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Original Research Article

STUDY OF CONGENITAL CLUBFOOT IN NEWBORNS

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ABSTRACT

Background: Clubfoot or CTEV is one of the most common serious congenital musculoskeletal anomalies with a worldwide incidence of 1 in 1000 live births. Approximately 80% of clubfoot occur as isolated birth defects and are considered idiopathic. Males are more frequently affected (2:1 male to female ratio), bilateral in approximately 50% of all cases, and the right foot is more often affected in unilateral cases.

Materials and Methods: The study was done at Mysore Medical College & Research Institute, Mysore, for a period of one year during which period, 12,753 newborn babies were examined which included live births and still births.

Results: The total number of cases with clubfoot were 24 with an incidence of 1.9/1000 births. 45.9% of cases were observed in mothers belonging to age group of 21-25 years, CTEV was more common in first para (50%). Occurrence of clubfoot was more common in male neonates than in female neonates (Male: Female ratio, 1:0.85), common in singletons (95.8%) than in twins, bilateral CTEV (75%) was more common than unilateral CTEV, consanguinity was (5/24, 20.8%), CTEV not detected by antenatal USG was (14/24, 58.3%). Risk factors associated with CTEV were oligohydramnios (8.3%), spina bifida (4.16%) and PIH (4.16%).

Conclusion: The incidence of CTEV is low compared to other studies. CTEV was more common in first para and in younger mothers. Significant number of cases were found in singletons, common in males, bilateral CTEV was significantly more common than unilateral CTEV, few cases were associated with history of consanguinity, few cases were detected by antenatal ultrasonography and CTEV was associated with various maternal risk factors commonest being oligohydramnios.

KEY WORDS: Clubfoot, Congenital, Oligohydramnios, Neonates.

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INTRODUCTION

The term 'talipes' is derived from the Latin word: talus (ankle) and pes (foot); equino-"horse like" (the heel in plantar flexion) and varus - inverted and adducted [1].

Clubfoot deformity was documented in early ancient Egypt. Smith and Waren in 1924 found that Pharaoh Siptah of the XIX Dynasty was afflicted with clubfoot. Talipes equinovarus was first introduced into the medical literature by

Hippocrates in 400 B.C [1].

CTEV is defined as fixation of the foot in adduction, in supination and in varus, i.e. inclined inwards, axially rotated outwards and pointing downwards. The calcaneus, navicular and cuboid bones are medially rotated in relation to talus, and are held in adduction and inversion by ligaments and tendons [2].

Many theories have been proposed to explain the etiogenesis of club foot. Hippocrates was the first one to put forth mechanical theory, which postulates that clubfoot results from an elevated intrauterine pressure during pregnancy [2]. Studies by Wynne-Davies R showed that clubfoot is inherited as a polygenic multifactorial trait, which implies that genetic factors do play an important role, but the mode of inheritance is not clear [3]. The connective tissue hypothesis suggests that a primary abnormality of the connective tissue is responsible for CTEV which is supported by the association of CTEV with joint laxity (Wynne-Davies R, 1964) [4]. Ippolito & Ponseti (1980) documented the presence of increased fibrous tissue in muscles, fascia, ligaments and tendon sheaths and concluded that a retracting fibrosis might be a primary aetiological factor [5]. Atlas et al. (1980) studied vasculature in clubfoot and documented vascular abnormalities in all deformed feet of 12 foetuses. At the level of the sinus tarsi there was blocking of one or more branches of the vascular tree of the foot and was most conspicuous in the early period of foetal life, and reduced to a simple knot of fatty infiltration and fibrous tissue in older specimens and the stillborn. Individuals with idiopathic congenital talipes equinovarus have muscle wasting of the ipsilateral calf, which may be related to reduced perfusion through the anterior tibial artery in development [6].

Von Volkmann in 1863 proposed a theory of arrested fetal development which states that the foot is normally in equinovarus and corrects to a pronated foot at birth. The development of the fetal foot is arrested because of an intrinsic error or an environmental insult, which retards the correction of the physiological position to the normal pronated foot and results in the clubfoot seen at birth [7]. Adams (1873) was the first to report that the disease tended to be familial. Family surveys of congenital club foot were made with contradictory conclusions such as autosomal recessive inheritance (Fetscher,1921; Idelberger, 1939), sex-linked recessive inheritance (Isigkeit, 1927) and autosomal dominant inheritance with reduced penetrance (Palmer, 1964) [8]. According to studies by Gurnett C A et al, clubfoot may result from mutation of transcription factor gene *PITX1* that is involved in early hind limb development [9].

