

# Results of Achilles Tendon Lengthening Using Z-Plasty in Equinus Feet

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## ABSTRACT

**Objective:** To determine the outcome of Achilles tendon lengthening using Z-plasty in children with equinus feet.

**Study Design:** Descriptive study

**Place and Duration of Study:** Department of Orthopaedics, Peoples University of Medical & Health Sciences Shaheed Benazirabad from 1<sup>st</sup> January 2016 to 31<sup>st</sup> December 2019.

**Methodology:** Thirty seven patients were enrolled. Both male and female patients aged more than 4 years having hemiplegic or diplegic spastic cerebral palsy having a preoperative lateral view radiograph of involved ankle joint with ankle in maximum dorsiflexion and knee extended were included. Patients having history of surgery for equinus deformity on involved lower limb were excluded. Pain free plantigrade foot was the primary outcome measured. Z-plasty was performed under general anesthesia by an experienced orthopedic surgeon.

**Results:** Mean age was 7.43±2.10 years. There were 23 (62.1%) males and 14 (37.9%) were females. Twenty two (59.4%) had spastic hemiplegia and 15 (40.6%) had spastic diplegia. Surgery was performed on all the 52 feet affected. Following surgery 41 (78.8%) feet achieved plantigrade with pain relief. Correction was not adequate in 11 (21.2%) cases. Recurrence was observed in all the 11 (21.2%) cases with inadequate correction evident by progressive increase in equinus. Wound infection was seen in 12 (23.0%) cases.

**Conclusion:** Z-plasty for Achilles tendon-lengthening has a high success rate in treating equinus deformity and recurrence rate is high in patients with inadequate initial correction.

**Keywords:** Achilles tendon, Z-plasty, Equinus deformity

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## INTRODUCTION

Equinus deformity is referred to as loss of ability to dorsiflex the foot beyond the plantigrade with neutral position of hind foot and extended knee joint.<sup>1,2</sup> Equinus feet are commonly seen in children suffering from cerebral palsy. Achilles tendon contracture may also result from other abnormalities such as trauma, including burns, or various neurological abnormalities.<sup>3</sup> Presence of equinus leads to disruption in gait by causing decrease in stance phase disability and inadequate swing phase clearance.<sup>4</sup> Both operative and non-operative measures are used for management of equinus deformity. Non-operative measures include exercises of stretching, use of botox injection<sup>5,6</sup> and use of casting.<sup>7</sup>

Various surgical management options are being used for management of equinus feet. These include lengthening of achilles tendon,<sup>8</sup> lengthening of gastrocnemius or soleus muscles,<sup>9</sup> or combined achilles tendon lengthening with shortening of tendon of tibialis anterior tendon.<sup>10</sup> Z plasty technique is usually employed for achilles tendon lengthening.<sup>11</sup> Recently, a stair shaped achilles tendon lengthening technique has also been introduced with satisfactory results.<sup>12</sup>

The goal of equinus feet treatment is to improve gait and also improving ability to stand. Moreover, age is an important factor in treatment of equinus feet. Recurrence is the most important complication of the procedure of equinus correction. Chances of recurrence are higher if equinus deformity is corrected early. Other factors associated with the recurrence include type of cerebral

palsy and type of surgery performed. The aim of this study was to determine the outcome of Achilles tendon lengthening using Z-plasty in children with equinus feet.

