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Vetrivel Chezian Sengodan
Director and Professor, Institute of Orthopedics and Traumatology, Coimbatore Medical College and Hospital, Coimbatore, Tamil Nadu, India

B Anbuvigneshwaran
Institute of Orthopedics and Traumatology, Coimbatore Medical College and Hospital, Coimbatore, Tamil Nadu, India

AS Vijay Krishnan
Institute of Orthopedics and Traumatology, Coimbatore Medical College and Hospital, Coimbatore, Tamil Nadu, India

Corresponding Author:
Vetrivel Chezian Sengodan
Director and Professor, Institute of Orthopedics and Traumatology, Coimbatore Medical College and Hospital, Coimbatore, Tamil Nadu, India

Reaching the unreached- success story in the management and research in club foot in a government medical college hospital in India. A model for other government hospitals

Sengodan VC, Anbuvigneshwaran b and Vijay Krishnan AS

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Abstract
Background: Congenital Talipes Equinovarus (CTEV), or clubfoot, is a prevalent birth defect occurring in 1 in 1,000 live births. If untreated, it causes lifelong disability. This study evaluates the management and genetic research of clubfoot at the Government Coimbatore Medical College and Hospital (CMCH), India.
Materials and Methods: A longitudinal study was conducted between 2011 and 2025 involving 581 children (345 male, 236 female) aged up to 10 years. Treatment followed the gold-standard Ponseti technique, utilizing serial casting and, where necessary, percutaneous tenotomy of the tendoachilles. Additionally, genetic analysis was performed on blood samples from 50 children to identify Single Nucleotide Polymorphisms (SNPs) in the PITX1 gene.
Results: Out of 581 children, only 105 (18%) required surgical tenotomy to achieve a plantigrade foot, a significantly lower rate than other Indian studies (ranging from 84% to 100%). Genetic results identified 27 different SNPs. Specifically, the Chr5:135031277 C>T mutation was significantly associated with isolated clubfoot, being 2.26 times more likely to occur than previously reported pathogenic mutations in this population (P=0.0463).
Discussion and Conclusion: The success of the CMCH model is attributed to early intervention, meticulous serial casting without limiting the number of applications, and dedicated parent counseling. The study demonstrates that the Ponseti technique remains highly effective in high-volume public health settings. Furthermore, the genetic findings suggest regional variations in the genetic "drivers" of clubfoot in the Indian demographic

Keywords: CTEV, Ponseti technique, PITX1 gene

Introduction
Congenital Talipes Equinovarus (CTEV), or clubfoot, is a complex, three-dimensional musculoskeletal deformity characterized by a specific set of malalignments: midfoot cavus, forefoot adductus, hindfoot varus, and ankle equinus. It is one of the most prevalent congenital birth defects, occurring in approximately 1 in every 1,000 live births globally. If left untreated, the condition results in severe physical impairment, as the child is forced to walk on the lateral aspect or the dorsum of the foot, leading to chronic pain, secondary skin callosities, and lifelong disability. The primary aim of this study is to explain the management and research in clubfoot and achievements at Institute of Orthopaedics and Traumatology (IOT) at Government Coimbatore Medical College and Hospital (CMCH), under the leadership of Prof. S. Vetrivel Chezian. The aim is to ensure that every affected child can achieve a plantigrade, "near-normal" foot, allowing them to walk without assistance and integrate fully into society. By prioritizing early intervention, the institute seeks to eliminate the long-term socio-economic burden of locomotor disability in the Indian population.

Materials and Methods
The study was done in Institute of Orthopaedics and Traumatology, Government Coimbatore Medical College Hospital, Coimbatore. The study period was between 2011 to 2025.Total

number of children in the study group was 581 in the age group of new born up to 10 years of age. In the study group 345 were male and 236 were female. Among 581 children, surgical procedure was done for 105 children to correct the deformity. Children with club foot were included in our study. Children with plantigrade foot were excluded in our study.