MATERIALS AND METHODS

The study was carried out collecting the data from the Department of Obstetrics & Gynecology and Paediatrics, Cheluvamba Hospital, attached to Mysore Medical College & Research Institute, Mysore, for a period of one year from October 2011 to September 2012, during which period 12,753 new born neonates were examined which included live births and still births. All births after 28 completed weeks were examined for clubfoot deformity within 24-48 hours after birth with a written consent from parents/relatives. The details regarding maternal age, parity, details of antenatal history, gender of the baby, history of consanguinity were recorded as per the proforma and prenatal ultrasonography reports were collected. Photographs and radiographs were taken in necessary situation.

Inclusion criteria: 1. All births after twenty eight completed weeks (live births and still births) with CTEV were included 2. Babies born with other system anomalies along with CTEV were included

Exclusion criteria: Babies born before twenty eight completed weeks were excluded from the study

Statistical methods applied: Descriptive statistics, Chi- square test for goodness of fit.

Fig. 1: Comparison of unilateral v/s bilateral CTEV in different studies.

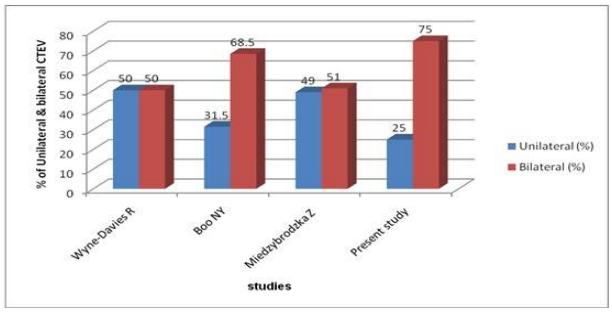

Fig. 2: Bilateral Clubfoot.

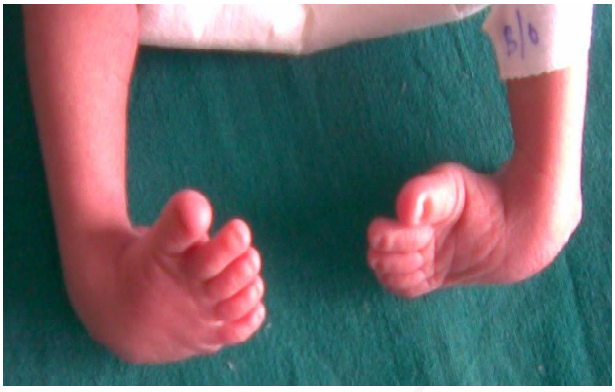

Fig. 3: Radiograph of bilateral clubfoot.

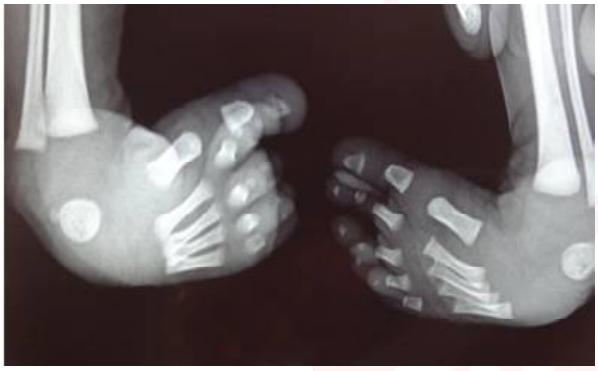

Fig. 4: Baby of Pierre Robin syndrome with CTEV of right foot with oligodactyly (4 toes) and overriding of toes in both feet.

RESULTS AND DISCUSSION

The incidence of CTEV is estimated to be 1-2/1000 births [10]. In our study, the incidence of CTEV is 1.9 per 1000 births which is comparable with studies by Ahuka OL [11] (1.1/1000), Samina Shamim [12] (2.32/1000), Tootoonchi [13] (2.6/1000) and Gupta RK et al. [14] (2.5/1000). The incidence of CTEV is higher in studies by Aigoro NF [15] (7.9/1000) and Hussein AJ [16] (9.68/1000). However, Simpkiss M et al. [17] has documented lower incidence of CTEV (0.48/1000). (Table 2)

Table 1: Incidence of CTEV in India.

Sl. NO.	Author	Region	Year	Incidence (per 1000 births)
1	Dutta v et al. [35]	Rural Maharashtra	2000	1.1
2	**Our study**	**Mysore**	**2012**	**1.9**
3	Gupta RK et al.[14]	Jammu, India	2003	2.5
4	Verma et al. [36]	Ludhiana, India	1991	4.7

Table 2: Comparison of incidence of CTEV with other studies.