## MATERIALS AND METHODS

This descriptive study was conducted at Orthopedic Department of Peoples University of Medical and Health Sciences Shaheed Benazirabad 1<sup>st</sup> January 2016 to 31<sup>st</sup> December 2019. Both male and female patients aged more than 4 years having hemiplegic or diplegic spastic cerebral palsy having a preoperative lateral view radiograph of involved ankle joint with ankle in maximum dorsiflexion and knee extended were included. Patients having history of surgery for equinus deformity on involved lower limb were excluded. Pain free plantigrade foot was the primary outcome measured. Z-plasty was performed under general anesthesia by placing patients in supine position. Incision was made posteromedially between Achilles tendon and posterior aspect of medial malleolus in the midway and the lower end extended to the superior aspect of calcaneus and later proximally for approximately 5 cm. Following tendon exposure, its sheath was split longitudinally freeing the tendon from adjacent soft tissues. Incision was made from proximal to distal end in middle of Achilles tendon in a longitudinal manner. On reaching distal end, scalpel was turned medially dividing tendon into half transversely. Forceps was used to hold this cut portion of tendon. Proximally, the scalpel was turned laterally, in the opposite manner to distal cut again dividing half tendon transversely. This caused Achilles tendon to be completely free. A

transverse division to plantaris tendon was also made medially to the Achilles. The Achilles tendon was allowed to retract half way to its original resting length and later it was sutured to distal tendon by keeping the position of ankle at approximately 10 to 15 degrees of dorsiflexion. Heavy absorbable sutures were used to make repairs followed by wound closure placement of long leg cast. As soon as the patient became free, ambulation was allowed. Placement of long leg cast was continued for 4 weeks duration followed by changing it to short leg cast which was later continued for 2 weeks duration. After discharge, patients were followed up every two weeks for total six weeks. After cast removal patients were called every three months for total follow up duration of 2 years. Statistical package for social sciences was used for data entry and analysis. Mean and standard deviation was calculated for quantitative variables and frequency and percentages for qualitative variables.

## RESULTS

Mean age of the patients was  $7.43 \pm 2.10$  years. Total 23 (62.1%) were male and 14 (37.9%) were females. Out of 37 patients, 22 (59.4%) had spastic hemiplegia and 15 (40.6%) had spastic diplegia. Surgery was performed on all the 52 feet affected. Following surgery, 41 (78.8%) feet achieved plantigrade with pain relief. Correction was not adequate in 11 (21.2%) cases. Recurrence was observed in all the 11 (21.2%) cases with inadequate correction evident by progressive increase in equinus. All the 41 feet with surgically adequate correction showed no recurrence. Out of 52 operated feet, wound infection was seen in 12 (23.0%) cases that were managed with appropriate oral or intravenous antibiotics (Table 1).

Table 1: Demographic information of the patients (n=37)

Variable	No.	%
Age (years)	$7.3 \pm 2.1$	
Gender		
Male	23	62.1
Female	14	27.9
Cause		
Spastic Hemiplegia	22	59.4
Spastic diplegia	15	40.6
Surgery outcome in 52 feet		
Plantigrade feet	41	78.8
Not adequate correction	11	21.2
Complications		
Recurrence	11	21.2
Infection	12	23.0

## DISCUSSION

In children with cerebral palsy (CP) feet deformities are quite common. Majority of children have equinus deformity, usually evident at the start of walking or standing. Initial management is via orthotics for plantar flexion. Moreover, exercises in the form of plantar flexor stretching are also instructed to perform several times in a day.

Surgery is usually indicated if the child develops severe midfoot break or the child can no longer tolerate the orthotics for plantigrade. Children having equinus deformity with spastic cerebral palsy usually have Achilles tendon that is longer than the normal. Moreover, muscle bellies are shorter than the normal. The aim of the surgery is to

restore the normal ankle dorsiflexion without effect on architecture of the normal muscle tendon.<sup>13</sup> The focus of surgical correction should be centered on lengthening of contracted muscle. In cases of severe equinus, management is usually by Z lengthening of Achilles tendon.

