ORIGINAL ARTICLE

# Functional Outcome of Modified Steen Beek Foot Abduction Brace in the Maintenance of Corrected Congenital Talipes Equino Varus by Ponseti Method

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## Abstract

**Background:** Clubfoot, also known as Congenital Talipes Equinovarus (CTEV), is a foot abnormality that affects more men than women. Non-surgical treatment is possible, with the Ponseti approach being one of the most widely used. This study assessed the efficiency of the Modified Steen Beek Foot Abduction Brace (FAB) in maintaining CTEV correction in children under two years old.

**Methodology:** This research study was carried out at APPNA Rehabilitation Institute of Benazir Bhutto Hospital, Rawalpindi, where 29 patients who were given the Ponseti treatment were purposively sampled. Only samples of children up to the age of 2.5 years with idiopathic CTEV were taken. Assessment on the first visit was recorded using the Pirani score system and again after intervention. The data were analyzed using SPSS version 21.0, where descriptive statistics and paired t-tests were applied.

**Results:** Of the 29 patients, 26 completed the intervention. The average initial Pirani scores were 2.50 for the right foot and 2.00 for the left; they improved to 0.19 and 0.15 after the intervention. The change in the Pirani score was statistically significant ($p<0.000$). Compliance with bracing was 84.6%, while skin blistering occurred in 19.2% of the cases. A correction was maintained in 88% of the cases.

**Conclusion:** The Modified Steen Beek FAB is an effective brace in maintaining the corrected CTEV using the Ponseti method. Early diagnosis and proper material selection, proper sizing of the braces, and detailed counselling of the parents are paramount for the effective management of bracing.

***Keywords***
*Bracing, Club Foot, Compliance, Ponseti Method.*

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## Introduction

Clubfoot, or Congenital Talipes Equino Varus (CTEV), is a foot malformation present from birth[1-2]. It occurs in 0.39 to 6.8 per 1,000 live births, with males affected 2.5 times more often than females[3]. Clubfoot can occur as an isolated (idiopathic) condition or be linked with other primary congenital diseases such as meningomyelocele, arthrogryposis, or syndromic conditions[4].The cause of CTEV may be linked to intrauterine moulding, genetic defects, and developmental arrest during pregnancy, and neurogenic, myogenic, or vascular abnormalities[5].

CTEV is not considered an abnormality during embryonic development. A foot that is typically developing can become a clubfoot during the second trimester of pregnancy. It is rarely detected before the 16th week of pregnancy using ultrasonography. Clubfoot is considered a deformity that develops along with developmental hip dysplasia and idiopathic scoliosis[5].In CTEV, the ligaments in the posterior and medial ankle and tarsal areas thicken and shorten. This severely limits the foot's motion, causing it to be pointed while the navicular and calcaneus bones are turned inward. In more severe cases, the calf muscles (gastrocnemius and soleus) in the upper calf are underdeveloped. Additionally, the overproduction of collagen in the ligaments, tendons, and muscles can persist until the child is 3 or 4 years old, making relapses possible[6]. When viewed under a microscope, the collagen fibre bundles have a wavy appearance known as crimp, which allows the ligaments to be stretched, enabling manual deformity correction.

Several methods have been used to treat clubfoot, including gentle and forceful manipulation, plaster casts, strapping, splinting, passive motion, and sometimes surgery[7]. The Ponseti technique is widely accepted and has high success rates. It involves using a series of casts to correct the foot deformity, followed by a minor surgical procedure called percutaneous Achilles tenotomy if needed[8-12]. After the initial correction, a foot abduction brace is used until the child is five years old to prevent the deformity from coming back[13-14]. A study presented the treatment of 100 feet in 66 children with congenital idiopathic clubfoot using the Ponseti method. It used the standard Ponseti protocol and, as needed, performed percutaneous Achilles tenotomy under general anaesthesia. The assessment was conducted using the Pirani score system, with a mean follow-up period of 18 months. Tenotomy was necessary for 85 out of 100 feet. Of the 31 feet that relapsed after correct initial correction, 32% were successfully treated with repeat casting and proper application of the foot abduction brace, while 15 required extensive soft-tissue release. Poor compliance with the foot abduction orthosis was identified as the primary cause of failure[15].

