# Treatment of congenital vertical talus by reverse Ponseti technique

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**Background**
Congenital vertical talus (CVT), also known as congenital convex pes valgus, is a rigid flatfoot deformity characterized by fixed hindfoot equinus and an irreducible talonavicular dislocation. This deformity can either be idiopathic and isolated or can occur with other conditions such as neural tube defects (myelomeningocele and spina bifida occulta), neuromuscular disorders like cerebral palsy and anterior horn cell disease, and in chromosomal aberrations like Down's syndrome. The use of serial manipulation and plaster cast treatment followed by minimal surgical interventions has provided good early results in the treatment of idiopathic CVT. The method of cast correction of a vertical talus is based on a specific way of manipulating the foot so as to gradually reduce the talonavicular joint. The principles are similar to those used in the Ponseti method of clubfoot correction.
**Aim of the study**
To evaluate the management and the outcome of patients with CVT managed with reverse Ponseti technique, and minimal surgical intervention.
**Patients and methods**
This prospective study included 25 feet in 17 patients with CVT, comprising eight patients with bilateral and nine with unilateral involvement. The study was done at the new Children Hospital Cairo University between January 2013 and December 2015. The follow-up period ranged from 10 to 14 months, with an average period of 11.6 months. Inclusion criteria were patients diagnosed to have idiopathic CVT and no age limit, and exclusion criteria were previous operative release and cases associated with neuromuscular disorders or syndromes.
**Results**
Three (12%) cases were classified as excellent, 12 (48%) cases were classified as good, eight (32%) cases were classified as fair, and two (8%) cases were classified as poor.
**Conclusion**
Favorable results were obtained using the reverse Ponseti method of closed manipulation and then limited open reduction and fixation with a pin in the talonavicular joint and percutaneous Achilles tenotomy. There were also fewer complications compared with extensive operative treatments, by avoiding more extensive surgery.

**Keywords:**
reversed Ponseti technique, serial casting, talonavicular joint, vertical talus

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## Introduction

Congenital vertical talus (CVT), also known as congenital convex pes valgus, is a rigid flatfoot deformity characterized by fixed hindfoot equinus and an irreducible talonavicular dislocation. This deformity can either be idiopathic and isolated or can occur with other conditions such as neural tube defects (myelomeningocele and spina bifida occulta), neuromuscular disorders like cerebral palsy and anterior horn cell disease, and in chromosomal aberrations like Down's syndrome [1]. The foot has a typical rocker bottom appearance, which is owing to the hindfoot equinus and markedly dorsiflexed and abducted forefoot. The tendo-Achilles is taut and ankle dorsiflexors are shortened owing to the everted forefoot. Classical CVT is a rigid deformity, and extensive surgery is usually required to restore foot alignment. Surgery can lead to stiffness, wound complications, undercorrection, and overcorrection [2–4].

The use of serial manipulation and plaster cast treatment followed by minimal surgical interventions has provided good early results in the treatment of idiopathic CVT [5]. The method of cast correction of a

vertical talus is based on a specific way of manipulating the foot so as to gradually reduce the talonavicular joint [6].

The described technique of serial manipulation and cast treatment, pin fixation of the talonavicular joint, and a percutaneous Achilles tenotomy provided good early results in terms of the clinical appearance of the foot, foot function, and radiographic evidence of correction. It is recommended that, as with clubfoot, treatment with manipulations and casts be initiated for idiopathic CVT as soon as the diagnosis is made [5].

This study aims to discuss the management and evaluate the outcome of patients with CVT managed with reverse Ponseti technique, and minimal surgical intervention.

## Patients and methods

This prospective study included 25 feet in 17 patients with CVT, comprising eight patients with bilateral and nine with unilateral involvement. The study was approved by the institutional ethics committee in the Department of Orthopedic Surgery, Cairo University, Cairo, Egypt. The study was done at the new Children Hospital, Cairo University, between January 2013 and December 2015. The follow-up period ranged from 10 to 14 months, with an average period of 11.6 months.

Inclusion criteria were patients diagnosed to have idiopathic CVT and no age limit, and exclusion criteria were previous operative release, and cases associated with neuromuscular disorders or syndromes.

