

# Triple level percutaneous Achilles tendon tenotomy-how efficient?

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## Abstract

**Background:** Traditionally Open Z-Plasty lengthening is the choice of the procedure for treating Achilles tendon contracture seen in equinus deformity of the foot, which is commonly seen in club foot, spastic cerebral palsy, polio myelitis, post traumatic and post burn contractures etc. Percutaneous Achilles tendon lengthening by triple level tenotomy technique is based on sliding of partially cut tendon preserving its biology, strength and biomechanics. This study aims to evaluate the efficacy and safety of this new surgical therapeutic method.

**Methods:** A retrospective analysis of the Achilles tendon contracture cases in our hospital between 2015 and 2020 was conducted. Fifty-one cases of equinus deformities treated with percutaneous triple level Achilles tendon tenotomy. Operative time required, hospital stay, wound healing, Achilles tendon rupture and equinus recurrence were recorded and statistically analysed. American Orthopaedic Foot & Ankle Society (AOFAS) scoring system was used to assess the Foot and ankle function.

**Results:** The mean follow-up period was 20 months. The mean operative time was 6 minutes and mean hospital stay was 2 days. No cases had infection or wound healing complications. One patient had equinus recurrence which was minimal. The mean AOFAS score increased from 53% points before procedure to 96% at final follow-up.

**Conclusion:** This method of Achilles tendon lengthening by Triple level percutaneous tenotomy significantly reduces operative time, hospital stay and thus expenses. Also this technique is much better in maintaining soft tissue biology, strength and biomechanics thus helping in preventing rupture of the tendon and recurrence of the deformity.

**Keywords:** Achilles tendon, biomechanics, tenotomy, AOFAS, equinus deformity, cerebral palsy, hemi section.

## Introduction

The Achilles tendon originates from the middle of the calf, and fuses with the gastrocnemius

muscle proximally. The medial and lateral heads of the Gastrocnemius muscle fuse to become

a single belly forms the superficial posterior compartment of the leg. Along with the gastrocnemius muscle, Soleus muscle forms the triceps surae, which acts as plantar flexor of the ankle joint via its conjoint tendon, the Achilles tendon. The blood supply of the tendon, from its musculotendinous junction, surrounding soft tissues, and the osteotendinous junction [1], is age dependent, and decreases with age [2]. The Achilles tendon have three main vascular areas: the posterior tibial artery which supplies the middle part of the tendon, while the anterior tibial artery vascularised the proximal and distal ends of the tendon. The relatively poor blood circulations at the middle part of the Achilles tendon may explain the frequent incidence of pathology at this site [3,4].

Spastic disorders like Cerebral Palsy, Arthrogryposis Multiplex Congenital, neurological disorders like Polio Myelitis, Congenital Neural Tubal Defects, and Congenital Talipes Equino Varus of various causes and Trauma contribute to the risk of Achilles tendon contracture. Achilles tendon lengthening is the preferred method for treating Achilles tendon contracture. The goal of surgery is to correct the deformity and to achieve dorsiflexion of ankle. The traditional open Z-lengthening has the advantage of achieving enough lengthening, however, incision complication are frequently observed, some even result in other serious complications such as pain, scarring, failure, adhesion, relapse or infection [5]. Percutaneous Achilles tendon lengthening by triple hemi section was first employed by Hoke (1931) [6]. The advantages of this method are a shorter operating time, shorter hospital stay, avoiding the incision complication and no scarring [3]. Percutaneous Achilles tendon lengthening is now accepted globally as a least invasive and efficient method for the treatment of Achilles tendon contracture [7]. However, when the Achilles tendon contracture is of severe grade, complete rupture of the tendon can be a serious complication. Our study provide a therapeutic data of percutaneous sliding technique with three hemi-cuts in the Achilles tendon. Besides, partly known reason for the Achilles tendon contracture is soft tissue imbalance between the anterior and the posterior muscle compartment of the leg which makes the ankle strength in Plantarflexion stronger than in dorsiflexion. This soft tissue strength can be better balanced and reduce the recurrence of Achilles tendon contracture when Achilles tendon strength in Plantarflexion is weakened. In this study, we performed an analysis of the Achilles tendon lengthening by triple level percutaneous tenotomy done in our hospital from 2015 to 2020 and evaluated the efficiency and advantages of the new percutaneous Achilles tendon lengthening, providing reference for further promotion of this technique.

