ISSN: 0976-3031

Available Online at http://www.recentscientific.com

*International Journal of Recent Scientific Research*
*Vol. 6, Issue, 8, pp.5665-5671, August, 2015*

*International Journal of Recent Scientific Research*

**RESEARCH ARTICLE**

# REDEVELOP OF ACHILLES TENDON AFTER PERCUTANEOUS TENOTOMY IN IDIOPATHIC CLUBFOOT PATIENTS AS PER PONSETI'S METHOD OF CORRECTION CLINICALLY AND USING TWO NEEDLE

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**ARTICLE INFO**

***Article History:***

Received 5th, July, 2015
Received in revised form 12th, July, 2015
Accepted 6th, August, 2015
Published online 28th, August, 2015

***Key words:***

Regeneration, Achilles tendon ,percutaneous tenotomy

**ABSTRACT**

This study is attempt to establish the regeneration of Achilles tendon after percutaneous tenotomy in idiopathic clubfoot patients as per Ponseti's method of correction clinically and using two needles. This prospective study was conducted on babies less than 1 year of age with idiopathic clubfoot deformity admitted in orthopaedics ward of Rajendra Institute of Medical Sciences, Ranchi, Jharkhand with reference to age and sex for the period from December 2012 to September 2014. Babies with neurological condition, Babies with syndromic condition and recurrent, Resistant and complex Clubfoot cases are excluded from the study. Detailed personal history was recorded including the age, sex, father's & mother's name, address, date of first reporting, age of reporting, detailed history of previous treatment, etc. Distance between the two needles was measured with foot in fully dorsiflexion. In each foot clinical evidence of a successful tenotomy was taken as a definitive increase in dorsiflexion at the ankle and lack of a palpable heel cord. Increase in distance between the needle indicates successful tenotomy. Full leg corrective cast was applied for 3 weeks. At 3 weeks and 6 weeks, cast was removed and clinical assessment was done for healing of Tendo Achilles by palpating for heel cord and by Thomson's test. The same procedure of inserting two percutaneous 18 gauge needle as described before was repeated. The distance between the needles was measured. Increase in distance between the two needles shows lack of full continuity of the severed ends of the tendon. A total 47 feet were treated of 30 study subjects. Majority (26 feet of 16 subjects) of the study subject's was less than 3 months and majority (23, 76.66 %,) are male. There were total 30 cases out of which 13 were unilateral ( 8 right handed ,5 left handed),rest are bilateral. Incidence of CTEV was found to be more in the 1st born child with 22 cases, 6 cases were 2nd born. Incidence of CTEV was found to decrease as the birth order progress. Average distance increased was 6.18 millimeter.



## INTRODUCTION

Clubfoot has been existent and known since time immemorial and similar is the duration of controversies it carries within itself. The subject has been studied by innumerable workers; they all have contributed to its literature. Still the literature on treatment of club-foot is as a general rule that of unvarying success.[1]

The literature from about 1970 to 1990 contains enthusiastic reports on the correction of congenital clubfoot through extensive surgical release procedures. Over time, we have come to recognize the complications of such surgeries including recurrence, overcorrection, stiffness, and pain. Perhaps because of these findings there seems to be a renewed interest in non-operative techniques for the correction of congenital clubfoot.

The 20th century was marked by the classification of two concepts in the management of clubfoot. The first is the general acceptance of the principles of manipulation, strapping and serial correction plaster casts and the other favours numerous surgical procedures for the correction of clubfoot. But none of the described method can completely achieve the goal of functional, painless and cosmetically acceptable looking foot .[1] Idiopathic congenital talipes equinovarus can be managed by the technique described by Ponseti in infants under one year of age with a success rate in excess of 90%.[2]

Percutaneous Achilles tenotomy just above the calcaneal insertion may be used in up to 95% of patients based on the

