

Open Versus Percutaneous Lengthening Of Tendo Achilles In Spastic Cerebral Palsy: A Prospective Study Of Tendo Achilles Lengthening Trauma In Spastic Cerebral Palsy In Al-Yarmouk Teaching Hospital In Iraq

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Abstract:

Background: Cerebral palsy is a group of none progressive motor problem and physical disorders. Equinus deformity occurs with high frequency in patients with lower extremity CP in both the Hemiplegic and the Diplegic patients, which limits passive ankle dorsiflexion to less than the neutral position and results in characteristic toe-walking gait.

Objective: To compare between the two surgical methods for CP patients with Equinus, regarding technique of the operation, post-operative morbidity & complication rates, functional results and advantages of one over the other.

Patients & Methods: A prospective study carried out in Al-Yarmouk Teaching hospital for period from March, 2010-October, to 2011 on CP patients with Equinus deformity undergone surgery to correct their deformity by elongation of Tendo Achilles, we chose two methods of lengthening, Open and Percutaneous. Patients with their feet selected randomly to choose the procedure whether percutaneous or open. Follow-up of cases range from (6-12) months with an average of (6) month combined with post-operative physiotherapy and all the results were recorded in a prepared questionnaire.

Results: The most serious complications encountered were wound infection and recurrence of equinus: We faced 2 cases (14%) of deep and superficial wound infection in cases treated by Open method. -We faced 5 cases of recurrence of equinus: 4 feet (28.5%) of those treated by open technique. 1 foot (5%) of those treated by percutaneous technique. Fortunately, we didn't face any case with calcaneus deformity. In our study, percutaneous results seemed to us as an excellent and superior to the Open method results and at most levels. From the results we got, we found that percutaneous method had easier technique, less complicated, more satisfied from the parents and better functional results than that of open method. We got 80% excellent gait with percutaneous method in comparison with 57% for Open method.

Conclusions: In our study, percutaneous technique regarded as the technique of choice for surgical correction of primary fixed equinus deformity of the foot in spastic CP child.

Key words: Equinus, Cerebral palsy, Tendo Achillis, Percutaneous lengthening, Open lengthening.

Introduction:

As a result of the Achilles legend, the expression (Achilles Heel) came to mean a small but fatal vulnerability, and the tendon connecting the heel to the calf became known as [The Achilles Tendon]. The term was first devised in 1693 by Dutch Anatomist Philip Verheyden, when he was dissecting his own amputated leg¹.

Surgical lengthening of Tendo Achilles (TA) is one of the most common and widely used orthopedic operations performed to correct equines deformity. It is among the oldest procedure in orthopedics. Percutaneous lengthening of Tendo Achilles is a procedure started out previously as a temporary make-do for children with congenital heart disease further complicated by Cerebral Palsy (CP). In 1943, White was one of the first proponents of percutaneous lengthening of TA. He described using a tenotome to make two transverse cuts of the tendon allowing the section to slide apart and yet maintaining continuity. This technique gained mixed popularity with time. And although it is not widely used, many studies outlined its advantages over conventional open methods².

CP is a group of non-progressive motor problem and physical disorders that result from

immature brain injury or abnormal brain development, which may occur before, during, or shortly after birth. It appears during the first few years of life and generally doesn't worsen over time. The disorders are caused by faulty development of or damage to motor area in the brain that disrupts the brain ability to control movement and posture³.

There is no uniform agreement of the definition of Equinus. Anecdotally, some use inability to dorsiflex beyond 5 degrees, while others indicate that 10 degrees may be limited². Generally, Ankle Equinus defined as inability to do or limitation of passive dorsiflexion of the foot at the ankle minimum of 5 degrees with the knee in full extension. This deformity divided as either:

(A) Dynamic Equinus: This is passively correctable.

(B) Static (Fixed) Equinus: This cannot be passively corrected.