## Material and Methods

The inclusive criteria were.

1. Patients aged between 5 years and 14 years.
2. Severe Achilles tendon contracture and equinus.
3. The history of equinus deformity more than 6 months.
4. Primary procedure.

The Achilles tendon contracture cases in our hospital between 2015 and 2020 was conducted. Most of our patients were of idiopathic neglected clubfoot or spastic cerebral palsy and those with clubfoot had additional procedure of Triple Arthrodesis.

Twenty-four patients diagnosed as neglected idiopathic clubfoot, 5 patients diagnosed to have arthrogryposis with clubfoot and 22 patients had spastic cerebral palsy with moderate to severe equinus deformity. Silverskiold test [8], is used to analyse Achilles tendon contracture rather than gastrocnemius contracture. Routine ankle and leg radiographs were conducted to rule out the abnormal bone structure.

**Surgical technique:** All surgeries done under spinal anaesthesia. For Achilles tendon lengthening with percutaneous triple hemi cuts along with Triple arthrodesis for clubfoot deformities a midhigh tourniquet were used while for isolated percutaneous Achilles tendon lengthening, tourniquet were not used. The patient was placed in supine position, with operative foot kept over a pillow so that the other foot would not be disturbing the surgeon. Following skin preparation and draping exposing up to knee, the boundary of Achilles tendon and incision position was marked. Since the Achilles tendon strength need to be weakened more on the medial side than on the lateral side if the ankle has varus deformity, the most distal incision was placed at the medial side 0.5 cm proximal to the calcaneus. The middle incision was put at the lateral side 5 cm proximal from the most distal incision. The distance between the most distal incision and the middle incision could expand to 8-10 cm based on the degree of Achilles tendon contracture. The most proximal incision was on the Achilles tendon just distal to the gastrocnemius aponeurosis. The distance between the most proximal incision and middle incision was not constant. Three 0.5cm longitudinal incisions were made, then subcutaneous dissection was performed by haemostatic forceps. A No.11 blade was inserted longitudinally in the middle tendon at three levels. Next, blunt dissection was carried out during the course of operation; the blade was rotated 90 degrees and the Achilles tendon was transacted over half of the tendon. The hemi sections were performed with knee in semi-extension, then the ankle dorsiflexed gently till the equinus foot is overcorrected to slight dorsiflexion. One can feel the sliding break in the tendon. Achieving 10 degrees of dorsiflexion of ankle joint is the goal of the procedure. All three wounds closed separately in single layer with non-absorbable 3-0 sutures. After small dressing, foot kept in slight dorsiflexion and long leg cast applied. Sutures were removed after 10days through a small window made in the plaster cast posteriorly. Plaster of Paris cast was continued for 6 weeks in patients with isolated Achilles tendon tenotomy but cast were continued for 8 weeks in patients where adjunct bony procedures like triple arthrodesis was done. In both group of patients a below knee walking cast was applied after removal of long leg cast and encouraged to walk with full weight bearing over the cast for another 4 weeks. After the removal of plaster cast patients were strictly advised and encouraged for both active and passive dorsiflexion exercises. Operative time, hospital stay, post-operative pain, incision wound complications, Achilles tendon rupture and recurrence of deformity were recorded and statistically analysed. Patients and parents satisfactory and happiness towards the tenotomy procedures were also recorded separately for the future references. The function of ankle was assessed by AOFAS scores.

## Results

In this study, all 51 patients were followed up to mean period of 20 months (range 14 to 36 months). The mean operative time was 6 minutes for Achilles tendon tenotomy procedure. The mean hospitalization days was 2 days (range 1 to 4 days). The mean AOFAS score increased from 53% preoperatively to 96% at final follow-up. One patients suffered recurrence (1.96%) of mild equinus deformity (case of neglected idiopathic clubfoot) after 8 months due to long standing infection and persistent swelling & pain at the foot (diagnosed as post-operative deep infection). No patients suffered any incision wound complications, tendon rupture or infections.