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hypothesis of Ponseti and others that the tendon appears to re-unite within three weeks.[2] Two previous studies have demonstrated healing when the tendon was completely sectioned more proximally at the musculotendinous junction in children with cerebral palsy or inadvertently in percutaneous triple hemisection lengthening of tendo Achillis.[2]

Ponseti technique is of particular value in countries where there are few surgeons operative and resources are scarce because it is easy, effective, efficient, economical .It is a specific method of manipulation to stretch contracted ligaments and serial casting to hold the stretch. Percutaneous tenotomy of the tendo Achilles is an important part of it. It has a specific method of bracing for corrected foot and has long term follow up for recurrence.

There is a marked reluctance among clinicians to perform Achilles tenotomy because of fear about consequences of complete division of a major tendon .There is a need to alleviate the concern which can be done by clinically and a new method for assessment of healing of Tendo Achilles using two percutaneous needle, one in proximal and one in distal to tenotomy site.

**Objective**

To estimate the Regeneration of Achilles tendon after percutaneous tenotomy in idiopathic clubfoot patients as per Ponseti's method of correction clinically and using two needle.

## MATERIAL AND METHODS

This prospective study was conducted on babies with idiopathic clubfoot deformity admitted in orthopaedics ward of Rajendra Institute of Medical Sciences, Ranchi, Jharkhand with reference to age and sex for the period from December 2012 to September 2014.

**Inclusion criteria**

1. idiopathic CTEV cases
2. less than 1 year of age

**Excusion criteria**

1. Babies more than 1 year of age
2. Babies with neurological condition
3. Babies with syndromic condition
4. Recurrent, Resistant,Complex Clubfoot cases

This is a prospective study for all the children from birth to 1 year of age with congenital idiopathic clubfoot from December 2012 to September 2014 registered at our hospital who are willing to undergo treatment.

Detailed personal history was recorded including the age, sex, father's & mother's name, address, date of first reporting, age of reporting, detailed history of previous treatment, etc.

A thorough general & local examination was carried out & the deformity was scored according to Pirani' s classification at each visit before applying cast. The score was plotted against the time and the trend of score was noted with reference to effect of manipulations or other interventions on deformity. Manipulations were done by Ponseti's method followed by corrective casts at weekly interval without anaesthesia.

Then need for tenotomy of tendo Achilles for correction of equinus deformity was assessed according to the criteria of ponseti. Each infant underwent clinical assessment before tenotomy was undertaken. Clinical assessment was undertaken with the foot in maximum passive dorsiflexion. Tendo Achilles was palpated and graded as absent, indeterminate or palpable.

Under general anaesthesia one 18 gauge needle was inserted percutaneously into Achilles tendon in posterior to anterior direction 1 CM proximal to it's insertion. Another 18 gauge needle inserted into Achilles tendon 2 CM proximal to it in the same direction as above.

The tenotomy was performed by a medial percutaneous stab incision using a size 15 blade 2 cm above the calcaneum in between the two needles to cut the tendon from front to back according to the Ponseti technique. Care was taken to avoid inserting the blade any deeper than necessary and to position it posteriorly in order to avoid the posterior tibial neurovascular bundle and other tendons.

Distance between the two needles was measured with foot in fully dorsiflexion. In each foot clinical evidence of a successful tenotomy was taken as a definitive increase in dorsiflexion at the ankle and lack of a palpable heel cord. Increase in distance between the needles indicates successful tenotomy. Full leg corrective cast was applied for 3 weeks.

At 3 weeks and 6 weeks, cast was removed and clinical assessment was done for healing of Tendo Achilles by palpating for heel cord and by Thomson's test. The same procedure of inserting two percutaneous 18 gauge needle as described before was repeated. The distance between the needles was measured . Increase in distance between the two needles shows lack of full continuity of the severed ends of the tendon.

**Ponseti's Method of clubfoot correction**

"Aims at biomechanical realignment rather than anatomical or radiological correction."