The Ponseti method's initial findings and the Steenbeek Foot Abduction Brace (FAB) effectiveness were reviewed in 110 children with idiopathic clubfeet. The evaluation used the Dimeglio-

Bensahel classification and the Pirani scoring system. At the end of the casting period, excellent results were reported in 99 feet (89%). A good correction was maintained in all assessed feet, indicating that the Ponseti method, when applied with the Steenbeek FAB, is highly effective with full-time bracing for the first three months and part-time bracing at night[16]. However, there is limited evidence supporting brace intervention despite its recognized effectiveness. Therefore, this study aimed to establish the functional outcome of the modified Steenbeek FAB in managing corrected CTEV using the Ponseti method.

# Methodology

## *Study Design*

This study aimed to evaluate the effectiveness of the modified Steenbeek FAB in maintaining the correction of CTEV after initial treatment using the Ponseti method.

## *Study Setting and Sampling*

The study occurred at the APPNA Rehabilitation Institute of Benazir Bhutto Hospital, Rawalpindi, where 29 patients who had received the Ponseti treatment and met the inclusion criteria were selected via purposive sampling technique.

## *Eligibility of Participants*

### *Inclusion Criteria*

- Children up to 2.5 years old
- Diagnosed with idiopathic CTEV
- Treated by the Ponseti method from the beginning
- Good compliance with bracing
- No history of skin blistering
- Availability of Pirani score at initial and final presentations.

### *Exclusion Criteria*

- Patients with associated congenital anomalies such as meningomyelocele, arthrogryposis, and spina bifida.

## *Ponseti Method*

The Ponseti casting approach involves weekly manipulation and casting to address the precise patho-anatomy of CTEV. The key steps are as follows:

1. By rotating the first metatarsal, the initial cast corrects the cavus, aligned with the other metatarsals, and the forefoot and hindfoot are aligned.

2. Foot inversion is addressed by rotating the foot below the ankle bone, securing it in the ankle joint, placing a thumb on the ankle bone as support, and applying outward pressure to the first metatarsal and cuneiform.

3. The calcaneocuboid, talocalcaneonavicular, and posterior talocalcaneal joints are gently manipulated before a cushioned plaster cast is applied.

4. To address the equinus, the foot is dorsiflexed, and the heel is placed in a neutral or slightly inward position. This process may require two to three casts. If at least 15° of passive dorsiflexion is not achieved, the Achilles tendon is released through a surgical procedure performed under local anaesthesia. Subsequently, a toe-to-groin cast is applied for three weeks.

### *Intervention*

In this study, the intervention involved using a modified Steenbeek FAB following the correction of CTEV using the Ponseti method. The protocol included the following steps:

- After the initial correction with the Ponseti method, the modified Steenbeek FAB was applied to maintain the corrected position of the feet.

- Regular follow-up visits were scheduled to monitor the condition of the feet and adjust the brace as needed.

- Periodic counselling sessions were conducted with parents to ensure proper usage of the brace and address any compliance-related issues.

### *Pirani Score System*

The Pirani score was used to assess the severity of CTEV. A higher score indicated increased limb deformity. This scoring system was used during the initial screening and the post-intervention stages to compare treatment effectiveness.

### *Statistical Analysis*

Data collected were analyzed using SPSS version 21.0. Statistical methods applied included descriptive statistics and paired t-tests to compare initial and final Pirani scores.

### *Ethical Considerations*

The research project was conducted according to ethical guidelines and approved by the institutional ethics committee, and consent was obtained from all participants' parents or guardians. The patients' data recorded during the study were kept confidential and anonymous.

## Results

Of 29 patients, 26 completed the intervention, as 3 patients were discontinued due to medical complications. Of those who completed the study, 10 were female, and 16 were male. Among

these patients, 18 had bilateral CTEV, affecting a total of 38 feet. The remaining cases involved 4 right feet and 3 left feet with unilateral CTEV. The age of the patients at enrollment ranged from 1 to 13 months, with a mean age of 5.3 months.

## *Pirani Scores*

The initial and final Pirani scores for both the right and left feet were recorded and analyzed. The mean initial Pirani score for the right foot was 2.50, and for the left, it was 2.00. After applying the Steenbeek FAB, the mean final Pirani score for the right feet was 0.19, and for the left, it was 0.15. The mean change in the Pirani score was 2.00. The paired sample t-test for the before and after Pirani scores resulted in a statistically significant ($p<0.000$), indicating improvement (Table-1).

