.4	
4 weeks	84.93	3.82	
6 months	89.26	3.91	

DISCUSSION

The Pathophysiology of chronic Achilles tendon rupture is different from that of an acute rupture. Usually, in cases of chronic ruptures, the gap between the two ruptured ends gets filled with fibrous scar tissue. Treatment of chronic Tendoachilles rupture with large gaps has become a greater challenge for many Orthopaedic surgeons. Clinically, the rate of neglected Tendoachilles rupture has become greater than 20%⁽¹⁶⁾. Patient complaints of difficulty or inability to do ankle planar flexion movement, which causes difficulty in walking i.e. high steppage gait.

In our study we had performed chronic tendoachilles rupture repair by Modified Bosworth technique in 30 patients, in which the gastrocnemius muscle aponeurosis was used for the repair, which did not require any additional tendon transfer, thereby not compromising the function of any other tendon and also prevents another surgical scar.

Young males are more prone for tendoachilles injury due to the various reasons like active participation in sports activities, errors in training like usage of inappropriate training materials like footwear, change in surfaces or regions or terrains, varying schedules of training etc^(7,17) and that may go unnoticed due to the careless attitude, turning into a neglected one.

Local injection of corticosteroids into the tendon remains a major threat for rupture of tendons. In our study, 5 patients had history of injection of steroid into the Achilles tendon. Similarly, In a studies conducted by Mann RA et al⁽¹⁸⁾, Hahn F et al⁽¹⁹⁾ and Pavan Kumar A et al⁽⁵⁾, there were 3, 8 and 44 cases respectively, with similar history which remains a major risk factor for chronic tendoachilles tear.

Due to lack of knowledge among the general public regarding this injury and due to mismanagement by local practitioners, the patients with TA ruptures usually present very late to the hospital which poses a great challenge in treating tears as there can be fibrosis or retraction of the proximal end of the tendon higher above. In our study, the average duration of presentation to hospital after injury was 8.6 weeks whereas in a study conducted by Lin Y et al⁽¹⁹⁾, it was 20.4 weeks.

Various techniques have been described in the literature for the treatment of chronic tendoachilles rupture viz, tendon transfer (FHL, TP, FDL, PB etc), V-Y plasty, Gastrosoleus turndown plasty and many more. Myerson⁽²⁰⁾ in 1999 stated that, defects of 1-2cms can be repaired by end to end anastomosis, defects of 2-5 cms can be repaired by V-Y lengthening and defects >5cms, can be repaired by tendon transfer and V-Y plasty. Whereas in zone 1 tears, even when the gap is less than 2 cms, end to end repair is difficult due to the small length of the distal end of the tendon. In such cases, our method can be used to repair the defect.

Bosworth⁽²¹⁾ technique of repair involved the usage of a wide aponeurotic strip of the proximal end that was sutured through the proximal and distal ends of the ruptured tendon. But, to perform this procedure an intact distal stump was a pre-requisite. Whereas, to perform repair by our technique, there is no necessity of a distal stump, as we pass the aponeurotic strip through a tunnel made in the calcanei, which intum provides additional stability to the repaired tendon and a better outcome.

In the literature, there is no evidence of any prospective study that has been conducted on similar technique of repair as performed by us to compare our outcome with other studies. But, a retrospective study by Pavan kumar et al⁽⁵⁾ in 2011 is available, which was performed on 78 patients with long standing TA rupture, which was treated by a similar technique as performed in our study and had obtained excellent results and a good post operative ankle range of motion similar to our study.

In similar studies conducted by Mullaney MJ et al⁽²²⁾, in which mid-substance tendoachilles rupture was repaired by 4-stranded modified Kessler core suture using No. 2 Ethibond, they had noted weakness in the end-range plantar flexion motion. Whereas, in our study, the mean post op ankle plantar flexion was 42.23 degrees and there was no weakness in end range plantar flexion.

The mean Post-op American Orthopaedic Foot and Ankle Society (AOFAS) score in our study was 89.26, which is better than a similar study performed by Athar AMA et al⁽²³⁾ in which the TA ruptures within 1 cm of insertion of the tendon to the calcaneum were treated by, direct repair of tendon to calcaneum by suture anchor and Flexor hallucis longus (FHL) tendon transfer fixed to calcaneal tunnel with an interference screw to augment the repair. The mean Post-op AOFAS score of their study was 85.4.

Our study had less rate of superficial wound infection of 3.33%, as compared to 15.38% in a similar study by Hahn F et al⁽¹⁸⁾, in which harvested Flexor hallucis longus (FHL) tendon was utilised to repair the defect between the ruptured ends of the tendoachilles. Also there were No re-rupture following repair of the ruptured Achilles tendon unlike other studies conducted by Nellas ZJ et al⁽²⁴⁾, Renninger CH et al⁽²⁵⁾, Retting AC et al⁽²⁶⁾, which had re-ruptures in 1, 3 and 4 patients respectively.

The merits of the study were that it was a prospective in nature, which allowed us to compare the preoperative and postoperative functional status and the outcome of the surgical procedure. The limitations of the present study were the relatively small sample size and limited follow up duration. All the patients achieved the pre-rupture level of activity.

The relevant findings, including strength of the study as well as variables that were lacking will make up the gist of the study. The objective as well as functional outcome after Modified Bosworth repair are satisfactory as well as reproducible as evident by literature reviewed and compared with the present study. The present study reveals that the functional outcomes achieved after treatment of Chronic Tendoachilles rupture are satisfactory and the p-value (0.0000001) was highly significant for the Ankle Hind foot scale.

This method is highly suggested for patients with large gaps between the two ruptured ends of the tendon. The sample size however needs to be greater to exactly comment upon the rewards of the procedure, as it would be unfair to extrapolate these results over a large group of population. The follow up period of 6 months leaves a little more desired as it does not reflect upon long term results and complications. It is specially enthralling in a country like ours where everyone cannot afford expensive surgeries and are forced to live a life of misery and

morbidity.

CONCLUSION

This procedure is ideally suitable for Zone-1 tears without a distal stump and in cases with large gaps between the ruptured ends. With correct patient selection and meticulous adherence to basics, Modified Bosworth technique offers an excellent alternative to tedious and extensive procedures like V-Y plasty or tendon graft augmentation procedures.

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