Patients were assessed in the outpatient clinic to diagnose those who are candidates for this series by the following: (a) history: the age, sex, associated anomalies, for example, developmental hip dysplasia (and whether patient had previous operations to correct these associated anomalies or not), and history of previous manipulation and casting or previous surgical release; (b) clinical examination, including general examination, for example, searching for other associated anomalies or systemic neuromuscular disorder or any general debilitating disease, and local examination, for example, rocker bottom appearance, hindfoot equines, hindfoot valgus, forefoot abduction, and forefoot dorsiflexion at mid-tarsal joint, the plantar surface of foot is convex, skin of the foot is examined for callosities, breakdown on pressure area and scars of previous operation, and evaluation of the passive range of motion of the ankle and subtalar joints, whether unilateral or bilateral; (c) radiological assessment: anteroposterior and lateral radiographs (neutral, planter flexion, and dorsiflexion) of the feet are made at the time of presentation, immediately postoperatively, and at the time of the latest follow-up. The anteroposterior radiograph: the talocalcaneal and the talar axis-first metatarsal base angles are measured. The lateral radiographs: the talocalcaneal, tibiocalcaneal, and talar axis-first metatarsal base angles are measured, and comparisons are made between the mean pretreatment and follow-up measurements and between the mean standing and nonstanding (measurements after one year of operation); and (d) laboratory assessment: preoperative investigations including complete blood count and coagulation profile are done.

### Demographic data

Twenty-five feet of 17 patients were included, of whom, eight had bilateral and nine had unilateral affection. There were eight females (four bilateral and four unilateral) and nine males (four bilateral and five unilateral). Overall, 12 feet were right sided and 13 were left sided. The patients' age at presentation ranged from 3 up to 24 months, with an average of 13.5 months. A total of 13 feet were 6 months or less at presentation, seven were 6–12 months, whereas five were less than 2 years. The youngest case was a boy 3 months of age, having his feet bilaterally involved. The oldest case at operation was a 24-month-old boy having his left foot involved.

#### *Serial manipulation and casting*

Cases are dealt with first by the same principles of Ponseti technique in a reversed way (reversed Ponseti technique). First, it should be explained to the parents the steps of management and way of follow-up, and that this will take long time, and also that serial manipulation and casting mostly will be followed by operative procedure, but with help of this technique, it will be minimal.

As with the Ponseti method for clubfoot correction, treatment begins with serial manipulations and casts, but with the forces applied in the opposite direction, and all components of the deformity are corrected simultaneously, except for the equinus, which should be corrected last. The foot is stretched into plantar flexion, inversion and adduction, whereas counterpressure is applied to the medial aspect of the head of the talus. To maintain the correction obtained by gentle manipulation (Fig. 1), a plaster cast is applied in two sections. The first section, a short leg plaster cast extending from the toes to just distal to the knee, is applied first with the foot held in

**Figure 1**

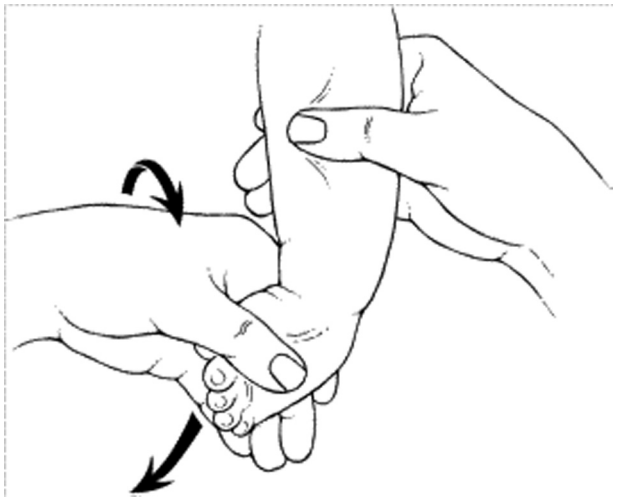


Illustration demonstrating the position of the foot with maximum hindfoot varus and forefoot adduction, with maximum plantar flexion [5].

**Figure 2**

Corrective cast for congenital vertical talus.

