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# The Percutaneous Achilles Tendon Lengthening by Triple Hemisection for the Management of Fixed Feet Equinus Deformity: Results of 12 Cases with Literature Review

Review Article

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## Abstract

We report the results of 12 patients followed for post traumatic feet equinus deformity treated by percutaneous Achilles tendon lengthening by triple hemisection. Thanks to its multiple advantages, this procedure allowed 11 patients to recover near complete foot neutral position in standing and walking.

**Keywords:** Feet Equinus Deformity; Post Traumatic; Percutaneous Achilles Tendon Lengthening; Triple Hemisection Procedure.

## Introduction

Achilles tendon contracture, which affects ankle dorsiflexion, is a common clinical symptom that can be most often encountered in the context of neurological pathology and traumatic sequelae [1]. Traditionally, surgical treatment involves open Z-lengthening which provides enough lengthening with fairly frequent complications such as adhesion, pain, scarring, and infection [2]. It is in this sense that the percutaneous Achilles tendon lengthening by triple hemisection, first employed by Hoke in 1931 [3], finds its interest because of its multiple advantages. We share through this article our experience concerning the management of Achilles tendon contracture by percutaneous tendon lengthening performed in 12 young patients.

## Patients and Method

Achilles tendon lengthening by triple hemisection was performed in 12 patients between 2017 and 2020. The surgery was practiced by two senior surgeons. At the time of the latest follow-up, all patients underwent full clinical examination by the authors. Preoperative data were obtained from hospital records. The intervention was carried as outpatient surgery. Anesthesia of lumbar plexus-sciatic nerve block and thigh tourniquet were used. All patients were placed at prone position, with feet a little away from the edge of the table to achieve easily the ankle dorsiflexion movement (Figure 1). In the case of ankle varus deformity, the most distal incision was placed at the medial site 0.5 cm away from the proximal calcaneus. The middle incision was placed at the lateral site 5 cm away 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 surface of the gastrocnemius aponeurosis (Figure 2). If the ankle was in valgus deformity, the orientation of the triple incisions would be in the opposite direction. The hemisections were performed with knee in extension. The dorsiflexion strength of ankle was gradually increased (Figure 3), and Achilles tendon lengthening was accomplished by the sliding tendon. When the degree of ankle dorsiflexion increased more than 90-100°, the purpose of surgical treatment was achieved. At the end of the surgery, the ankle was kept in appropriate position for 4 weeks with splinting immobilization (Figure 4). Postoperatively, the function of ankle was assessed by the American Orthopedic Foot and Ankle Score (AOFAS) (Table 1).

## Results

In our series, there were 8 men and 4 women. The deformation was exclusively post traumatic. The mean age was 27 years, and the mean duration of follow-up was 24 months. The mean operative time was 12 ± 5 minutes. The mean hospitalization days was 1.35 days. The mean equinus degree was 45 degrees before the

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**Figure 1. The patient's installation on the operating table in prone position.**

**Figure 2. Intraoperative view of percutaneous Achilles tendon lengthening by triple hemisection.**

**Figure 3. Intraoperative view of the progressive dorsi-flexion of the ankle after percutaneous Achilles tendon lengthening by triple hemisection.**

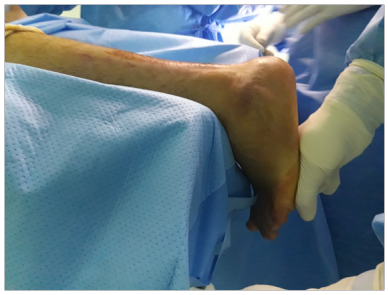

**Figure 4. Splinting immobilization of the ankle at the end of the procedure.**

operation. After surgery, the mean equines degree was 5 degrees and the mean range of motion (ROM) was 20 degrees. Patients were considered for surgery because all the feet were with fixed equinus deformity of the ankle sufficiently severe to prevent the patient from getting their foot in neutral position in standing and walking. The mean AOFAS score increased from 64 ± 10.16 preoperatively to 96.08 ± 3.17 at the final follow-up. The equinus recurrence rate was 8% (one patient) and there was no skin infection, blood vessel, nerve injury or Achilles tendon rupture at the last follow-up.