Sl. NO.	Author	Region	Year	Incidence (per 1000 births)
1	Simpkiss M et al. [17]	Uganda	1968	0.48
2	Ahuka OL et al. [11]	Democratic republic of Congo	2006	1.1
3	**Our study**	**Mysore**	**2012**	**1.9**
4	Samina shamim et al.[12]	Karachi, Pakistan	2010	2.32
5	Tootoonchi [13]	Tehran, Iran	2003	2.6
6	Ali A et al.[37]	Ahwaz, Iran	2008	3.2
7	Muga RO et al.[24]	Kenya	2009	3.4
8	Van meerder voort [38]	South Africa	1976	3.5
9	Karbasi SA et al.[39]	Yazd, Iran	2009	3.9
10	Tayebi N et al.[40]	Yazad, Iran	2010	4.2
11	Boo NY [25]	Malaysia	1990	4.5
12	Aigoro NF et al. [15]	South-west Nigeria	2009	7.9
13	Hussein AJ [16]	Iraq	2009	9.68

In our study, we found that 12 cases (48%) of CTEV were distributed in the younger age group of 21-25 years and 6 cases (25%) each distributed in the maternal age group of 16-20 years and 26-30 years respectively. we found 12 cases (50%) belonging to first para, 11 cases (45.9%) in para-2 and1case (4.1%) in para-3 and the difference was not statistically significant.

Study by Choudhury AR et al.[18] showed maximum number of CTEV cases distributed in the maternal age group of 25-30 years. Studies by Haruyasu Yamamoto [8] (found 61 cases out of 124 cases (49.1%) of first birth order), Wynne-Davies R (1964) [4] and Chung et al (1969) [19] revealed that maternal age and birth order were not related to the birth of child with congenital club foot.

Out of 24 cases of CTEV, 23 cases (95.8%) were seen in singletons and B/L CTEV was present in one of the (4.2%) dizygotic twins and the difference was statistically significant (chi-square test for goodness of fit, $p<0.0001$). The possibility

of occurrence of congenital club foot in a sibling is 1 in 35 and if present in an identical twin, the risk is 1 in 3 [1].

Lochmiller [20] reported increased incidence of CTEV among twins than in singletons. Engell V et al. [21] studied club foot among 55 twin pairs and found highest percentage of CTEV (22 twin pairs) among dizygotic same sex. Idelberger (1939) carried out a survey of twins and found that congenital club foot was concordant in 4 out of 134 (2.9~) dizygotic twin pairs and in 13 out of 40 (32.5~) monozygotic twin pairs. This result indicated that genetic factors had etiological implications in congenital club foot [8].

CTEV in male and female

Table 3: CTEV- unilateral v/s bilateral, in male and female neonate.

Club foot	No. of cases	Male		Female	
		Cases	Percentage	Cases	Percentage
Unilateral	6 (25%)	3	50%	3	50%
Bilateral	18 (75%)	10	55.60%	8	44.40%
Total	**24**	**13**		**11**	

(For laterality, Chi-square test for goodness of fit, p<0.0001)

CTEV has a male predominance of 2:1[10]. We found highest number of CTEV cases in males but the difference was not significant statistically (Table 3). Many authors have reported preponderance of CTEV in males. Lochmiller [20] found an overall ratio of affected males to females as 2.5:1. Oyinbo CA et al. [22] found the incidence of CTEV four times more common in males compared to females (4:1) and it was statistically significant. Wynne-Davies R [4] reported male to female ratio of CTEV as 2:1, Where as few studies have reported CTEV common in females: Bakare TIB [23] reported CTEV in 5 cases (0.80%) with 3 cases in females and 2 cases in males. Muga RO [24] reported equal incidence of CTEV in males and females (12 cases each). Choudhury AR et al. [18] found no significant correlation between occurrence of CTEV and sex ratio.

The occurence of bilateral CTEV is estimated to be about 50% [10]. In our study among 24 cases of CTEV, 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. Thus B/L CTEV was more common than unilateral CTEV and it was statistically significant (Table 3).

Miedzybrodzka Z [2] reported 51% cases of B/L CTEV and 49% of unilateral CTEV of which 29% had the right foot affected and 22% had the left foot affected. Wynne Davis R reported 50% cases of CTEV being bilateral. Boo NY [25] found 68.5% (26/38) of CTEV cases being bilateral. (figure : 1 shows comparison of unilateral v/s bilateral CTEV in different studies).

Gurnett C A et al. [9] (2008) described a 5-generation family with asymmetric right-sided predominant clubfoot segregating as an autosomal dominant condition with incomplete penetrance. They found a region on chromosome 5q31 that was common to all family members affected and identified PITX1 E130K mutation in a gene critical for early limb development. The PITX1 mutation was found in all affected family members and incomplete penetrance was noted with the presence of five carrier females which is consistent with the lower incidence of idiopathic clubfoot in females.