In most cases the deformity starts as Dynamic which turns into Static if not correctly managed⁴. Equinus deformity occurs with high frequency in patients with lower extremity CP in both the Hemiplegic and the Diplegic patients, which limits passive ankle dorsiflexion to less than the neutral position and results in characteristic toe-walking gait⁵. Equinus deformity in spastic CP can be treated by either nonsurgical or surgical method. Many surgical methods are used to correct this deformity

such as selective dorsal rhizotomy, neurectomy of some branches of tibial nerve, gastrocnemius head transplantation or anterior advancement of TA, but Surgical Lengthening of the A.T remains the most common and widely used orthopaedic surgery performed to correct equinus deformity. Two main different modalities of surgical intervention are performed to elongate the TA⁶:

(1) Open Lengthening of TA: Done by exposing the A.T through a posteromedial longitudinal surgical incision and making the lengthening. (2) Percutaneous Lengthening of T.A: Done by making partial tenotomies to the T.A through small puncture incisions without exposing the tendon and lengthening the tendon by sliding of tenotomised part one over the other.

Patients and methods:

Study design

Clinical randomized trial carried out in Al-Yarmouk Teaching hospital for period from March, 2010-to October 2011 on a convenient sample of 22 ambulatory spastic CP children selected from outpatients unit of the hospital.

Inclusion criteria

1. Spastic CP children.
2. Equineus deformity severe enough [approximately between 10-40 degree of fixed equines (plantar flexion) when examination with extended knee].
3. Toe-Walking gait and difficulties in ambulation.

Exclusion criteria

1. Family refused to participate.
2. Can be treated conservatively.
3. Serious medical problems.
4. Patients in whom equinus deformity associated with significant
5. component of varus or valgus
6. Patients younger than (4) years or older than (10) years of age.
7. Patients with dynamic equinus deformity, because most of them treated conservatively.
8. Prior foot surgery or trauma to the area of surgical operation.
9. Patients with other neurological disorders or systemic disease potentially affecting the foot or ankle (e.g: Duchenne Muscular Dystrophy).

Data collection

The data were collected by the researcher in a prepared questionnaire for each patient. The selection of surgical procedure to elongate TA was done randomly. And feet are divided into two groups basing on the technique of surgical operation (Open or Percutaneous):

- Some feet were treated surgically by Open Method: half of them by Z-Plasty & other half by Sliding Method.
- Other feet were treated surgically by Percutaneous Method.

The goals of our treatment procedures include:

- ✓ Relieve contracture; improve posture & walking and creating as much as possible normal heel-toe gait with good push-off power, in order to facilitate child communication, education, toilet and total body care.
- ✓ For those with Percutaneous technique was to perform simple procedure and reduce Hospitalization to minimum-
- ✓ The lengthening was performed by the researchers Al-Yarmouk Teaching Hospital.
- ✓ Follow-up of cases range from 6-12 month with mean of (6) month at the Outpatient Unit.

The questionnaire included the followings information:

- 1) Demographic: name, age, gender, residence and telephone no. of relative.
- 2) Clinical history of CP.
- 3) Silverskjold test results.
- 4) Degree of Equinus.
- 5) Operative procedures: A- Open lengthening of TA: which included:

-Z-plasty: The T.A is divided by Z-cut fashion, the vertical part of the incision split the tendinous fibers in the midline of the sagittal plane, at the lower end of this vertical incision the tendon transected medially at its insertion. At the upper end of the incision, near the musculotendinous junction, the tendon is transected laterally⁷.

-Open sliding: Cut the tendon partially at 2 or 3 levels under direct vision as follows:

- The lower cut: done by incise the tendon sheath, and cutting the medial half of the tendon just above its insertion into calcaneum.
- The upper cut: done by incise the tendon sheath and cutting the lateral half of the tendon at a Level below the musculotendinous junction.
- If a third cut is decided, it is done like others in stepwise fashion. 2 cuts at one side and the 3rd between them on the other side as in Open Hoke TA Lengthening Technique.

B/Percutaneous lengthening of TA:

After preparing the patients and giving appropriate anesthesia, with palpation make 3 partial tenotomies in the TA as follows:

- 1) Make the first medial, just at the insertion of the tendon into the calcaneus; cut through the half of the width of the tendon.
- 2) Make the second tenotomy proximally and medially, Just below the musculotendinous junction about 58 cm. from the first tenotomy.
- 3) Make the third tenotomy laterally, through the half of the width of the tendon midway between the two medial cuts. [The two incisions on the medial side if the heel is in slight varus as it usually are].