## Discussion

The equinus deformity, wich is usually secondary to retraction, shortening or spasticity of the triceps surae, leads to several gait disorders, causing changes in the foot support and affecting knee, hip and trunk. In this context it may require surgery. The aim is to correct the deformity and to conserve muscle strength with low rate of complications. For this, many different procedures were descriped and developed according to the degree of deformity, underlying disease, and patient profile.

**Table 1. The American Orthopedic Foot and Ankle Score (AOFAS).**

| **Pain (40 points)** | |
|---|---|
| None | 40 |
| Mild, occasional 30 | 30 |
| Moderate, daily 20 | 20 |
| Severe, almost always present 0 | 0 |
| Function (50 points) | |
| Activity limitations, support requirement | |
| No limitations, no support | 10 |
| No limitation of daily activities, limitation of recreational activities, no support 7 | 7 |
| Limited daily and recreational activities, cane 4 | 4 |
| Severe limitation of daily and recreational activities, walker, crutches, wheelchair, brace 0 | 0 |
| Maximum walking distance, blocks | |
| Greater than 6 | 5 |
| 6-Apr | 4 |
| 3-Jan | 2 |
| Less than 1 | 0 |
| Walking surfaces | |
| No difficulty on any surface | 5 |
| Some difficulty on uneven terrain, stairs, inclines, ladders | 3 |
| Severe difficulty on uneven terrain, tairs, inclines, ladders | 0 |
| Gait abnormality | |
| None, slight | 8 |
| Obvious | 4 |
| Marked | 0 |
| Sagittal motion (flexion plus extension) | |
| Normal or mild restriction (30° or more) | 8 |
| Moderate restriction (15°-29°) | 4 |
| Severe restriction (less than 150) | 0 |
| Hindfoot motion (inversion plus eversion) | |
| Normal or mild restriction (75%-100% normal) | 6 |
| Moderate restriction (25%-74% normal) | 3 |
| Marked restriction (less than 25% normal) | 0 |
| Ankle-hindfoot stability (anteroposterior, varus-valgus) | |
| Stable | 8 |
| Definitely unstable | 0 |
| Alignment (10 points) | |
| Good, plantigrade foot, midfoot well aligned | 10 |
| Fair, plantigrade foot, some degree of midfoot malallgnment observed, no symptoms | 5 |
| Poor, nonplantigrade foot, severe malallgnment , symptoms | 0 |
| Total score | /100 |

Surgical lengthening of Achilles tendon is one of the most common and widely used orthopedic operations performed to correct equinus deformity. The procedures can be performed using both open and percutaneous surgical approaches. From a biomechanical point of view, cadaveric simulation studies conclude that Achilles tendon lengthening does not lead to statistically significant medial displacement of the joint center of pressure and have not a significant effect on the contact pressure in static weight bearing model of the lower limb [4-7].

The open Z-lengthening is an effective method for treatment of Achilles tendon contracture, but higher rate of failures such as contracture recurrence, adhesion, pain, skin dehiscence and infection can be frequently observed in this region poorly vascularized. This is a classic technique whose indications are currently limited to neglected congenital clubfoot defects and the hemiplegic spastic child with great deformity. Technically, the incision lies on the skin of the medial border of the tendon, and should expose only its posterior face, avoiding detachment of adjacent tissues that carry vascularization [8]. Using the calcaneus bony insertion and the calf muscle origin of the Achilles tendon as reference, proximal (lateral) and distal (medial) hemisections are performed at 5 cm away from the 2 ends of the tendon. A linear incision was then made at the midline of the Achilles tendon to divide

it. We should avoid dissecting the two branches of the "Z" and only slide them with progressive dorsiflexion of the ankle till the neutral position [9].

