



Original Research Article

Variation in the size of foot and great toe in unilateral CTEV (club foot deformity)

Mohammed Jalal Mohiuddin¹, Syeda Sadia Sameera^{1,*}, Hafsa Razvi Syeda¹, Sai Rithwika¹¹Deccan College of Medical Sciences, Telangana, India

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ABSTRACT

Introduction: Congenital Talipes Equinovarus (CTEV) is one of the common foot deformities seen in new born. It has prevalence of 1 in 1000 population with male preponderance. There is lot of anatomical and functional differences between the effected foot and the normal foot. These differences include variation in size of foot, size of toes, altered vasculature of foot, muscle imbalance between the everters and invertors of foot. These differences can easily be made out if it's a unilateral deformity as the control for comparison will be the normal foot.

Materials and Methods: Present study was done at our institute with coordination with department of orthopedics, including 20 patients with unilateral CTEV. The size of the foot and toes measured after full correction of the deformity.

Results: It was found that there is constant decrease in the size of effected foot which is obvious on measurement and there is considerable clinical shortening of the great toe in comparison with the second toe in Club feet.

Conclusion: The results obtained in present study will help the orthopedic surgeon to look into the matter of size of foot in future as the child grows and its cosmetic and functional impact over the activity of the subject.

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1. Introduction

Club foot deformity has been described in ancient Egypt literature as Pharaoh Siptah of the XIX Dynasty supposed to have this deformity. It was Hippocrates who introduced the word Talipes Equinovarus in medical literature in 400 B.C. He treated the cases with gentle manipulation and bandage application His saying about manipulation “manipulate the foot as if holding a wax model, not by force, but gently” is very well known.¹⁻³

The CTEV has incidence of about 1-2 cases per 1000 births with male predominance.⁴ According to the global initiative report, incidence of children born with club foot in India is 30,000 per year. It is by CCW (cure club foot worldwide) in collaboration with local organization in main states of India which include Tamil Nadu, Karnataka, Bihar and Delhi, who takes care of CTEV effected feet in India.

* Corresponding author.

E-mail address: drsadia2323@gmail.com (S. Sadia Sameera).The incidence found is 1.2 per 1000 live births.¹

Banskota et al. in their study of 145 patients involving 220 feet, Seventy-five patients had bilateral involvement constituting 51.7 percent of clubfoot, while 40 (27 percent) had involvement of the right side and 30(20%) had involvement of the left.⁵ It's more common a bilateral presentation followed by right side and then left.

There are various other anomalies coexist with CTEV includes joint laxity, congenital dislocation of the hip, tibial torsion, ray anomalies of the foot (oligodactyly), absences of some tarsal bones, anterior tibial artery defect, Peronei muscle weakness and small sized foot and great toe.^{6,7}

Katz K. et al. has described⁸ antenatal diagnosis of the deformity as early as 18 to 22 weeks of gestation by help of ultra sonogram with 80% of accuracy in the diagnosis. Early existence of the deformity in fetal life may have possible association with conditions like Trisomy 18, Larsen's syndrome, neural tube defects and congenital heart

defects. Though suggested diagnostic amniocentesis it's not being practiced as there is associated risk of fetal loss after the procedure.⁹

Though it remains a clinical diagnosis, as the bones are not ossified in new born x rays has no major role in diagnosis. When there is suspicion of other anomalies or for follow up the commonly done X-rays are anterior posterior and lateral views of foot. The talocalcaneal angle in anterior posterior view otherwise called as Kites angle should be in between 30 degrees to 50 degrees. It decreases in CTEV affected feet. The other angles measures are talo first metatarsal angle (normal 0 degree to 10 degrees). Talo calcaneal angle (normal 30 degrees to 50 degrees) and Tibio calcaneal angle (normal 10 degrees to 20 degrees) are measured on lateral view X-ray. Long standing unattended Ctev feet has flattened talar head in X-rays.¹⁰

1.1. Gross development of lower limb and foot¹¹

Lower limb buds appears at about 4 weeks age of gestation and by the end of the 6th week the distal portion of the limb bud develops into the digital plate. Initially digital plates are oriented in line with the long axis of the lower leg. Due to the presence of external rotation of the whole lower limb, the plantar surface of the digital plate is facing in a cranial direction. The digital plate becomes notched at the beginning of the 8th week. The notches become deeper and this gives rise to a fan-like appearance of the digital plate. As these is gradual decrease in the amount of existing external rotation, the plantar surface faces more medially than at earlier stages. The degree of plantar flexion (Equinus) starts to decrease, which makes more evident the inversion (varus) and adduction of the foot.