Figure 1: Stages of percutaneous lengthening.

- 4) Post-operative Measures (After treatment): Above knee cast is left in place with the knee in full extension for 3 weeks, taking in consideration that we should change it after 10 days from operation to check the healing of the wound and remove skin stitches in open type lengthening and new above knee cast placed to complete the 3 weeks.
- 5) Post-operative Physiotherapy: Post-operative physiotherapy is complementary section for our surgical work, since it will strengthen the muscles and improve coordination of movement and gait. This program starts after 6 weeks from the operation (i.e: after removal of the cast).

Post-Operative Follow-up: Follow-up of cases done weekly in the first 6 weeks postoperatively and 2 weeks interval till about 6 month post-operatively, though in many cases the follow-up was not so regular either because of the family or other causes. However, all patients are clinically reviewed after 6 months, the results were collected and they were based on:

- Assessment of patient's lower limb function (standing, walking & active dorsiflexion and plantar flexion).
 - Parent's satisfaction.
 - Morbidity and Complications.
- And from all of the above we assess the advantages and disadvantages of each method of surgical treatment separately and at all levels.

Ethical considerations:

- ✓ Objectives of the study were clarified and informed consent had been taken from the relatives written on ethical paper with privacy.

- ✓ Confidentiality of the data was maintained throughout the study.
- ✓ All collected data were used for research purpose and held in a password protected computer.
- ✓ Telephone no. of the researchers was given to relatives to inform them of any complication for early management.

Statistical analysis

Data of all patients were entered into computerized software, and a database was made in Excel Windows. Descriptive statistics were presented as frequencies (number) and percentages for categorical variables. Finally, the results were presented in tables and or figure with an appropriate explanation for each table or figure according to the findings.

Results:

Total number of patients included in this study was bilateral and (10) unilateral giving total number of (34) feet. (18) feet were right and (16) were left. Patient's age varied from 4-10 year. Gender distribution was with male predominance (14 males & 8 females) forming 64% and 36%, respectively (figure 2). All of the patients are with Spastic C.P with the most common pattern being Diplegia (14 cases) followed by Hemiplegia (6 cases) and lastly Monoplegia (2 cases) (figure 3). All the feet are with fixed equinus deformity of the ankle sufficiently severe to prevent the patient from getting their foot in neutral position in standing and walking. Those feet were decided for surgery to elongate Tendo Achilles. 14 Of those feet treated by Open Surgery Technique. Eight of them were treated by Open Z-Plasty and 6 of them by Open Sliding Technique. 20 Feet were treated by Percutaneous Technique.

Those feet are judged according to the result of:

1. Pattern of Gait gained after surgery.
2. Parents' satisfaction.
3. Presence or absence of complications

Regarding Pattern of Gait: For Percutaneous Technique: 16 feet (80%) graded as Excellent, 3 feet (15%) graded as Good and 1 foot (5%) graded as Fair. For Open Technique: 8 feet (57.2%) graded as Excellent, 2 feet (14.3%) graded as Good. 3 feet (21.4%) graded as Fair and 1 foot (7.1%) graded as Poor table 1. Regarding Selective ability to dorsiflex the foot voluntarily between (0-10) degrees: For Percutaneous Technique: 18 feet (90%) were able. 2 feet (10%) was unable. For Open Technique: 10 feet (71%) were able. 4 feet (29%) were unable, figure 4. Regarding Parent satisfaction: (A) For Percutaneous Technique: 18 feet (90%) parents were completely satisfied. 2 feet (10%) parents were little satisfied. For Open Technique: 9 feet (64.3%) parents were completely satisfied. 3 feet (21.4%) parents were little satisfied. 2 feet (14.3%) parents were not satisfied, figure 5. Regarding Complications: For Percutaneous Technique:

1 foot (5%) only develops recurrent Equinus. For Open Technique:

1 foot (7%) developed wound hematoma, 2 feet developed Wound Infection: 1 foot (7%) was superficial infection, 1 foot (7%) was deep infection,

4 feet (28.6Y,) develop Recurrence, 3 feet (21.4%) develop hypertrophic scar. The most expected complications, whether they encountered or not were summarized in the following table 2.