Fig 1

Fig 2

Fig 3

Fig 4

Fig 5



Fig 6

Fig 7

Fig 8

Fig 9

## Discussion

The Achilles contracture in an isolated or adjunct equinus foot deformity can be treated by gastrocnemius-soleus lengthening at either the musculotendinous junction with an elongation, at the level of the Achilles tendon through an open or percutaneous approach or aponeurosis recession. Numerous procedures have been evolved over period of time, used in the treatment of equinus contracture but it is difficult to compare among these studies and success rates. The choice of surgical management of ankle equinus is a widely debated topic, and procedure selection is mostly based on surgeon's preference because there is no definitive consensus regarding the superiority of a single procedure.

Two open techniques for Achilles tendon lengthening, the gastrocnemius recession and Z-plasty lengthening are the most commonly practiced. Both procedures require a surgical sophistication and expertise and are time consuming to perform. The patient is generally turned prone to perform the above procedures, which dramatically increase the operating room time and increase the anaesthesia complications.

The Z-lengthening by open method is an effective procedure for the treatment of Achilles tendon contracture but it has significant and worrisome complications like unsightly scarring, adhesions of soft tissue leading to recurrence of the equinus deformity and infections <sup>[9]</sup>.

Multiple percutaneous methods have been described in various literatures, to avoid many of such difficulties and complications of the open procedures. White was the first to describe a percutaneous technique. He based the procedure on the relative rotation of the Achilles tendon on its longitudinal axis. White stated that the tendon rotated laterally 90 degrees approximately. He therefore recommended the anterior 2/3 of the Achilles tendon be severed distally, about 2.5cm proximal to the insertion at the calcaneus <sup>[2]</sup>. This procedure is at times difficult to perform precisely due to variation in the amount of rotation of the tendon fibres. Mercado, based upon cadaveric dissections and study observations, felt the rotation of the

tendon is a myth and in an anatomic study by van Gils, Steed and Page, which is published in Journal of Foot and Ankle Surgery in 1996, they observed that the tendon rotated laterally anywhere from 11degrees to 65degrees with an average lateral rotation of 37degrees<sup>[10]</sup>.

Percutaneous Achilles tendon triple tenotomy lengthening has definitive advantages of minimal injury to soft tissue and tendon sheath around Achilles tendon and thus reducing the damage to Achilles tendon blood supply, so it is better accepted globally nowadays. In patients with low degree of Achilles tendon contracture, percutaneous Achilles tendon lengthening is effective adding advantages of the procedures. However, in patients with severe Achilles tendon contracture, there is a high risk of Achilles tendon rupture<sup>[3, 11]</sup>. The complete rupture of the Achilles tendon could lead to ankle and knee instability<sup>[12]</sup>.

Achilles tendon contracture in equinus deformity is caused by soft tissue imbalance which makes the ankle strength in plantar-flexion stronger than in dorsiflexion. By weakening the Achilles tendon in Plantarflexion, recurrence can be prevented. In our study, the most proximal incision was made at the tendon-forming regions in gastrocnemius. Achilles tendon strength in Plantarflexion can be weakened by cutting through tensioned tendon tissue of gastrocnemius at most proximal incision. If this tension tendon at this zone is cut, it would have no adverse influence on the function of the ankle which is observed in our clinical practice. Meanwhile strength of the tendon can be maintained at the same level as previous because only the half of the tendon is transacted at all three level as we know that one grade of motor strength is lost when any tendon is cut fully in transverse plane.

While performing Achilles tendon lengthening by triple hemi-section, if the distance between the two tendon cuts was less than 5 cm, on stretching theoretically the cut may extend longitudinally to join the other cut making the tendon to rupture. Hence the distance between distal two cuts were kept at least 5cm away in our study.

Recurrence of equinus deformity needs to be checked and evaluated during follow up visits after Percutaneous Achilles tendon lengthening. In our study, only one (1.96%) patient, a case of neglected idiopathic clubfoot, found to have equinus recurrence and we believed that the reason of this recurrence had no association with our procedure itself. This particular patient developed recurrence of the equinus deformity after 8 months of the index procedure due to long standing deep postoperative infection associated with persistent swelling and pain, the child was uncooperative for the regular mobilization program. After a culture and sensitivity testing of the wound discharge at the foot where triple arthrodesis was done, the patient was given antibiotics and regular dressing. The infection was controlled but patient continued with pain and swelling for a significantly longer time during which we found mild equinus deformity of 10 degrees which we managed with heel rise footwear.