At the end of the 8th postovulatory week the plantar surfaces face each other and the feet are in a position of equino-varus-adductus. The degree of equinus, varus, and adductus decrease gradually during the 10th-11th week. The feet will reach an almost neutral position at the end of the 11th postovulatory week.

These positions cannot be attributed to a restriction of movement as the embryo is relatively small at this stage and severe restrictions of movements of the fetus in the amniotic fluid usually start at about 6 months. Therefore, the positional changes of the feet during earlier periods seem to depend mostly on the predetermined skeletal and neuromuscular development. And to insist here is about the joint which doesn't appear at this stage.

Various theories have been proposed regarding the development of the deformity. These includes,

1. Mechanical or positional theory.
2. Bone and joint hypothesis.
3. Connective tissue hypothesis
4. Vascular theory.
5. Developmental arrest.

1.2. Mechanical or positional theory¹²

Hoffa et.al promoted this theory, stating hypothesis of uterine restriction, considering fetal foot movement restriction by the tight uterus caused Idiopathic club foot. Oligo-hydramnion being considered as the possible cause of this deformity.

The facts against the positional hypothesis is that clubfoot can be detected from the second trimester, long before any uterine pressure would be exerted on the developing embryo in the majority of cases. And if at all tight uterus is the cause of it, there is no any increased incidence in twin pregnancies and no other anomalies associated with it.¹³

1.3. Bone and joint hypothesis¹⁴

It is the most ancient proposed etiology, even described by Hippocrates that there is defect in endochondral ossification of the bones. The deformity of the foot is completely a bony deformity and the ligaments and muscle changes are adaptation to this deformity of bones.

1.4. Connective tissue hypothesis¹⁵

Ippolito E. et al. Proposed this after serial dissection of aborted fetuses affected with CTEV. They found increased fibrous tissue in muscles, fascia, ligaments and tendon sheaths, which causes loss of elasticity and results in CTEV.

1.5. Vascular theory¹⁶

Atlas et.al studied the vascularity of foot in fetal and the new born feet. There is abnormal blockage of the vessels around sinus tarsi in the fetus having CTEV and the evaluation of the feet in newborns showed hypoplasia of calf muscles and alteration in the course and dimension of anterior tibial artery. There was decrease in caliber of anterior tibial artery and it found absent in few cases.

1.6. Developmental arrest¹⁷

Böhm M. et. al and many authors supported this theory. The recent improvement in non invasive imaging technique has made the development of foot inutero very clear. The wax model of fetal foot was made using the images obtained. The severely effected club foot resembles the foot of two months embryo. These studies support the theory that the possible cause of clubfoot development is due to an arrest of the normal medial rotation of the foot in late foetal development.

1.7. Patho anatomy in CTEV

There is altered relation of the bone alignment in CTEV. The hind foot is held in equinus position with tight heel cord (Tendo Achilles) and adaptive atrophy of Gastro soleus

musculature. The fore foot is supinated and adducted in relation to the hind foot giving the cavus foot deformity.¹⁸

The high riding calcaneum makes heel to feel soft, an empty heel sign. There is increased in the depth of the posterior and plantar creases.

There are various musculo-tendinous structures, fasciae and the ligaments which are thickened and shortened along the postero medial aspect of effected CTEV.¹⁹ The muscles includes gastrocnemius soleus complex posteriorly, FHL (flexor hallucis longus), FDL (Flexor digitorum longus), TP (Tibialis posterior) along the medial aspects.

The ligaments along the foot get tightened and have altered tissue structure includes Plantar fascia, deltoid ligament, spring ligament and the posterior talo-fibular ligaments. Capsular tightening is seen along the posterior ankle joint and subtalar joint capsule, talonavicular joint capsule and naviculo cuneiform joint capsule.

There is associated imbalance between invertors (tibialis anterior and posterior) and everters (Peronei muscles) of foot. This imbalance predisposes foot to go into supination and varus at the fore foot after complete correction and some time need rebalancing by lateralizing tibialis anterior insertion to the third cuneiform or cuboid bone from the first metatarsal.