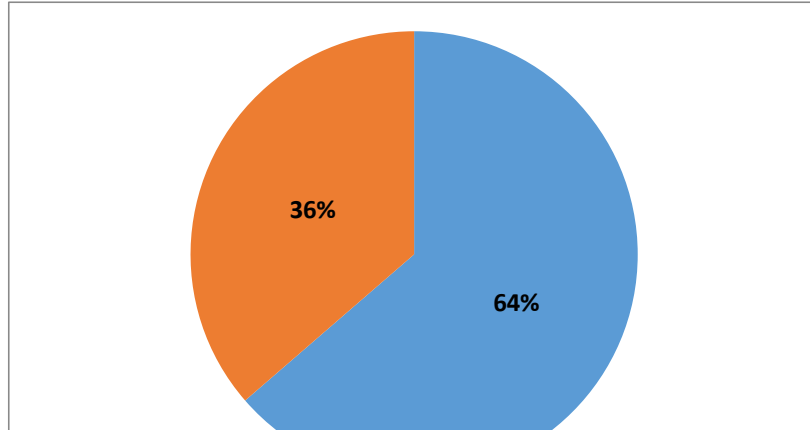


Figure 2: Gender distribution.

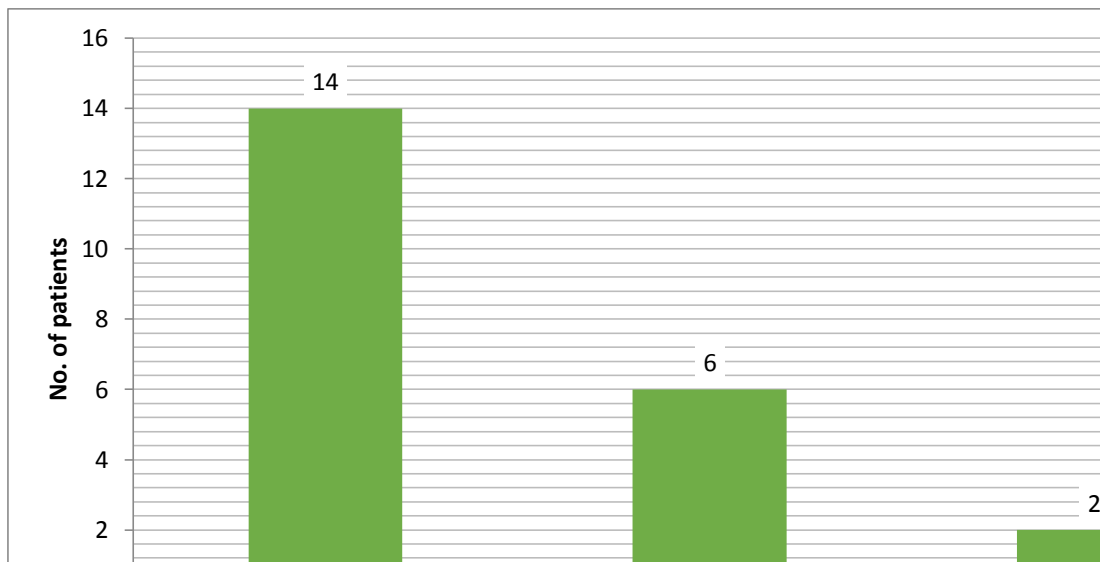


Figure 3: CP distribution.

Table 1: Gait results after 6 month follow up.

Grade	Percutaneous		Open	
	No. of feet	%	No. of feet	%
Excellent	16	80.0	8	57.2
Good	3	15.0	2	14.3
Fair	1	5.0	3	21.4
Poor	0	-	1	7.1
Total	20	100.0	14	100.0