**Scientific Basis of Management[3]**

The Ponseti treatment of clubfoot is based on the biology of the deformity and of the functional anatomy the foot.

The abnormal area on the involved foot is compared to the same area on the normal foot (if the deformity is not bilateral) and scored:: -

0 = No deformity 0.5 = Moderate deformity

1 = Severe deformity

**Hind Foot Contracture (HFC)**

1. Posterior crease (PC)
2. Empty Heel (EH)
3. Rigid Equinus (RE)

***Possible HFCS between 0 and 3***

**Mid Foot Contracture (MFC)**

1. Curvature of Lateral Border of Foot (CLB)
2. Medial Crease (MC)
3. Lateral part of Head of Talus (LHT)

***Possible MFCS between 0 and 3***

## METHOD

The foot is evaluated every week during serial cast treatment. The infant is kept supine at the end of examination table and is examined while feeding & relaxed.

***LOOK***

- CLB (Curved lateral border)
- MC (Medial Crease)
- PC (Posterior Crease)

***FEEL***

- LHT (Lateral Head of Talus)
- EH (Emptiness of Heel)

***MOVE***

- RE (Rigidity of Equinus)

**CLB (Curved lateral border)**

Look at the plantar surface of the foot at rest and gauge the curvature of the lateral border of the foot by placing a straight edge along lateral border

- Normal 0
- (Straight from heel to 5th Metatarsal head)Mildly curved 0.5
- (Curvature in the distal part)
- Pronounced curvature 1
- (Curvature at calcaneocuboid joint)

**MC (Medial Crease)**

Assessed with the foot in maximum correction and looking at the longitudinal arch of the midfoot.

Multiple fine creases which don't change contour of the arch: 0.0

1-2 deep creases which don't change the contour of the arch : 0.5

Deep creases which change contour of arch : 1.0

**PC (Posterior Crease)**

Assessed with the foot in maximum correction and looking at back of the heel

Multiple fine creases which don't change contour of heel: 0.0

1-2 deep creases which don't change the contour of the heel: 0.5

Deep creases which change contour of heel: 1.0

**LHT (Lateral part of Head of Talus)**

Assessed with the foot in deformed position

Lateral part of head talus is palpated and foot is everted. Note if the navicular reduces on to the head of the talus

- Inability to palpate LHT 0.0
- (Complete reduction of T-N joint)
- LHT palpable with difficulty 0.5
- (Partial reduction of T-N joint)
- LHT easily palpable 1.0
- (Fixed medial subluxation of navicular)

**EH (Emptiness of Heel)**

Assessed with the foot in maximum correction with the examining finger placed on corner of the heel and applying gentle pressure

- Tuberosity of calcaneum immediately palpable 0.0
- Tuberosity palpable deep in the heel 0.5
- No bony prominence appreciated 1.0

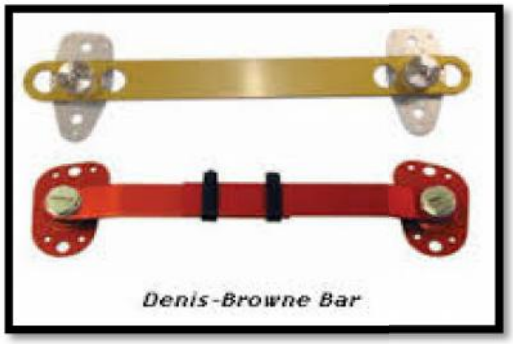
**RE (Rigidity of Equinus)**

Assessed with the baby supine, knee extended and foot in maximum correction from the lateral side

- Ankle dorsiflexes fully 0.0
- (Foot touches the shin)
- Ankle dorsiflexes up to neutral 0.5
- Ankle dorsiflexes to less than neutral 1.0

## RESULTS

Total number of feet treated in this study was 47 of 30 patients. Maximum, minimum and average follow up periods were 21 months, 3 months and 11.1 months respectively. After achieving correction patients were given maintenance device and followed every month thereafter to look for any recurrence.