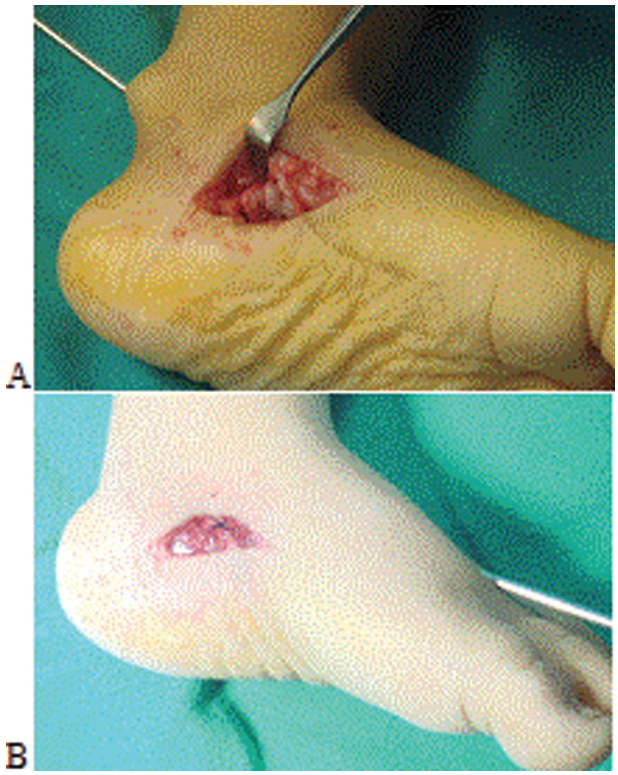
plantar flexion and inversion and with care taken to carefully mold the arch, the malleoli, the head of the talus, and above the calcaneus. Once the plaster has set, the cast is extended to a long leg cast, covering the knee and thigh, with the knee in 90° of flexion (Fig. 2). The casts are changed in the clinic on a weekly basis, and the manipulations are the same before the application of each cast. When the final cast is applied, it is important to obtain a position of maximum plantar flexion and inversion to ensure adequate stretching of the contracted dorsolateral tendons, joint capsules, and skin. No attempt is made to correct the equinus deformity during this portion of the cast process. During the cast treatment, the foot simulates the position of a clubfoot. A lateral radiograph of the foot should be made while the limb is in the last cast to ensure reduction of the navicular on the head of the talus. As the navicular is not ossified in infants, an indirect radiographic measurement (the talar axis-first metatarsal base angle on the lateral radiograph) is used. After the talonavicular joint has been reduced (a talar axis-first metatarsal base angle in maximum plantar flexion of $<30°$), surgical fixation with a percutaneous Kirschner wire is used to hold the talonavicular joint in the reduced position.

The wire is placed retrograde from the navicular into the talus with the foot held in maximum plantar flexion. The wire is then bent and cut outside the skin to allow removal in the clinic. Accurate placement of the Kirschner wire is based on the surgeon's ability to palpate the head of the talus and the navicular, as those bones are primarily cartilaginous and difficult to visualize radiographically in infants. If the talonavicular joint is not seen to be reduced radiographically (the talar axis-first metatarsal base angle in maximum plantar flexion is $\geq 30°$) after six casts have been applied, then an attempt is made in the operating room to lever the talus into position percutaneously with a Kirschner wire placed into the talus in a retrograde manner. If this is successful, the talonavicular joint is then held with Kirschner wire fixation as described before. If the talonavicular joint cannot be reduced or closed, then a small medial incision is made over the talonavicular joint and a dorsal capsulotomy of the talonavicular joint is performed. Traction is applied to the forefoot in the plantar flexed direction, while thumb pressure is applied simultaneously over the prominence of the head of the talus to medially push the talar head dorsally. Rarely, if the surgeon deems them to be obstacles to achieving an adequate talonavicular reduction, the peroneal brevis tendon and/or tibialis anterior tendon must be fractionally lengthened at the musculotendinous junction. Once the talonavicular joint is reduced and stabilized with the Kirschner wire (Fig. 3), a percutaneous tenotomy of the Achilles tendon is used to correct the equinus deformity. A Beaver eye blade is introduced through the skin onto the medial edge of the Achilles tendon about 1 cm above its calcaneal insertion with the cutting surface of the blade pointed proximally. The undersurface of the tendon is palpated with the tip of the blade, which is then rotated 45° to allow the tendon to be severed from ventral to dorsal. The Kirschner wire prevents loss of reduction of the talonavicular joint as the hindfoot is brought into dorsiflexion (Fig. 4).