In the present study, we included patients with equinus deformity aged 5 years or above who underwent lengthening of Achilles tendon by Z plasty. The mean age was 7.43 years. A previous study has shown a higher mean age as compared to our study.<sup>14</sup> Another study has shown a mean age of 7 years at the time of Achilles tendon lengthening surgery.<sup>15</sup> Majority of the children in our population were males. A similar finding was also observed in a previous study.<sup>14</sup>

Our study results have shown a high success rate of Z-plasty in equinus deformity correction. Another study has shown that Achilles tendon lengthening by transverse skin incision also yielded satisfactory results with improvement in mean American Orthopedic Foot and Ankle Society score.<sup>16</sup> Appropriate lengthening of Achilles tendon is essential to avoid over or under correction. A study was conducted regarding assessment of two methods for calculation of Achilles lengthening.<sup>17</sup> One method used was cosine law and another method was intraoperative assessment. Z plasty was performed as a standard procedure for Achilles tendon lengthening and showed that law of cosines allowed accurate tendon lengthening and limited the incision size.<sup>17</sup> Another study also demonstrated that Achilles tendon length calculated according to Cosine calculations showed excellent agreement with length during surgery. The study concluded that Cosine law was more reliable in determining the Achilles tendon length at the time of Z plasty.<sup>11</sup>

A high recurrence rate of approximately 21.2% was reported in our study. Recurrence of equinus is common after Achilles tendon lengthening. That may be as a result of inadequate initial correction. A study has reported lower recurrence rate of 9.1% in comparison to our study.<sup>18</sup> The study showed that ankle dorsiflexion at initial contact preoperatively was a significant factor for recurrence of equinus deformity. Type of limb involvement and age were not significant.<sup>18</sup> Another study showed 22.2% rate of recurrence which was slightly higher as compared to our study.<sup>19</sup> In that study, patients with recurrence showed smaller popliteal angle before surgery and a greater popliteal angle at follow up.<sup>19</sup>

In a study, stair shaped lengthening of Achilles tendon was performed and compared with Z plasty lengthening. The study results also demonstrated that stair shaped Achilles lengthening patients recovered significantly quicker than patients who underwent Z-plasty.<sup>12</sup> The study concluded that stair shaped Achilles tendon lengthening yielded successful equinus deformity correction with preservation of tendon continuity without its complete resection.<sup>12</sup>

A study compared mesh lengthening of Achilles tendon with Vulpius and Z plasty lengthening.<sup>20</sup> The results demonstrated that mesh lengthening patients achieved quicker correction than both the groups. The advantage of mesh lengthening according to the study was that its preserved the gastrocnemius muscle without its complete

section. This procedure conferred stability against the gravity and quick patient recovery.<sup>20</sup>

A study was conducted regarding a new helical cutting method for lengthening of Achilles tendon in its entire continuity. The study concluded that helically cutting Achilles tendon can leave tendon in its continuity with the length of tendon being more than Z-plasty. The authors suggested that this can improve the resistance of limb to the tensile load.<sup>21</sup>

Our study demonstrated that complications of wound infection were present in 23% of the patients. Complications such as pain, wound infection, or flap necrosis are common after Z-plasty. A previous study reported no complication of wound infection, but reported pain in tendon suture in one foot.<sup>16</sup>

Few limitations should be considered for our study. This study was a single center study and conducted on a small sample size. Another limitation of this study was that follow up period was 2 years. We did not have a long term follow up of our patients. It is recommended that follow up studies based on a longer duration shall be carried out to validate the results of this study.

## CONCLUSION

Z-plasty for achilles tendon-lengthening has a high success rate in treating equinus deformity and recurrence rate is high in patients with inadequate initial correction.