The mean AOFAS score increased from 53% preoperatively to 96% at final follow-up which is equally comparable to open z-plasty lengthening of the Achilles tendon.

Patients with the recurrence of Achilles tendon contracture, this procedure did not have a better outcome, because of the postoperative local tissue adhesion and sutures<sup>13</sup>. For the revision cases, the other open methods of tendon lengthening procedures are recommended<sup>14</sup> and we do not recommend using this percutaneous Achilles tendon triple tenotomy lengthening in those patients.

## Conclusion

Percutaneous triple level Achilles tendon tenotomy provides successful and adequate lengthening of the contracted tendon, achieving approximately 20 degrees of improvement in dorsiflexion angle of the ankle. This technique can also be useful in treating severe equinus contractures with or without other foot and ankle deformities involving both the gastrocnemius and the soleus, but it needs surgeon's expertise. Operative time and hospital stay were significantly shorter as compared with other open Achilles tendon lengthening

procedures. Precise planning and marking of the tenotomy sites can avoid tendon rupture while, maintaining better tissue balance and tissue strength between ankle dorsiflexion and ankle Plantarflexion, avoiding recurrence of the deformity. By our experience, percutaneous triple Achilles tendon lengthening better be used in the primary operation, but the surgeon need to have expertise for severe degree of Achilles tendon contracture.

## References

1. Ahmed IM, Lagopoulos M, McConnell P, Soames RW, Sefton GK. Blood supply of the Achilles tendon. *J Orthop Res.* 1998;16:591-596.
2. Hastad K, Larsson LG, Lindholm A. Clearance of radiosodium after local deposit in the Achilles tendon. *Acta Chir Scand.* 1959;116:251-255.
3. Lee WC, HS Ko. "Achilles tendon lengthening by triple hemi section in adult," *Foot & Ankle International.* 2005;26(12):1017-1020.
4. Chen TM, Rozen WM, Pan WR, Ashton MW, Richardson MD, Taylor GI. The arterial anatomy of the Achilles tendon: anatomical study and clinical implications. *Clin Anat.,* 2009;22:377-385.
5. Rattey TE, Leahey L, Hyndman J, Brown DC, Gross M. "Recurrence aer Achilles tendon lengthening in cerebral palsy," *Journal of Pediatric Orthopaedics.* 1993;13(2):184-187.
6. Hatt RN, Lamphier TA. "Triple hemisection: a simplified procedure for lengthening the Achilles tendon," *e New England Journal of Medicine.* 1947;236(5):166-169.
7. Phillips S, Shah A, Staggers JR *et al.*, "Anatomic evaluation of percutaneous achilles tendon lengthening," *Foot & Ankle International.* 2018;39(4):500-505.
8. Hoh TK, Hung RW, Steinberg JS, Raspovic KM. "A wound complication aer percutaneous achilles tendon lengthening requiring surgical excision: a case report," *e Journal of Foot & Ankle Surgery.* 2017;56(3):680-682.
9. Berg EE. "Percutaneous Achilles tendon lengthening complicated by inadvertent tenotomy," *Journal of Pediatric Orthopaedics.* 1992;12(3):341-343.
10. Chapter Io Achiilles Tendon Lengthenings Jelfrey S. Boberg, DPM Erica Torgtrude, DPM Jana Poock, DPM.
11. Jordan C. "Current status of functional lower extremity surgery in adult spastic patients" *Clinical Orthopaedics.* 1988;233:102-109.
12. Saini SS, Reb CW, Chapter M, Daniel JN. "Achilles tendon disorders", *e-Journal of the American Osteopathic Association.* 2015;115(11):670-676.
13. Yasuda T, Shima H, Mori K, Kizawa M, Neo M. "Direct repair of chronic Achilles tendon ruptures using scar tissue located between the tendon stumps," *e Journal of Bone & Joint Surgery.* 2016;98(14):1168-1175.
14. Lin Y, Yang L, Yin L, Duan X. "Surgical strategy for the chronic Achilles tendon rupture," *BioMed Research International.* 2016, 1416971.