Then the wounds are closed in layers with absorbable sutures, and the Kirschner wire is cut off and bent outside the skin. Above-knee cast is applied and

molded to maintain the medial plantar arch. The cast is changed in the outpatient clinic after 10 days to check for wound closure and subsidence of edema then another well-fitting cast is applied. After 8 weeks, the cast and wires are removed. The patient then uses a shoe and bar brace system, which must be worn full time for 2 months and then only at night for 2 years, to prevent relapse. The shoes on the brace are set pointing straight ahead to stretch the peroneal tendons. When a static bar is used (Fig. 5), it is important not to place a dorsiflexion bend in the bar. The dorsolateral soft tissue is tighter than the posterior structures; therefore, it is more important to stretch the foot into plantar flexion. The dynamic bar allows active motion at the knees and ankles and has a spring assist that promotes stretching of the

**Figure 3**

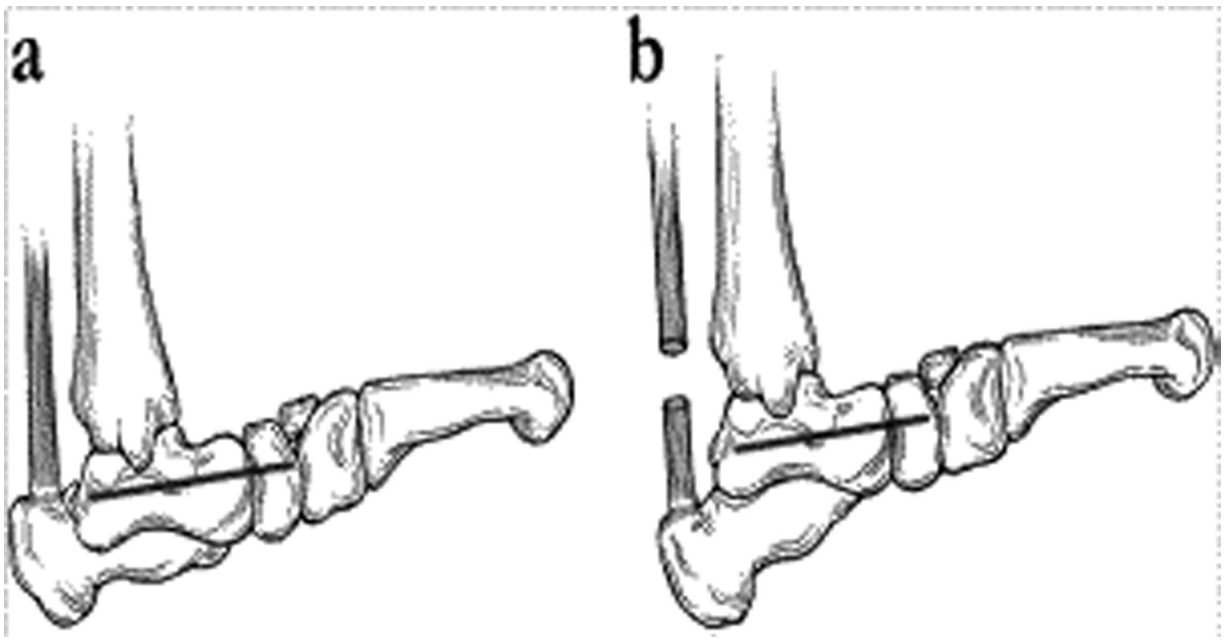



(a) Open reduction of talonavicular joint with direct medial incision, and (b) foot shape after pinning of reduced talonavicular joint showing restoration of medial arch.

**Figure 5**

Ankle-foot splint after correction of vertical talus (static bar).

**Figure 4**




Illustrations of the minor surgical procedures performed to correct the vertical talus deformity. (a) Reduction of the talonavicular with pin fixation. Note the residual equinus of the calcaneus. (b) After a percutaneous tenotomy of the Achilles tendon, there is correction of the equinus of the calcaneus [5].

dorsolateral soft tissues at rest. Parents are also taught foot stretching exercises that emphasize ankle plantar flexion and foot adduction; these exercises are to be performed several times a day at diaper changes to maintain flexibility in the feet. Once patients are old enough to walk, daytime bracing with a solid ankle-foot orthosis is used for support instead of the bar brace system. The patients are followed in the outpatient clinic every month for 1 year. In each visit, the patient is examined both standing and supine. The range of motion of the ankle and subtalar joint is assessed, and anteroposterior and lateral radiographs are obtained.