**Table-1 Pirani Scores**

| Foot Sides | Mean±S.D |
|---|---|
| **Right** | |
| **Initial PS** | 1.46±0.88 |
| **Final PS** | 0.38±0.55 |
| **Left** | |
| **Initial PS** | 1.15±0.90 |
| **Final PS** | 0.19±0.42 |

## *Compliance and Complications*

Of the 26 cases, 4 (15.4%) were non-compliant with the bracing protocol, while 22 were compliant. Skin blistering was observed in 5 cases (19.2%). Notably, the correction of CTEV was maintained in 88% of the cases (Table-2).

**Table-2 Post-intervention Effects**

| Variables | n (%) |
|---|---|
| **Commonly Affected Side** | |
| **Left** | 3 (11.5%) |
| **Right** | 4 (15.4%) |
| **Bilateral** | 18 (69.2%) |
| **Compliance** | |
| **Non-Compliance** | 4 (15.4%) |

| | |
|---|---|
| **Compliance** | 22 (84.6%) |
| **Skin Blistering** | |
| **Present** | 5 (19.2%) |
| **Absent** | 21 (80.8%) |
| **Maintenance of Correction** | |
| **Yes** | 21 (88.8%) |
| **No** | 4 (15.4%) |

## Discussion

Bracing is crucial for maintaining the correction from the Ponseti method for CTEV. The brace helps keep the foot in the correct position and maintains it in that position after correction. If bracing is not done as scheduled, the likelihood of recurrence is nearly 100%. Non-operative management, precisely the Ponseti method, has gained substantial acceptance as the primary initial treatment for this deformity. This approach, particularly during the early months of life, has demonstrated high success rates in young children. This research study aimed to assess the functional outcome after using a modified Steen Beek FAB following the initial Ponseti method treatment in children under two years of age.

The study results show that a modified Steen Beek FAB effectively maintains corrected CTEV. The success of the brace can be attributed to its design, including comfortable straight-laced shoes that fit both feet without curves. Careful selection of materials ensures that the brace is skin-friendly and the right size, preventing skin issues. Moreover, counselling parents has been crucial in ensuring compliance with the bracing schedule. This highlights the importance of discouraging self-modification of the brace and addressing non-compliance promptly.

Our study showed a male-to-female ratio of 70.3%, close to a study with a male ratio of 68%. Another critical factor determined by this study was a relapse rate of over 80% in the absence of good bracing compliance[17]. In our series, with good parental counselling, we had a non-compliance rate of only 15.4%. The percentage of bilateral involvement in our study was 69.2%, slightly higher than Gupta et al.[18] study of 60%. Skin damage was generally mild and superficial, and its prevention included soft, inline materials.

Despite the favourable outcomes, there were some limitations to the study. The multi-centre study being conducted would provide a better estimate of the frequency and gender distribution of CTEV. Early diagnosis and treatment, including Ponseti management with subsequent bracing, are essential in preventing long-term complications of untreated CTEV. Patient counselling is vital to maintain compliance, which has otherwise been too high. The casting material should also be skin-friendly and have no sharp edges or points, such as soft leather. Educating parents about bracing is also essential for effective management[19].

## Conclusion

The modified Steen Beek FAB has proven to be an effective tool for maintaining corrected CTEV using the Ponseti method. Early diagnosis and treatment are crucial to avoid the complications that arise from untreated CTEV deformity. Essential factors to consider for accurate bracing management are appropriate and skin-friendly materials, precise sizing, and comprehensive counselling. Giving more attention to these factors will lead to better results, reduce relapses, and ultimately improve the quality of life for affected children.

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***Conflict of Interest***

None.

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**AUTHORS' CONTRIBUTION**

The following authors have made substantial contributions to the manuscript as under:

**Conception or Design:** Mumtaz A, Rehman Z

**Acquisition, Analysis or Interpretation of Data:** Rehman Z, Tassadaq N

**Manuscript Writing & Approval:** Mumtaz A, Rehman Z, Tassadaq N

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.