Fig 1: Before and after correction of a child with club foot by Ponseti method

Blood sample from 50 isolated club foot children were analysed to identify the genetic pathway in club foot under Prof. S. Vetrivel Chezian, Director, Institute of Orthopaedics and Traumatology using Multidisciplinary Research Unit in Coimbatore Medical College

Fig 2: Before and after correction of a child with club foot by Ponseti method and tenotomy of tendoachilles

Fig 3: Club foot clinic was conducted even during COVID 19 pandemic

Fig 4: Child wearing CTEV splint post correction

Results

The gold standard Ponseti technique was used in our study to correct the foot deformity [1]. After Ponseti technique, the persistence of equinus deformity is corrected by percutaneous tenotomy of tendoachilles and foot is maintained in plantigrade position with plaster of paris (Figure 1). In our study 581 children were treated conservatively using Ponseti technique and 105 children out of 581 children percutaneous tenotomy of tendoachilles was done to correct the deformity (Figure 2). Regarding genetic research in club foot, a study was done to find out the prevalence of Single nucleotide polymorphism in PITX1 gene that are associated with isolated clubfoot babies in Indian population. In our results The Chr5:135031277 C>T type mutation is 2.26 times more likely to happen than the Chr5:135031290 C>T mutation group in Indian population. The z-statistics which tested the odds ratio is 1.992 which is significant as the probability is less than 0.05 (P=0.0463) [2].

Discussion

Club Foot Clinic as a Sub speciality clinic in Orthopaedics was started in 2011 [3]. It is functioning on Thursdays after 12 PM every week. During Covid pandemic the club Foot Clinic (Figure 3) was operational to alleviate the suffering of parents and to prevent foot deformities among children with club foot. Newborn children are treated since birth. The grandmother and mothers are provided psychological counselling and gentle manipulation of the club foot during breastfeeding. Once the skin condition is normal, serial plaster correction was done as per Ponseti technique. Pirani scoring was done for the children to evaluate the club foot deformity collection. Once the child foot is corrected to Plantigrade position, it is maintained with splints (Figure 4). In Ponseti technique series of plaster casts are applied. The first is supination cast to correct cavus foot deformity by elevating the head of metatarsals and applying plaster cast. These are followed by abduction cast to correct forefoot adduction and varus deformity by applying pressure to head of talus and using it as fulcrum to achieve the cast position. Persistent equinus deformity is corrected by percutaneous tenotomy of tendoachilles. The club foot clinic was operational even during COVID 19 Pandemic with the help of administration by Prof. S. Vetrivel Chezian, to alleviate the sufferings of the parents with club foot when private hospitals were closed in India.

The efficacy of the Ponseti technique in the Indian healthcare landscape is well-documented across multiple high-volume longitudinal studies. Malhotra *et al.* (Rohtak), in one of the largest Indian cohorts involving 356 patients (402 feet) over four years, reported a nearly universal tenotomy rate of 92-100% [4]. Similarly, Shah *et al.* (Ahmedabad) and Sud *et al.* (New Delhi) demonstrated high success rates in smaller cohorts (96 and 45 patients, respectively) with tenotomy requirements exceeding 86% [5, 6]. These findings suggest that while the casting phase is highly effective, percutaneous Achilles tenotomy remains a nearly mandatory procedural step for achieving successful dorsiflexion in the Indian population.

The adaptability of the protocol to "neglected" cases is a unique focus of Indian literature. Studies by Sinha *et al.* and Mehtani *et al.* (New Delhi), with follow-ups extending beyond two years, consistently report a 100% tenotomy rate in walking-age children (up to 25 patients), underscoring the necessity of surgical tendon release as chronicity increases [7, 8]. Furthermore, contemporary data from Agarwal *et al.* (New Delhi) confirm that even in shorter-duration prospective studies (18-24 months), tenotomy rates remain high (84-85%) [9].

But in our study we used a large sample size of about 581 children which is the first study conducted in India with such a large sample size. Our tenotomy conversion rate was also

much lower which is only 18% when compared with other studies conducted in India (Table 1).