**Denis-Browne Splint (Courtesy Cure Clubfoot Society)**

**Table 1**Age-wise distribution of the baby

| Age of presentation | Patients(%) | Feet |
|---|---|---|
| Birth- 3 months | 16(53.33%) | 26 |
| >3 months- 6 months | 03(10.00%) | 05 |
| >6 months- 9months | 05(16.67%) | 08 |
| >9 months- 1 year | 06(20%) | 08 |
| Total | 30(100%) | 47 |

Above table shows that 16(53.33%) cases presented within 3 months . Youngest patient was 1 month old, oldest was 1 year old.

**Table 2** Sex distribution of the baby

| Sex | Patients | Percentage |
|---|---|---|
| Male | 23 | 76.66 |
| Female | 7 | 23.33 |
| Total | 30 | 100% |

**Above table shows that majority [23, 76.66%] of study subject (baby) were male.**

**Table 3**Laterality

| Unilateral | | Bilateral | U/L: B/L |
|---|---|---|---|
| Right | Left | | |
| 8 | 5 | 17 | 1: 1.31 |

There were total 30 cases out of which 13 were unilateral (8 right handed, 5 left handed), rest bilateral.

**Table 4** Birth sequence

| S. No | Birth Sequence | No. of Cases |
|---|---|---|
| 1 | 1st | 22 |
| 2 | 2nd | 6 |
| 3 | 3rd | 2 |
| | Total | 30 |

Incidence of CTEV was found to be more in the 1st born child with 22 cases, 6 cases were 2nd born. Incidence of CTEV was found to decrease as the birth order progress

**Table 5** Average Number of casts required for full correction achievement vs Age of Presentation

| Age at presentation | Average No of casts required for full correction achievement |
|---|---|
| Birth- 3 months | 5.97 |
| >3 months-6 months | 4.60 |
| >6 months- 9 months | 4.88 |
| >9 months- 1 year | 6.75 |

**Table 6** Average Distance increased following tenotomy vs age of presentation

| Age at presentation | Distance increased in millimetres |
|---|---|
| Birth- 3 months | 5.3 |
| >3 months - 6 months | 6.2 |
| >6 months- 9 months | 6.5 |
| >9 months- 1 year | 8.7 |

Post tenotomy distance between two needles increased with increasing age of presentation.

Average distance increased after tenotomy was 5.4mm in cases with age of presentation of upto 3 months. It increased to around 8.7 mm in cases with age of presentation from 9 months to 12 months.

At 3 weeks increased distance of 2mm and 1mm found in one foot each. No increase in distance was observed in rest 45 feet.

**Table 7** Results of our new method and Clinical findings before and immediately after tenotomy and at three and six weeks after healing

| Stage | Number of tendons clinically intact | Number of tendons shown to have continuity by our new method |
|---|---|---|
| Pre-tenotomy | 47 | 47 |
| Immediately after tenotomy | 0 | 0 |
| Three weeks after tenotomy | 40 | 45 |
| Six weeks after tenotomy | 47 | 47 |

40 tendons were clinically intact at 3 weeks, while continuity was observed in our new method in 45 tendons at 3 weeks. All tendons showed clinical evidence of an intact cord and evidence of continuity in new method by six weeks.

**Table 8** Distance increased vs Pirani score

| Pirani score | Average no of casts required for full correction | Average Distance increased in mm post tenotomy |
|---|---|---|
| 3.5 | 4.5 | 4.5 |
| 4 | 4.7 | 5.0 |
| 4.5 | 5.0 | 6.0 |
| 5 | 5.2 | 6.0 |
| 6 | 6.6 | 7.1 |

Post tenotomy distance increased as initial Pirani score increased. Number of casts required for full correction also increased with increased initial Pirani score.