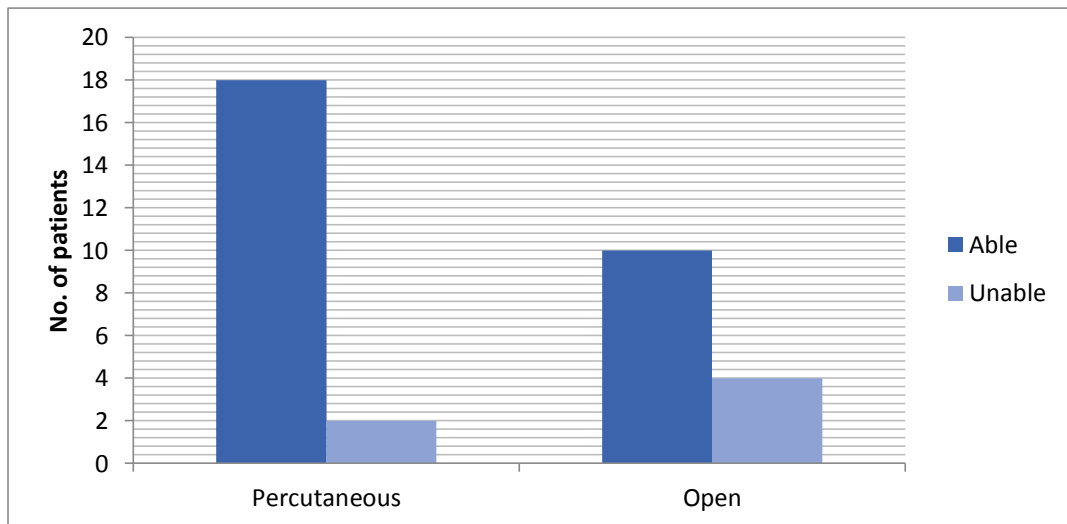


Figure 4: Distribution of patient according to ability to dorsiflex.

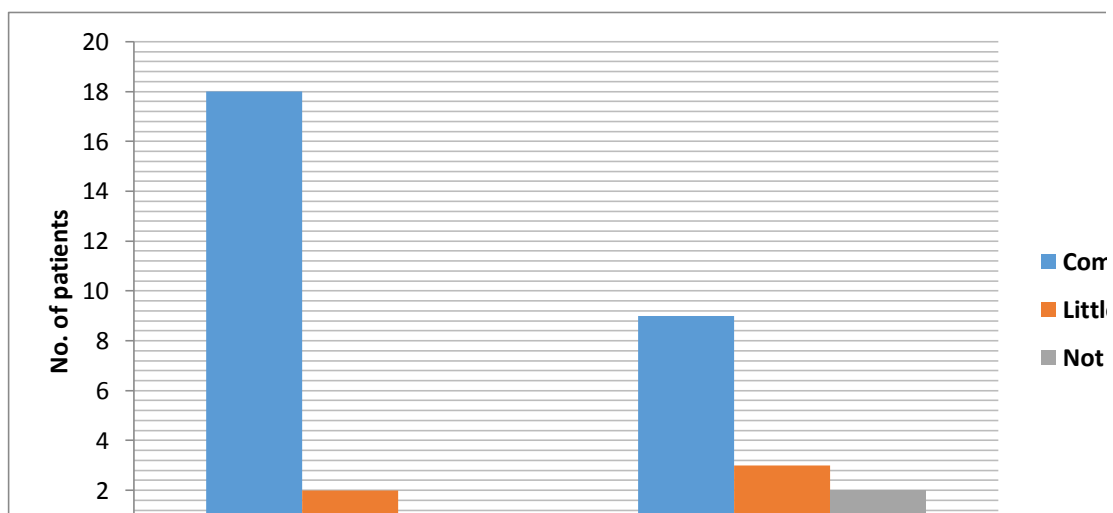


Figure 5: Parents satisfaction.

Table 2: Complication recorded for both techniques.

Complications	Percutaneous	Open
Bleeding	0	0
Sural N. injury	0	0
Inadvertent tenotomy	0	0
Hematoma formation	0	1
Wound edge necrosis	0	0
Infection	0	2
Recurrence	1	4
Calcaneus deformity	0	0
Hypertrophic scar	0	3

Discussion:

Though the Percutaneous ETA is not a new technique, it is not widely used in comparison with Open technique. In our study we tried to compare between the two to evaluate which is the more dependable method to elongate T.A and correct the equinus deformity depending on the statistics and results we got from the patients in our study.