The treatment method of CTEV changed a lot from the manipulation in Hippocrates period, various surgeries in eighteenth and nineteenth century. At present Ponseti method of treatment supposed to be the gold standard method which is serial manipulation and Tendo Achilles Tenotomy.²⁰ Long term studies on correction of CTEV by Ponseti have effectively demonstrated the improvement of the affected feet using clinical, radiographic, functional, gait, pedo-barographic and electro-goniometric analyses.²¹

Anthropometries of foot have been studied by very few authors. It has been proposed that the effected site is relatively smaller than that of normal side and the difference depends on the correction method utilized. The surgically treated CTEV foot is much smaller than that managed with Ponseti method.²²

Recent studies of long term follow up following Ponseti assisted CTEV correction demonstrated that the foot size will not affected much if the foot correction done early in the life. The bracing after the correction of the deformity has proved to have no impact on foot size.²³ There is no published literature on the size of the great toe to the best of our knowledge.

Present study has been done at our institute evaluating the size of the foot and great toe.

2. Aims and Objectives

1. To study the variation in the size of CTEV affected foot.
2. To study the variation in size of the great toe in CTEV affected foot

3. Materials and Methods

Study was done after clearance from IRB (Institutional Review Board) and after taking parent's consent.

3.1. Study design

Cross-sectional study.

3.2. Study place

Study has been carried out in the Department of Orthopedics in Medical College.

3.3. Participants

20 patients diagnosed as idiopathic CTEV in last 3 years were included in the study

3.4. Inclusion criteria

1. All CTEV (idiopathic and secondary)
2. Treated conservatively
3. After complete correction of the deformity.
4. Unilateral club foot deformity.

3.5. Exclusion criteria

1. CTEV cases which had undergone open surgeries.
2. Bilateral CTEV

4. Methodology

Patients collected after reviewing the out patient's OPD record. Patient who got full correction of deformity following manipulation and maintained on abduction brace were selected.

The foot prints collected over the white paper stick on hard cardboard, all precaution taken to take impression of heel and all the toes completely. The length of foot measure with scale by two observers from the tip of second toe to the heel (second toe selected as its size remained un effected in opposition to first toe which has smaller size in CTEV effected feet).

The size of the toes noted after taking a photograph, to compare the length of the first and second toe.

5. Results

There were 20 subjects included in over study, all had unilateral involvement of foot. Fifteen patients are male (75%) and five (25%) were female with male to female ratio of 3:1. There was left foot involvement in thirteen patients contributing 65 percent of the study subjects. Seven patients have right foot involvement.

Great toe was shortened in seventeen out of twenty patients when compared with the normal side (**Figure 1**). Three had normal length of the great toe.

There was decrease in the size of foot in all patients (Figure 2). The shortening ranged between 0.3 cms to 0.5 cms with mean decrease in the size of foot by 3.85 cms.



Fig. 1: Great toe size



Fig. 2: Size of the foot

6. Discussion

Our study has male 75 % were female and this findings correlate with the published data where the incidence is more in males, its 80% in study done by Pulak S, Swamy M et al.²⁴

Our study has left foot involvement in 65 % patient which is different than the findings by other authors like Gunalan R et al.²⁵ where the right side involvement is higher, this may be an incidental or may be due to small sample size.

85 percent of the effected feet in our study has shortened great toe in comparison with the second toe and there is no much literature found regarding this. The great toe has important role in gait cycle and effect of its shortening over the gait cycle has to be studied in future.

Foot size was small in all subjects when compared with their normal counterpart. The possible cause of this

might be generalized hypoplasia of the effected limb in the uterus. The future size of the foot depends on the timing of correction and method used.

It appears that the early correction of the deformity with the ponceti technique makes foot anatomically normal and used equal to its counterpart (unaffected foot) for the activity. This stimulates its growth and decrease the proportion of size as the foot develops.

7. Conclusions

It has been found that there is shortening of the feet effected with CTEV and the size of great toe also shorter than the normal foot. The impact of this shortening over the cosmetic appearance in view of different size of foot wear for the foot, need to find out. The effect of toe shortening over the gait cycle will answer if at all any such changes exist.

There need to evaluate further whether the timing of correction of deformity has any effect over the size difference and is there any limb length discrepancy co exist with the deformity.

There are many famous people in history who had CTEV woth mentioning are Claudius, the Roman emperor, Dudley Moore, the English actor, Damon Wayans, the American actor and comedian, Steven Gerard, the English soccer player, Kristi Yamaguchi, winner of 1992 Olympic gold medal for figure skating.

Though it's a major foot deformity, early intervention and correction will help the patients to perform out standing in life and sports.

8. Acknowledgements

None.

9. Conflicts of Interest

None.

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Author biography

Mohammed Jalal Mohiuddin Assistant Professor

Syeda Sadia Sameera Assistant Professor

Hafsa Razvi Syeda Medical Student

Sai Rithwika Medical Student

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