Alvarado et al. [26] performed an MRI of the lower limbs of a patient with unilateral clubfoot from the family originally studied by Gurnett C A et al. (2008), and observed a reduction in the overall size of the affected clubfoot limb, with reduced muscle and bone volumes. The limb was more severely affected below the knee. Although all muscle compartments were involved, the anterior compartment containing the tibialis anterior muscle was particularly small and partially replaced with fat. Magnetic resonance angiography demonstrated diminution of the anterior tibial and peroneal arteries on the affected limb compared with the unaffected limb. In our study, 10 cases of CTEV (41.4%) out of 24 were diagnosed by antenatal ultrasound. Bakalis S et al. [27] has reported an incidence of fetal talipes following ultrasound examination as 0.10%. Gaetano Pagnotta et al [28] studied 6351 pregnant women and found 41 clubfeet by antenatal ultrasound in 27 pregnancies in the early part of the second trimester of pregnancy. Though clubfoot can be diagnosed at 18-20 weeks of gestation by antenatal ultrasonography, this is only 80% accurate. If the antenatal diagnosis is made at <20 weeks, some authors [29,30] have suggested amniocentesis

because of the high incidence (14.2%) of associated genetic anomalies, such as Trisomy 18, Larsen's syndrome, neural tube defects and congenital heart defects but high false positive rate of the ultrasound and the associated risk of foetal loss with amniocentesis have to be considered [7].

In our study, 5/24 cases (20.9%) belonged to consanguineous couples and 19/24 (79.1%) belonged to non-consanguineous couples. All 5 neonates had B/L CTEV deformity. No instance of consanguineous marriage was encountered among parents of the probands in the study by Haruyasu Yamamoto [8].

Lochmiller C et al. [20] in his study reported a family H/O CTEV in 24.4% of all propositi studied. Haruyasu Yamamoto [8] reported family H/O CTEV in three families, in two of the latter the father was affected and in one the mother was affected. But in our study there was no family H/O CTEV in any of the cases with CTEV malformation.

The various risk factors associated with CTEV in our study were oligohydramnios in 2 cases (8.3%), spina bifida in 1 case (4.16%) and PIH in 1 case (4.16%). Hoffa suggested that CTEV occurs due to oligohydramnios sequence; reduced amniotic fluid volume causes uterine restriction which in turn causes restriction of foetal foot movement thus causing CTEV [2]. In our study there was H/O of oligohydramnios in 2 cases and supports the hypothesis.

Association of CTEV with spina bifida has also been reported. Abnormal nerve conduction was reported in 18 of 44 cases of CTEV, with 8 of these 18 cases having abnormality at the spinal level [31]. We found one case of CTEV associated with spina bifida. Gaetano Pagnotta et al reported association of club foot with neural tube defects in 6 patients by antenatal ultrasonography [28]. Parker SE et al. [32] reported significant association of CTEV with maternal diabetes mellitus and smoking.

Many authors have reported association of CTEV with other anomalies. Muga RO [24] reported one case of B/L CTEV associated with Prune belly syndrome, posterior urethral valves and hydroureters. We found 1 case of meningomyelocele with bilateral CTEV, the baby also had Arnold Chiari malformation and dilatation of lateral ventricles of brain as revealed by antenatal USG.

Alsulaimani AA [33] has reported 1 case of multiple malformations which had spina bifida with hydrocephalus and club foot. We also found 1 case of hydrocephalus with spina bifida and B/L CTEV. Wynne-Davies R [4] reported association of CTEV with Pierre Robin syndrome. One baby presented with Pierre Robin Syndrome with three classical features i.e. micrognathia, glossoptosis and cleft palate. The baby also had associated CTEV of right foot with oligodactyly (4 toes) and overriding of toes in both feet (Figure - 4). Studies have shown that PITX1 inactivation also leads to loss of bones derived from the proximal part of the mandibular mesenchyme apart from impairment of hind limb development suggesting the role of PITX1 gene in hind limb patterning and mandible development [34].

CONCLUSION

Congenital clubfoot leads to disability and handicaps. The birth of an infant with CTEV, whether diagnosed antenatally or not, evokes an emotional parental response. Parents are likely to feel anxious and guilty on learning of the existence of CTEV and require sensitive counselling. Prenatal ultrasonography can detect CTEV which can later be followed by adequate treatment at the earliest. Early recognition of CTEV at birth is important as appropriate measures can be taken to correct CTEV. Furthermore, implication of a transcription-factor gene involved in early hind limb development suggests additional pathways for the future investigation of idiopathic clubfoot etiology in humans.

ABBREVIATIONS

CTEV - Congenital Talipes Equinovarus
PIH - Pregnancy Induced Hypertension
USG - Ultrasonography
MRI - Magnetic Resonance Imaging
H/O - History of

Conflicts of Interests: **None**

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