In 2010, Lamm B M and Paley D [10] presented this technique in percutaneous approach. A longitudinal percutaneous incision is made centrally and just proximal to the Achilles tendon insertion into the calcaneus. This incision is deepened through the Achilles tendon. A Smillie knife is inserted into the split beneath the Achilles tendon sheath and pushed for 4 cm proximally. A second percutaneous longitudinal central tendon incision is made over the tip of the Smillie knife. Then each half of the tendon is cut transversely at the level of the incisions, being careful not to injure the tendon sheath. In the case of varus hindfoot, the distal cut is medial and the proximal is lateral. When a valgus hindfoot is present, distal cut is made laterally and proximal cut is practiced medially. By progressive dorsiflexion, complete Z lengthening within the sheath is obtained.

White JW [11] described in 1943 a double Achilles tenotomy in which the medial twothirds are cut proximally and the anterior two-thirds are cut distally. This double-cut Achilles tendon lengthening left enough lateral fibers intact to compromise satisfactory lengthening. Similar results were found in 1968 by Morimoto and Ogata [12] in 264 specimens. However several authors have reported satisfactory outcomes using the White technique [13, 14].

Considering Achilles tendon torsion first described by White in 1943, and which is the leading cause of failure in Achilles tendon lengthening procedures [11], Chen et al., [15] developed in 2016 through a cadaveric study covering 40 lower limbs a rotary incision technique for triple-hemisection Achilles tendon lengthening. During the procedure the incision rotation corresponded with the rotation of the Achilles tendon fibers. The rotary angle of the proximal incision was 0°, and one half of the fibers on the medial region of the Achilles tendon were disarticulated. The rotary angle of the midline incision was 30°, and one half of the fibers on the anterior lateral region of the Achilles tendon were disarticulated. The rotary angle of the distal incision was 60°, and one half of the fibers on the medial posterior region of the Achilles tendon were disarticulated. Rotary percutaneous triple-hemisection was compared to routine triple-hemisection and double-hemisection. This procedure allowed, according to the authors more even extension of the incisions and achieved the greater degree of ankle joint dorsiflexion [15].

In the literature, the first described triple-cut Achilles tendon lengthening was performed anterolateral-posterolateral-anterolateral, all through stab wounds from the medial aspect of the Achilles tendon [16]. Then the medial-lateral-medial (MLM) and the lateral-medial-lateral (LML) patterns which are a modification of this original technique have been developed. These techniques appear in an article by Michael Hoke [17] on flat foot treatment in 1931 and were performed initially by open approach, as disclosed by Bleck in 1979 [18] and percutaneously as reported recently in 2006 by Salamon et al [19]. This last takes place in the supine position. The limits of the Achilles tendon are identified by palpation. Three markings on the tendon are made: the most distal is near the insertion in the medial direction. One inch above the middle marking is made the intermediate marking, which goes from the center of the tendon to the lateral edge. Finally, the third marking is one inch away from the middle marking and goes from the center to the medial border. The cuts are made percutaneously on the markings and then dorsiflexion is forced progressively causing its lengthening by tendon shear. By the percutaneous technique, potential complications described by the majority of authors include essentially injury of neighboring structures (sural nerve, tibial nerve and long flexor hallucis tendon) [20].

In our daily practice and taking into account its multiple technical and functional advantages, the percutaneous Achilles tendon lengthening by triple hemisection as descriped by Salamon et al represents our procedure of choice to treat fixed feet equinus deformity. Thanks to this technique, our mean AOFAS score increased significantly, the equinus recurrence rate was 8% (one patient) without complications until the last follow-up.

## Conclusion

The percutaneous Achilles tendon lengthening by triple hemisection represents a simple, reliable and reproducible surgical technique for the management of fixed feet equinus deformity. In our daily practice and with great conviction, we adopt this procedure which considerably improves the quality of life of patients in the perspective to a prospective study with longer following up and a greater number of patients.

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