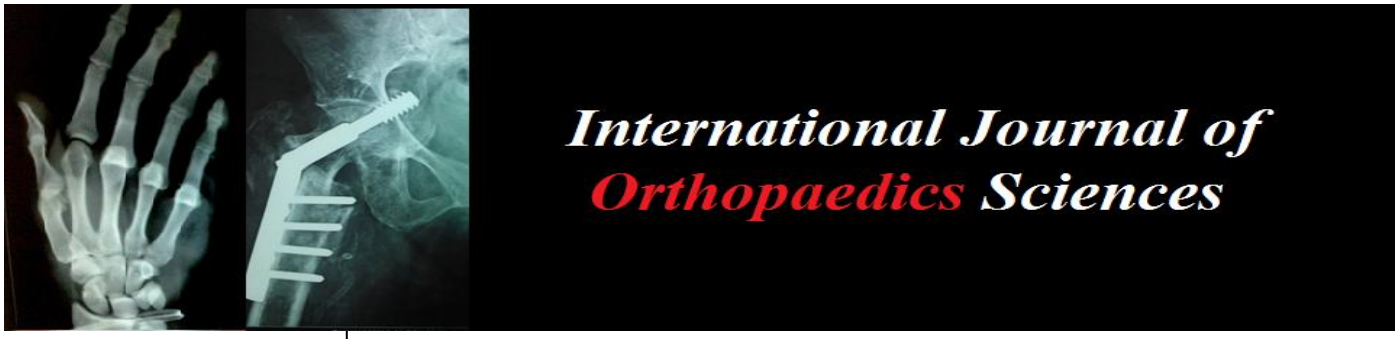

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2020; 6(1): 271-275

www.orthopaper.com
Received: 16-11-2019
Accepted: 20-12-2019

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CTEV - brief over view and short term follow up study

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DOI: https://doi.org/10.22271/ortho.2020.v6.i1e.1872

Abstract
Background: The plan of studying CTEV correction was proposed as it is one of the common congenital orthopedic deformity with various available mode of treatment. Among available treatment modalities it was found that Ponseti method of manipulation is least invasive, easy to learn and highly effective. Under this impression project was proposed to study its effectiveness.
Aim: Aim of study was to evaluate the effectiveness of Ponseti technique of the plaster cast application in the management of CTEV.
Objectives: The objectives were to compare the effected limb with the normal limb (in unilateral cases), evaluate the Achilles tendon function and morphology after percutaneous tenotomy clinically and sonologically and to assess the recurrences of deformities.
Methodology: The study is Retrospective observational type of study carried out in the Department of Orthopedics with 20 patients diagnosed with CTEV (both unilateral and bilateral) who were treated at our centre from beginning. Pirani score at presentation was taken to quantify the severity of the deformity. The Ponseti Technique was used to correct this deformity. Percutaneous Tendo Achilles tenotomy was performed in those cases that had resistant equinus deformity. Dennis brown splint was offered to all the patients after complete correction. Ultrasound examination of the hip, vessels, Tendo Achilles was performed to check for underlying hip dysplasia, patency of vessels and for the continuity of Achilles tendon. The strength of the Peronei muscles was measured clinically.
Result: It was found that out of 20 patients under study contributing 27 feet, 15 were males and 5 were females. There was bilateral presentation in 7 patients and remaining 13 has unilateral deformity which was on left side in 9 and right side in 4 patients. One patient presented with amniotic band syndrome with right sided CTEV. The average Pirani's score was 3.74/6. 13 patients showed a Pirani score of 4.5. In patients of unilateral CTEV there was variation in the sizes of foot where the effected foot was smaller than that of the normal with a mean difference of 0.45cms. Great toe shortening was noticed in 17 patients with no significant limb length difference. Ultrasound screening of the hip showed that all the hips were mature and stable with alpha angle being greater than 60 degrees. Ultrasound for the vascular status revealed no abnormality in the wave pattern of the vasculature of effected foot with the normal foot in unilateral cases. In the patient with congenital band syndrome, the peroneal artery was absent. The Tendo Achilles (TA) tendon regained continuity in all the patients that have undergone percutaneous TA tenotomy. Three patients showed recurrence of the deformity and all of them were found noncompliant with the Abduction Brace. These three patients needed surgery for the deformity that has recurred. One had under gone PMSTR; one need limited posterior release and one patient required Tibialis.
Conclusion: The study was about necessity to diagnose this deformity as early as possible, preferably in antenatal scans. As it helps the patient to seek early intervention for its correction. There are many existing anatomical alterations these all need to be evaluated further in future and their impact on CTEV correction, its relapse and performance of foot in future. The compliance to the abduction brace after correction is most important factor to prevent development of the relapse.