## DISCUSSION

Treatment of idiopathic clubfoot is either surgical or manipulative conservative or surgical. Despite long term

experience in many centers, there still are outcome controversies surrounding both alternatives. Controversies persist because of lack of a) standards for evaluating functional outcomes, rendering comparisons between treatment groups problematic, and b) long-term follow-up studies showing results. Lloyd-Roberts[4] wrote "Clubfoot will doubtless continue to challenge the skill and ingenuity of Orthopaedic Surgeons, but so long as much fundamental knowledge eludes us, our practice will continue to be flavoured with a certain ingenious empiricism. Art-has had its day. Let us now resolve to concentrate on the science of Orthopaedic surgery" Long back in 1960s Prof. Ignacio Ponseti[3] devised his method of conservative treatment of Congenital Talipes Equino Varus which starts from day one of age and is based on the fundamentals of kinematics and pathoanatomy of the deformity. This method successfully realigns clubfoot in infants without extensive and major surgeries. This method has correct biomechanical basis for realigning deformed ankle and foot joints and corrects deformity due to favourable fibroelastic properties of the connective tissue and the ligaments. So this method does not aim at anatomical and radiological correction and can be evaluated critically on the basis of clinical correction. The Ponseti technique for the treatment of idiopathic congenital talipes equinovarus has been shown to be very effective. It requires little technology and is therefore suited to Africa and other areas with poor technological resources. Tenotomy of the Achilles tendon is an integral part of Ponseti's technique for the treatment of clubfeet. The indication for tenotomy has been clearly described and is reported to be necessary in approximately 70% to 80% of patients.[5] Tenotomy to correct the equinus deformity, after the cavus, adductus, and heelvarus have been corrected, allows more expeditious correction of the clubfoot deformity, decreasing the number of casts and the overall duration of treatment. Although the effectiveness of the Ponseti technique has been made clear in multiple publications over the past 30 years, the specific role of the Achilles tenotomy has not been addressed. Reluctance to consider complete tenotomy of tendo Achilles may stem from three understandable concerns. First, sectioning of a tendon is not a normally recommended treatment. Secondly, other structures may be in- advertently damaged during tenotomy and lastly the tendon may not heal satisfactorily. A recent report of the use of botulinum toxin A as an alternative way of defunctioning the tendo Achillis is limited by the availability of this toxin and its prohibitive cost in developing countries. If reluctance to use percutaneous tenotomy cannot be overcome, the rate of tenotomy will be lower with a greater risk of failed correction. The indications for surgical tenotomy in orthopaedic surgery are limited and are usually reserved for fixed shortening of a muscle or muscle group.

An infant with idiopathic congenital talipes equinovarus is a 'special case' by virtue of the abnormal gastrosoleal muscle complex in the calf. There is a definite risk of iatrogenic damage to adjacent structures if the tenotomy knife is used injudiciously. This can be obviated or significantly reduced in developed countries by the use of an open technique under general anaesthesia, but elsewhere in the world there is a risk of or lack of general anaesthesia. Complications of percutaneous tenotomy have been described, but in our study none were experienced, although the number of patients treated was small. To overcome the final objection to tenotomy there must be a plausible mechanism to explain regeneration of the tendon and experimental evidence for it. Healing of the tendon has been classically described as involving extrinsic or intrinsic factors or a combination of the two. In an extrinsic process, the gap is invaded by fibroblasts, and the repair leads to the formation of a fibrous scar with adhesions that favour the blood supply[6] but may interfere with the sliding mechanism, and may also represent a mechanical shortcoming[6] . In an intrinsic repair process, a cascade of cellular and biochemical events takes place; fibroblast migration tends to proceed in an orderly fashion, and thus tendon tissue is regenerated in a fetal like process[6]. The results of our study showed that the gap heals spontaneously and rapidly within three weeks after tenotomy. We provided objective evidence that a lesion that is still separated heals satisfactorily, and that three weeks is sufficient for a post-tenotomy cast. Knowing this will prevent repeated shortening or excessive prolongation of the time required for immobilization. Thus, the rapid healing seen in infants, in whom progenitor cells are abundant, may involve the same mechanism, although the predominance of either one of these processes depends on the tendon, grade of injury, blood supply, gap size, age, and mechanical factors[6]. Recent research has suggested that embryonic mechanisms may be responsible for healing in the adult tendon.[6] Thus the rapid healing in infants aged one to two months in whom progenitor cells are abundant, could involve the same mechanism.