## Results

### Clinical results

A mean of six casts (five, six, and seven casts) were required to achieve reduction of the navicular onto the head of the talus. All patients required percutaneous Achilles tendon lengthening for correction of the hindfoot equinus. Two patients had fractional lengthening of the tibialis anterior tendon and one has fractional lengthening of the peroneal brevis tendon as part of the initial treatment to help achieve reduction of the talonavicular joint. No patient underwent extensive soft-tissue releases. Most of the parents were satisfied with the appearance of the foot.

The appearance of 22 (88%) feet was cosmetically acceptable. They were plantigrade with well-formed longitudinal arch. However, some flattening was noticed in eight (32%) feet on weight bearing. A reversed arch with recurrence of rocker-bottom deformity was observed in one (4%) foot with callosities beneath the metatarsal heads and the depressed anterior aspect of the calcaneum. The heel posture, viewed from behind during standing, was neutral in 18 (72%) feet, mild to moderate valgus was noted in nine (36%) feet, whereas varus of the heel occurred in the remaining foot, and residual abduction of the forefoot was observed in six (24%) feet with slight concavity of the lateral border. Minimal medial talar prominence was noted in four (16%) feet with neither callosities nor ulceration. The ankle movements were mildly restricted in 10 (40%) feet. No foot with gross equinus or fixed dorsiflexion was observed. Slight equinus occurred in two (8%) feet. The range of passive plantar flexion ranged from 10 to 25°, with a mean of 18±6.5°. Eighteen (72%) feet had some restriction of inversion and eversion. Rigidity of the whole tarsus occurred in one (4%) foot. There were no functional limitations, with painless feet in 17 (68%), mild reduction of activity and occasional pain in five (20%), painful feet after strenuous activity in two (8%), and difficult walking in one (4%). Ordinary footwear was used in all except two (8%) feet which needed special shoe wear (Fig. 6).

**Figure 6**


(a) A 4-month-old male patient with rocker bottom deformity. (b) Lateral radiography view in dorsiflexion, platerflexion, and anterposterior view. (c) Serial casting. (d) Open reduction of talonavicular joint. (e) Postoperative radiography after reduction, Kirschner wire insertion, achilis tenotomy, and casting. (f) Follow-up radiography in reduced position. (g) Correction of deformity.

The results of this series were clinically and radiologically evaluated and assessed according to the point-scoring system described by Adelaar in 1980 and published by Mazzoca in 2001. Adelaar described five clinical points and five radiological points to assess and evaluate the foot with CVT after surgical correction. The maximum score is 10 points, with one point subtracted for each abnormality noted either clinically or radiologically.

### Clinical points

(1) The presence of range of motion of the ankle joint (dorsiflexion and plantar flexion).
(2) Cosmetic appearance (good or bad).
(3) Prominence of talar head (present or absent).
(4) Hindfoot valgus (present or absent).
(5) Abnormal shoe wear (present or absent).

### Radiological points

(1) Anteroposterior talocalcaneal angle (normally 20–40).
(2) Anteroposterior talar axis-first metatarsal axis angle (normally 0–30).
(3) Lateral talocalcaneal angle (normally 25–55).
(4) Lateral tibiocalcaneal angle (normally 55–95).
(5) Lateral talar axis-first metatarsal axis angle (normally 0–20).

A score of 10 points is considered excellent; a score of 7, 8, or 9 points is considered good; a score of 4, 5, or 6 points is considered fair; and a score of 0, 1, 2, or 3 points is considered poor (Table 1).

According to this scoring, the cases were evaluated as follows:

Three (12%) cases were classified as excellent, 12 (48%) cases were classified as good, eight (32%) cases were classified as fair, and two (8%) cases were classified as poor (Table 2).