Keywords: CTEV, ultrasound, toes, pirani

Introduction
CTEV (Congenital Talipes Equinovarus) generally known as club foot is a common congenital deformity with prevalence of 1 in 1000 population. According to the global initiative report, incidence of children born with club foot in India is 30,000 per year [1]. The etio- pathology behind the deformity has been explained much in literature. The standard treatment followed presently for the correction of the deformity is Ponseti method of serial manipulation. The classically described method by Ponseti is serial cast application till fore foot and mid foot get

corrected, the residual equinus deformity most of the time needs percutaneous tendo Achilles tenotomy.

The important phase in Ponseti technique of CTEV treatment is the maintenance phase which need abduction splint to be worn for 3 years duration.

The presently done study is the follow up study performed over the patients who got treated by the above method and under the maintenance phase. Lots of papers being published in past, regarding the follow up results of this technique. The few things which are specifically enlightened in our study are

1. the muscle balance of the feet (the action of two opposing muscle that are important in CTEV pathology which are peronei muscles vs. tibialis anterior and posterior).
2. The vascular status of the foot in effected limb when compare to the normal which was done by checking the patency of tibialis anterior, tibialis posterior and peroneal vessels using ultra sonogram.
3. The Tendo Achilles status after tenotomy was studied by the ultrasound assistance.

Study performed is the retrospective study done over period of 3 months and the patients under follow up were considered. Except vascular status and tendo Achilles status all information gathered with previous patient and hospital record. Selected patients for the study were subjected to undergo ultrasound evaluation for vascular status and Tendo Achilles status (after tenotomy).

It was found during the study that there are lots of believes associated with this condition which are sometimes very difficult for the mother as she was blamed for it. These need to be weaned off from the community. There was only one case detected prenatally by ultrasound and parents were counseled about it and they were comfortable during the management period.

The study has minimum economic burden over the institute as there are no invasive methods involved and the evaluation was done in single ultrasound sitting, rest of information was by the revision of the hospital and patient records.

Review of literature

Club foot deformity has been described in ancient Egypt literature. It was Hippocrates who introduced the word Talipes Equinovarus in medical literature in 400 B.C. and he only advised that manipulation and splinting will correct the deformity [2, 3]. The CTEV has incidence of about 1-2 cases per 1000 births with male predominance [4]. There is bilateral involvement in almost 50% cases and next common is right side foot. History of CTEV in family predisposes the chances of new born developing CTEV [5].

CTEV can present as isolated deformity of the musculoskeletal system at the time of birth, idiopathic type which is more common. It can be a presentation of many other conditions myelodysplasia, arthrogryposis, or multiple congenital abnormalities etc [6]. Many theories have been proposed to explain the etiology of idiopathic clubfoot which includes vascular deficiencies, environmental factors, in utero positioning, abnormal muscle insertions, mesenchyme theory, developmental arrest theory and genetic factors [7].

Development of lower limb and foot

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 decreases, 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 decreases 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/programmed skeletal and neuromuscular development.

Considering above development stages, the arrest theory explains the etiology of CTEV occurrence. The CTEV can be seen on antenatal ultrasound at least about 16 weeks of gestation.

Pathology in CTEV

It is the TCN (Talo calcaneo navicular) joint dislocation with the soft tissue contractures around the ankle and TCN joint that maintains this deformity. These contractures involve muscles, tendons, tendon sheaths, ligaments and joint capsules [8].

The contractures are divided into four groups: posterior, medial plantar, subtalar and plantar.

Musculo-tendinous structures which are contacted includes Tendo Achilles (TA), Tibialis posterior, Flexor Hallicus Longus (FHL), Flexor Digitorum Longus (FDL), abductor hallicus. There is over active tibialis anterior with weak opposing peronei muscles.

The ligaments shortened are plantar fascia, Deltoid ligament, posterior talo-fibular ligament, interosseous ligament of the talo-calcaneum and spring ligament.

The contracted joint capsules include ankle joint capsule, subtalar joint capsule, talo navicular joint capsule and naviculo cuneiform joint capsule.

Master Knot of Henry, overlies over navicular bone where FHL and EHL cross each other and has inter communication which is of great importance at the time of surgery, failure to release which may results in recurrence [9].