Graham HK, et al studied ETA by Open White Slide Technique in 35 hemiplegic children, included patients less than (4) years of age in his study and follow them. He noted that most of the recurrences were in the group of children less than (4) years of age, so he suggested that early surgery are not advised⁸. We follow this advice in our study, and the mean age of children in our study was 6 years with a minimum age of 4 years. In the younger

patients (below 4 years of age) even with severe dynamic equinus, some authors still prefer using splints rather than early surgery⁸. As we observed in many anatomy texts this twist is not present in all humans and there is a personal variation. However, in our study (like many other studies e.g.: Marc J. Moreau & David M. Lake study who done Percutaneous Lengthening of T.A for 90 feet of 55 children on an outpatient bases)⁹. Heel cord torsion was virtually ignored, and no problems were encountered... There is no any lengthening failure and all tendons remain in continuity.

In Percutaneous technique we got an overall significant improvement of gait in (95%) of cases, and it is near the percentage gained by Dr. Moreau MJ in his study (97%) from 90 feet and Dr. Cheng JC in his study (89%) from 71 feet (30)¹⁰.

For Open technique we got a lower percentage (71.5%) of significant improvement and it is less than the percentage of Grant AD, et al in his study when gained (84.6%) of significant gait improvement from a total number of 84 feet⁵.

Parental Satisfaction is a parameter used by many studies (as in studies of Kogan on 15 children & Moreau on 55 children, on patients treated by Percutaneous method on an outpatient bases)¹¹, and we think it is an important parameter especially if the family is well educated.

The child spends most of the time with the family and his parents who really can touch the changes occur to the child before and after operation, and whether these changes are to the best or to the worse.

Fortunately, most of the parents of the child in our study were completely satisfied with the result. More satisfied gained from percutaneous method than Open one and the overall satisfactions were approximate to the results of the above studies.

The child's gait and performance were greatly improved and this gives another push to the family to continue on physiotherapy program. In those who are little or not satisfied, the main cause was the development of complications which cause a delay in improvement of child's performance. We think most of these complications developed because of family neglecting or low level of education even to understand our notes and instructions. Regarding Recurrence which defined in our study as any fixed equines greater than (5) degrees which results in toe-heel gait. However when it is below (5) degrees it seems to be acceptable because it is compatible with near good gait with either flat-footed strike or heel-toe strike when wearing suitable shoe heel⁵.

Voluntary active control of dorsiflexion enables the patient to be free from orthosis more time during the day and can become completely brace free after 2 years post-operatively¹². In our study, we instruct the family that we prefer to continue on night brace till growth completion. We think that prolonged protection of the foot with

casting and bracing may account in large part of our success as advised by Grant AD, et al in his long term study for 10 years on 39 cases when shows that there is a decrease in recurrence rate with prolonged management programs with night bracing⁵.

Post-operative care and physiotherapy programs we have outlined in our study seems to be significantly improve both active plantar flexion and dorsiflexion and reduce the recurrence rate that reported in many previous studies¹³.

The economic, social and financial benefits from percutaneous surgery are striking compared with those of Open surgery. In our study, the psychological support has been also clearly observed on both child and parents. This is also certified by Dr. Walter B. Green study when he compared between 24 Inpatient and 15 patient treated by Ambulatory surgery to Elongate TA¹⁴. There is reduction of the emotional effect of the long time staying in hospital especially for the child who needs only simple nursing care immediately after surgery. No IV or IM drugs needed post-operatively and this greatly reduce the fear of the child and improve his self-esteem which in turn increase his threshold of pain and reduce post-operative analgesia used.

As mentioned by Joseph L. Garbarino in his study on 26 feet of 20 spastic CP children treated by ETA, the main beneficial effect of surgery become obvious in the first 6 months after surgical intervention and the child continue to progress in the following periods¹⁵.

We must concentrate especially during the first 6 months because most early and late complications in our study and other studies are due to neglection¹⁶. This study concluded that the benefit of Percutaneous elongation of Tendo Achilles is most rewarding as seen in our study by improvement of child's Gait and overall function and communication. It gives a high rate of parental satisfaction in addition to its advantages and lower rates of complications. In our study, Primary Percutaneous Lengthening is better to Open Surgical Procedure to lengthen the Tendo Achilles in Spastic CP children with Equinus Deformity of the foot.

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