This study was carried out on an outpatient basis at our institute from the period of December 2012 to September 2014 with 30 patients (47 feet) participating in the study.

***Sex incidence:*** There were 23 male and 7 female patients in our series with a male female ratio of 3.29:1. The male: female ratio in Kite's[7] series was 2.07: 1 and in series of Wyne Davis[8] was 2.17: 1. Dr. G. S. Vyas and Pradeep Verma[9] (2004) had recorded a sex ratio of 2.0:1. The reason for preponderance of male patients as compared to female patients could be that the female child is still neglected in the lower socioeconomic strata which formed the bulk of our patients.

***Laterality:*** As regards laterality, the ratio of bilateral to unilateral clubfoot is 2.62:1. (72.3% bilateral and 27.7% unilateral). 17 (57%) of our cases were bilateral and 13 (43%) were unilateral (8 right and 5 left sided) which is in concordance with other series presented by workers like Palmer (50% bilateral and 50% unilateral), Wyne Davis[8] (44% bilateral and 56% unilateral). In Mckay [10] (1983) series has observed an incidence of unilateral and bilateral ratio 1:1.7 has been observed G. S. Vyas and Pradeep Verma in their series had found an incidence of unilateral 51% and bilateral 49%. [9.]

***Birth Sequence:*** In the present study it was noted that the first born child was affected in 22 cases. It was found that incidence decrease as the birth sequence increase. We have observed 6 cases in second birth order, 2 cases in third birth .G. S. Vyas and Pradeep Verma [9] (2004) in their study of 43 cases had also made same observation. That is first born child was more affected than the other. In their series 26 cases were observed

in first born child, 7 cases in second born, 6 cases in third born, 3 cases in fourth born and one case in fifth born.

***Age:*** When the feet were divided on the basis of the age at first reporting, it was seen that a large proportion of patients seen were less than one month old.

The youngest patient who was included in this study was only 24 day old. The oldest patient was 12 months of age.

***Number of Cast Required Vs Age:*** If we look at the age wise distribution it is obvious that most of the patients who had reported in first three month of their life, showed a pattern three response i.e. both the scores (mid foot and hind foot) got corrected and did so fairly quickly. The average number of manipulation required in a foot before maintenance cast was given was 4.24 (average) in age group of 0-3 months while the number of manipulation required for full correction increased steadily with increase in age at presentation; 6.75 (average) at >9 months-1 year of age.

***Pirani Scores Vs Number of Cast Required:*** If we categorize the feet on the basis of initial Pirani Score, we find that those feet which had lower initial score 3 to 4 (that is less severe and less rigid deformity) were more amenable to correction and responded relatively early when compared to those with higher initial score 4.5 to 6 (i.e. more severe and more rigid deformity). The number of cast application required to achieve full clinical correction were 4.5 (average) in patients whose initial Pirani scores were 3.5 while in patients with initial Pirani scores 6, number of cast required to obtain full clinical correction increased to 6.6 (average).

***Distance increased post tenotomy:*** The average distance between the severed ends of Achilles tendon 6.21±2.32 in mm (range, 2 to 12 mm).