## REFERENCES

- Shore BJ, White N, Kerr Graham H. Surgical correction of equinus deformity in children with cerebral palsy: a systematic review. *J Child Orthop* 2010;4(4):277-90.
- Hur GY, Rhee BJ, Ko JH, Seo DK, Choi JK, Jang YC, et al. Correction of postburn equinus deformity. *Ann Plast Surg* 2013; 70(3):276-9.
- Kay RM, Rethlefsen SA, Ryan JA, Wren TA. Outcome of gastrocnemius recession and tendo-achilles lengthening in ambulatory children with cerebral palsy. *J Pediatr Orthop B* 2004;13(2):92-8.
- de Morais Filho MC, Kawamura CM, Lopes JA, Neves DL, Cardoso Mde O, Caiafa JB. Most frequent gait patterns in diplegic spastic cerebral palsy. *Acta Ortop Bras* 2014;22(4): 197-201.
- Tilton AH. Injectable neuromuscular blockade in the treatment of spasticity and movement disorders. *J Child Neurol* 2003;18 Suppl 1: S50-66.
- Choi JY, Jung S, Rha DW, Park ES. Botulinum toxin type A injection for spastic equinovarus foot in children with spastic cerebral palsy: effects on gait and foot pressure distribution. *Yonsei Med J* 2016; 57(2):496-504.
- Tustin K, Patel A. A critical evaluation of the updated evidence for casting for equinus deformity in children with cerebral palsy. *Physiother Res Int* 2017;22(1):e1646.
- Krupiński M, Borowski A, Synder M. Long term follow-up of subcutaneous achilles tendon lengthening in the treatment of spastic equinus foot in patients with cerebral palsy. *Ortop Traumatol Rehabil* 2015;17(2): 155-61.
- Rong K, Ge WT, Li XC, Xu XY. Mid-term results of intramuscular lengthening of gastrocnemius and/or soleus to correct equinus deformity in flatfoot. *Foot Ankle Int* 2015;36(10):1223-8.
- Kläusler M, Speth BM, Brunner R, Tirosh O, Camathias C, Rutz E. Long-term follow-up after tibialis anterior tendon shortening in combination with Achilles tendon lengthening in spastic equinus in cerebral palsy. *Gait Posture* 2017;58:457-62.
- Ozyalvac ON, Akpinar E. Comparison of two different methods in preoperative planning of the amount of lengthening in Z achilloplasty technique. *J Pediatr Orthop B* 2020; 29(1):35-9.
- Li Z, Zhang N, Wang Y, Cao S, Huang Z, Hu Y. Stair-shaped Achilles tendon lengthening in continuity: a new method to treat equinus deformity in patients with spastic cerebral palsy. *Foot Ankle Surg* 2019;25(2):165-8.
- Wren TA, Cheatwood AP, Rethlefsen SA, Hara R, Perez FJ, Kay RM. Achilles tendon length and medial gastrocnemius architecture in children with cerebral palsy and equinus gait. *J Pediatr Orthop* 2010;30(5):479-84.
- Horsch A, Götze M, Geisbüsch A, et al. Prevalence and classification of equinus foot in bilateral spastic cerebral palsy. *World J Pediatr* 2019;15(3):276-80.
- Dietz FR, Albright JC, Dolan L. Medium-term follow-up of Achilles tendon lengthening in the treatment of ankle equinus in cerebral palsy. *Iowa Orthop J* 2006;26:27-32.
- Kim HT, Oh JS, Lee JS, Lee TH. Z-lengthening of the achilles tendon with transverse skin incision. *Clin Orthop Surg* 2014; 6(2):208-15.
- Ozyalvac ON, Akpinar E, Gur V, Beng K, Yagmurlu MF, Bayhan AI. A formula to predict the magnitude of achilles tendon lengthening required to correct equinus deformity. *Med Princ Pract* 2020;29(1):75-9.
- Chung CY, Sung KH, Lee KM, et al. Recurrence of equinus foot deformity after tendo-achilles lengthening in patients with cerebral palsy. *J Pediatr Orthop* 2015;35(4): 419-25.
- Sala DA, Grant AD, Kummer FJ. Equinus deformity in cerebral palsy: recurrence after tendo Achillis lengthening. *Dev Med Child Neurol* 1997;39(1):45-8.
- Lin CL, Lin CJ, Huang MT, Su WR, Wu TT. Mesh Achilles tendon lengthening: a new method to treat equinus deformity in patients with spastic cerebral palsy: surgical technique and early results. *J Pediatr Orthop B* 2013;22(1):14-9.
- Farshad M, Gerber C, Snedeker JG, Meyer DC. Helical cutting as a new method for tendon-lengthening in continuity. *J Bone Joint Surg Am* 2011;93(8):733-8.