There are many other anatomical defects and the coexisting deformities postulated to exist along idiopathic CTEV, which has been proven and disproven in literature. These include existence of hip dysplasia, anterior tibial vessels defects and peronei muscle weakness etc.

There are studies were association of hip dysplasia with CTEV is around 0 to 5.7 percent, where hips shows IIb or worse hip of Graf type. These need to be identified and treated on time. Regarding the analysis of calf muscles and the peronei muscle anatomy and activity, there was relative hypotrophy and decreased in the relative length of the Tendo Achilles and decreased electrical activity of the peronei muscles. There was a decrease in the proportion of muscles with increase in the fat proportion [10]. these has been proved by MRI and EMG study [11].

The severity of the deformity is measured universally by two methods that are Pirani's scoring system and Dimeglio scoring system with good correlation between them. Pirani's scoring system has been used in our study. It includes total of 6 points. There are three points given for hind foot deformity and three points for mid foot deformity, worse being 6 out of 6 points [12]. Fore foot parameters used are lateral border curvature, plantar crease and talus uncovering. Hind foot parameters considered are posterior crease, equinus and heel emptiness.

The treatment of CTEV has been divided into pre and post Ponseti era, the splinting techniques described by Hippocrates which were forgotten, again reintroduced in refined form by Ignacio V. Ponseti. During this time lapse there were many techniques described and none was up to the mark. To brief these includes include force full management and Scarpa's shoes application [13], Thomas wrench assisted forceful manipulation, astragalectomy, Tendon elongations, Tendo Achilles Tenotomy [14].

After invention of Plaster of Paris, it was used after manipulation for splinting first by Guerin [15]. Gentle manipulation and cast immobilization was first properly described by Kites [16]. Operative treatment was first described by Phelps in 18th century which was later modified by Turco's in 1980 [17].

Ponseti technique [18].

Ponseti technique involves serial manipulation and cast application.

First cast applied with supination of fore foot over mid foot, correcting the existing cavus deformity. Point need to be noted here is that the fore foot should never be pronated during the serial cast otherwise the cavus deformity reoccurs.

This supination brings fore foot and mid foot as single lever arm with talus as fulcrum. The further correction achieved with serial abduction of the lever arm. This manipulation should perform without anesthesia.

The more resistant deformity is the equinus deformity. The correction can be tried by Dorsiflexion at ankle with heel n little valgus. If it feels resistant, due to the shortened tendo Achilles percutaneous Tendo Achilles (TA) needs to be performed. Percutaneous TA tenotomy avoids the possibility of rocker bottom talus development.

Every time cast application has to be done in two stages. First is below knee and second stage it has to be extended above knee with knee in 90-degree flexion and external rotation. External rotation slowly corrects existing internal tibial torsion deformity.

Once the deformity has corrected fully, maintenance is by abduction brace (Dennis Brown splint). It's a dynamic splint with the bar in between (equal to the bi-acromial diameter of the patient) and the shoes in 70 degrees abduction and 15-degree dorsiflexion.

This brace need to be used for at least 3 years with tailored weaning.

Relapse of deformities is most of the time is due to noncompliance of the brace and in adequate follow-ups. various studies have proved Ponseti technique importance in CTEV and its success

Aims and Objectives

- Study the effectiveness of Ponseti technique of plaster cast application in the management of CTEV.
- Compare the effected limb with the normal limb in cases of unilateral CTEV.
- Evaluate the Achilles tendon function and morphology after the percutaneous tenotomy clinically and sonologically.
- Assess the recurrence of deformities if any.

Materials and Methods

It was done after clearance from Institutional Review Board (IRB) and informed written consent from the parents.

Study design: Retrospective observational study.

Study place: Department of Orthopedics

Participants: 20 patients with CTEV treated in last 3 years by Ponseti technique.

Inclusion criteria

- All CTEV – treated at our center from the beginning.
- Unilateral or bilateral
- At least 3 months from the point of complete correction.

Exclusion Criteria

- CTEV managed partially by other centers.
- CTEV due to Spinal defects or muscle imbalance etc.
- CTEV with more than three anomalies AMC (Arthrogryposis multiplex Congenita)
- Pirani's scoring system is used to quantify the severity of the deformity.
- For the length of foot, the foot prints taken over the white paper. The measurement is taken from the proximal most heel impression to the distal most impression of second toe.
- For hip screening Ultrasound assisted Graf method was used.
- Vessels and Tendo Achilles anatomy are studied by linear 12 MHz probe.
- Peronei muscles strength measured clinically.