***Pirani score vs distance increased post tenotomy:*** In this study it was noted that average distance increased post tenotomy were less in feet with low Pirani score while feet with Pirani score of 5 or more had more distance between the separated ends of tendon, indicating amount of contracture of Achilles tendon. The distance increased was 4.5mm (average) in patients whose initial Pirani scores were 3.5 while in patients with Pirani score 6 , distance increased were 7.1mm (average). This indicates more rigid feet were having more contracture of Achilles tendon.

***Clinical assessment vs Two needle assessment:*** Clinical evidence of an intact cord was found in 40 tendons at 3 weeks while two needle method indicated continuity of tendon in 45 feet by showing no increase in distance between the two needle. Two tendons showed increase in distance of <2 mm indicating partial continuity of Achilles tendon. All the tendons showed intact tendon both clinically and with two needle method . This indicates majority of Achilles tendons heal in three weeks and all Achilles tendons heal within six weeks after tenotomy.

***Residual deformity:*** Out of 30 cases we had one case of residual deformity. There was one recurrence which was corrected by corrective casting and posteromedial soft tissue release.

**Our study corroborates with the studies carried out by the following authors**

Maranho DA, Nogueira-Barbosa MH (2009)[12] *et al* studied 37 tenotomies in 26 patients with congenital clubfoot treated with ponseti technique with ultrasound scan and found mean retraction of 5.65 mm+/-2.26 mm (range ,2.3 to 11.0 mm) between tendon stumps after tenotomy. After 3 weeks, ultrasonography showed tendon repair with the tendon gap filled with irregular hypoechoic tissue, and also with transmission of muscle motion to the heel. Six months after tenotomy, there was structural filling with a fibrillar aspect, mild or moderate hypoechogenicity, and tendon scar thickening when compared with a normal tendon. One year after tenotomy, ultrasound showed a fibrillar structure and echogenicity at the repair site that was similar to a normal tendon, but with persistent tendon scarring thickness. They concluded that there is a fast reparative process after Achilles tendon percutaneous section that reestablishes continuity between stumps. The reparative tissue evolved to tendon tissue with a normal ultrasonographic appearance except for mild thickening, suggesting a predominantly intrinsic repair mechanism.

Agarwal A, Qureshi NA (2012)[15] *et al* in an ultrasonographic study of Achilles tendon in congenital clubfeet before and after tenotomy on 39 feet of 27 cases found functional continuity of the Achilles tendons 4 weeks after tenotomy using clinical and ultrasonographic methods .

Saini R, Dhillon MS (2010)[13] studied the regeneration potential of Achilles tendon after percutaneous tenotomy in 34 clubfeet treated by Ponseti's technique clinically and using MRI at 6 weeks and 6 months. The study revealed continuity of the tendon in all cases at the end of 6 weeks and 6 months of the tenotomy . They concluded that tendo-achilles does regenerate following percutaneous tenotomy, used in the correction of clubfoot using Ponseti's technique.

Kowalczyk B, Lejman T (2004)[11], studied early results of conservative treatment in congenital clubfeet with percutaneous tenotomy of Tendo Achilles in 10 children(16 feet ).On follow-up found that all Achilles tendons regenerated. They concluded that the percutaneous tendon Achilles tenotomy is a safe and valuable procedure which allows to avoid early surgery in 88% of clubfeet.

Mangat KS, Kanwar R (2010)[14] in an ultrasonographic study of gap healing following Ponseti-type Achilles tenotomy on 27 tendons 20 patients of idiopathic clubfeet found transition to normal structure was frequently demonstrated by ultrasonography only at twelve weeks. They claimed that although there is evidence of continuity of the Achilles tendon by three weeks after tenotomy, healing is not complete until at least twelve weeks.

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**How to cite this article:**

Govind Kumar Gupta *et al*., Redevelop Of Achilles Tendon After Percutaneous Tenotomy In Idiopathic Clubfoot Patients As Per Ponseti's Method Of Correction Clinically And Using Two Needle. *International Journal of Recent Scientific Research Vol. 6, Issue, 8, pp.5665-5671, August, 2015*

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