By meticulous planning and serial correction by Ponseti technique without giving weightage to number of plaster applications since entire treatment is free of cost in our institution. In an average more than 10 plaster corrections are necessary to get plantigrade foot.

Early identification of club foot and correction of deformity as per Ponseti technique is the secret behind our success rate in club foot with reduction in tenotomy. Dedicated orthopaedic team, counselling of patients about lengthy conservative management about the plasters, the free club foot treatment without any expenditure to the family and the serial plaster correction by Ponseti technique without bothering about the number of plaster corrections in club foot are the key factors behind lower incidence of tenotomy in our study.

In our club foot study On interpretation of our results 27 different single nucleotide polymorphisms were found prevalent in pitx1 gene of isolated club foot patients among which Chr5:135031277 C>T mutation with reference sequence id rs 987364689 was significantly associated with isolated non-syndromic club foot babies which is 2.26 times more likely to happen than the already reported Chr5:135031290 C>T mutation group. The findings of this study offer a localized genetic perspective that builds upon established global research. While general studies by Alvarado *et al*. and Gurnett *et al*. have estimated the heritability of isolated clubfoot at approximately 30% [10, 11], Sengodan *et al*. specifically examined the Indian population to identify unique markers. Although previous research by Gurnett *et al*. highlighted the E130K mutation in the PITX1 gene as a key factor, this study identified 27 different polymorphisms in Indian subjects.

Notably, Sengodan *et al*. found that the Chr5:135031277 C>T mutation was significantly more prevalent in their sample, occurring 2.26 times more frequently than the mutations typically reported as pathogenic in global literature (P=0.0463) [2]. This suggests that while global studies confirm a genetic basis for the condition, the specific genetic "drivers" may vary by region, with the C>T variant playing a more prominent role in the Indian demographic (Table 2).

Table 1: Comparison of various studies conducted on treatment of clubfoot by Ponseti technique

Study	Place	Sample size (patients)	Tenotomy rate	Study duration
Malhotra *et al* [4]	Rohtak	356	92 to 100%	4 years
Shah *et al* [5]	Ahmedabad	96	86.4	2 years
Sud *et al* [6]	New Delhi	45	91	2 years
Sinha *et al* [7]	New Delhi	25	100	7 years
Mehtani *et al* [8]	New Delhi	41	94	18.6 months
Agarwal *et al* [9]	New Delhi	28	85	2 years
Our study	Coimbatore	581	18	11 years

Table 2: Comparison of various studies with our study on genetic pathway of club foot

Feature	Reported Studies	Our Study
Demography	USA, China, UK	India
Primary Focus	General heritability, twin concordance, and ethnic prevalence.	Specific PITX1 gene single nucleotide polymorphisms (SNPs) in Indian babies (first of its kind study in India)
Genetic Focus and Significance	Mutation c.388G/A (substitution of lysine for glutamic acid). Chr5:135031290 C>T is already reported as pathogenic.	Mutation Chr5:135031277 C>T and Chr5:135031344 G>C. Chr5:135031277 C>T is 2.26x more likely than the pathogenic control ($P=0.0463$).
Prevalence Data	0.39/1000 in Chinese; 7/1000 in Hawaiians/Maoris.	Confirms global baseline of ~1 in 1000 live births.
Heritability Estimates	Estimated at around 30% based on twin/familial data.	Aimed at improving Indian-specific genetic knowledge and to improve management.
Sample Demographics	Consistent 2:1 male-to-female ratio across ethnic groups.	32 males and 18 females (approx. 1.7:1 ratio) in a 50-baby sample.

Conclusion

The gold standard Ponseti technique is useful to correct club foot deformities and to prevent foot deformities and disabilities. Our study with largest sample size in India proves this to great extent even with less tenotomy conversion rate. A multicentric study with big sample size will confirm our single nucleotide polymorphisms in PITX1 gene

Conflict of Interest

Not available

Financial Support

Not available

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