Results

Out of 20 patients in the study (contributing 27 feet) 15 were male and 5 were females. There was bilateral presentation in 7 patients and remaining 13 has unilateral deformity which was on left side in 9 and right side in 4 patients. Only one patient has other condition with CTEV that is amniotic band syndrome with right side CTEV and absent little toe. Among 20 patients included in the study two patients have been diagnosed about the deformity in antenatal scanning.

Hip screening was done in all for rolling out underlying subclinical hip dysplasia and all hip found mature and stable with alpha angle more than 60 degrees.

Average Pirani's score was 3.74/6 with 1/6 as least and 6/6 as the highest score.13 patients has Pirani's score of 4.5. Out of 27 feet 23 needed percutaneous Tendo Achilles tenotomy before final cast application. There was no any functional deficit of plantar flexion found in them and ultra sound done over them showed linear structure of tendon which resembles a normal tendon.

All patients with unilateral CTEV the size of foot was smaller than normal size with mean difference of 0.45cms (range 3 cms to 5 cms). There was great toe shortening found in 17cases (85%) with no measurable limb length difference. Out of 27 feet peronei activity was found absent in 13 patients and weakened in rest of 14 patients.

Ultrasound for the vascular status revealed no abnormality in the wave pattern of vasculature of effected foot when compared to the normal in unilateral cases. One patient with congenital band syndrome had absent peroneal artery with the aberrant vasculature in the substance of Tendo Achilles.

There were three patients who had recurrence of the deformity and all of them were found non-compliant with the Abduction Brace. These three patients needed surgery for the deformity that has recurred. One had under gone PMSTR (Turco's posterior medial soft tissue release), one need limited posterior release (Tendo Achilles lengthening and posterior capsular release and one patient required tibialis anterior lateralization.

Discussion

In study by Shylaja D K *et.al*. with sample size of 24, 18 cases (75%) were bilateral and 6 cases (25%) were unilateral of which 3 cases had right foot affected and 3 cases had left foot affected [19]. In our study most common presentation is unilateral that is about 75 percent and only 35 percent subjects had bilateral involvement. This finding differs with the published literature as the bilateral involvement is the most common involvement ranging from 53 to 70 percent in various studies. This is the noticeable variation but does not have any impact over the management protocol.

A study published by Rosselli P *et.al*. regarding the antenatal diagnosis of club foot deformity [20]. 61 out of 178 (34%) patients in their study were diagnosed antenatally. This has considerable impact on management as the patients who were diagnosed antenatally seeked treatment early (mean 9.9 days) when compare to other group who were presented after birth (mean 30 days). Among our patients has only 10 percent (2/20) had antenatal diagnosis. This might be contributed to the lack of awareness or training of the relevant personalle to look for the deformity in TIFA scan or follow-up antenatal scans.

Chou DTs *et al* [21] has done screening of 101 children effected with CTEV and concluded that there is no associated hip dislocation in patients with isolated club foot deformity. In similarity with them in our study we did not have any hip dislocation. As screening of hip is noninvasive, OP based ultrasound imaging, we continue to screen all subjects of CTEV for any associated DDH.

Though it is mentioned in literature that anterior tibial artery is functionally suppressed in CTEV foot, we could not find such changes. Study done in past by Pinto *et al* [22]. over 20 patients (equals our sample size), in which there was no significant difference in the vasculature of foot. This may be due to small sample size of the study.

Agarwal *et.al*. in their study regarding the anthropometry of CTEV effected feet they found mean of 0.7cms shortening when compared to unaffected side. Our study though has shortening but the mean is 0.45cms. This may be due to either relatively small aged subject or due to small sample size.

There is no much literature available regarding the size of he great toe in relation to the second toe and its impact on the rigidity of club foot. Regarding the relapse of CTEV after Ponseti correction, it is contributed solely to the noncompliance with the abduction brace and it stands same with our study where noncompliance with the brace resulted in recurrence of deformity.

Conclusion

Club foot being the commonest foot deformity, its necessary to diagnose it early, preferably in antenatal scans. This will help patient to seek early intervention for its correction. It was found that when Pirani's score kept constant the factor affecting the outcome is the time since birth when first cast was applied.

There are many existing anatomical alteration in form of smaller foot size, small great toe, weak peronei etc. these all needs to be evaluated further in future and their impact on CTEV correction, its relapse and performance of foot in future.

The adherence to the abduction brace after correction is the single most important factor to prevent development of the relapse, parents' motivation and counseling plays important role in following the bracing protocol.

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