**Table 1 Application of Adelaar score on case series**

| | Number of patients scored 1 | Number of patients scored 0 |
|---|---|---|
| Range of motion | 22 | 3 |
| Cosmetic appearance | 21 | 4 |
| Prominent talar head | 25 | 0 |
| Hindfoot valgus | 5 | 20 |
| Abnormal shoe wear | 5 | 20 |
| AP TC angle | 19 | 6 |
| AP TAMBA | 15 | 10 |
| Lat TC angle | 20 | 5 |
| Lat tibiocalcaneal angle | 19 | 6 |
| Lat TAMBA | 11 | 14 |

AP, anteroposterior; Lat, lateral; TAMBA, talar axis-first metatarsal base; TC, talocalcaneal.

### Relation between sex and results

There is no statistical correlation between sex and the results ($P$=0.823) (Table 3). $P$ value more than 0.05 is nonsignificant.

There is a strong statistical correlation between age and the results ($P$=0.041). The younger the patient, the better the result (Table 4).

The best score was obtained in children operated upon during the first year ($P$=0.035).

### Side and bilaterally

There was no statistically significant difference in the mean score between the right and left-sided affection ($P$=0.17). Moreover, the difference in the mean score between unilateral and bilateral cases was statistically insignificant ($P$=0.52).

### Hereditary factors

Overall, 35% of cases of idiopathic CVT showed positive family history.

The data are shown as the mean±SD. The Wilcoxon test was used to compare the angles in degrees before and after treatment. The SPSS software program

**Table 2 Radiological data of the study**

| Angle | At presentation | | | Last follow up | | | *P* value |
|---|---|---|---|---|---|---|---|
| | Range | Mean | SD | Range | Mean | SD | |
| AP TC | 30–50 | 41.43 | 5.25 | 15.45 | 25.54 | 8.09 | 0.006 |
| Lat TC | 35–52 | 44.21 | 3.82 | 20–45 | 35.00 | 6.25 | 0.004 |
| Lat TiT | 130–180 | 159.68 | 12.77 | 80–150 | 99.86 | 16.41 | 0.007 |
| Lat TiC | 100–135 | 118.11 | 10.13 | 70–130 | 87.68 | 13.3 | 0.002 |
| TAMBA | 60–90 | 73.64 | 7.36 | –10–45 | 19.93 | 13.62 | 0.008 |

AP, anteroposterior; Lat, lateral; TAMBA, talar axis-first metatarsal base; TC, talocalcaneal; TiT, tibiotalar, TiC-tibiocalcaneal.

**Table 3 Relation between sex and results**

| Result | Sex [*n* (%)] | | Total [*n* (%)] |
|---|---|---|---|
| | Female | Male | |
| Excellent | 1 (12.5) | 2 (22.25) | 3 (12) |
| Good | 2 (25) | 2 (22.25) | 4 (48) |
| Fair | 4 (50) | 4 (44.5) | 8 (32) |
| Poor | 1 (12.5) | 1 (11) | 2 (8) |
| Total | 8 (100.00) | 9 (100.00) | 100.00 |
| *P* value | | 0.823 | |

Data are expressed as frequency and percentage data.

**Table 4 Correlation between age and score**

| Patients | Score | |
|---|---|---|
| | *r* | *P* value |
| Age (month) | –0.417 | 0.041 |

*r*, Pearson's correlation coefficient. *P* value less than 0.05 significant.

(Statistical Package for the Social Sciences, version 17.0, SPSS Inc., Chicago, Illinois, USA) was applied for the statistical analyses. In the present study, *P* value 0.05 was regarded as being statistically meaningful.

### Complications

(1) Pin-tract infection occurred in two patients, but it was controlled by oral antibiotic and frequent dressings.
(2) Wound infection occurred in one patient, and it was controlled by intravenous antibiotics and frequent dressings.
(3) In one case, the talonavicular Kirschner wire was accidentally removed after 3 weeks during cast change and the patient continued by a molded cast for 4 weeks.
(4) Avascular necrosis was not seen in any case till last time of follow-up of each case.
(5) Overcorrection was observed in three cases in the form of cavus deformity. This mild deformity did not affect the patients' daily activities, so it is not taken into consideration.
(6) Skin sloughing did not happen in any case owing to limited skin incision in percutaneous technique for tenotomies.
(7) Two patients started to relapse, one of them started to relapse after 4 months of cast removal and the other one started to relapse after 7 months. A below-knee well-molded cast was applied for these two cases for 2 months.
(8) Pressure ulcers were observed on the site of pressure over the head of the talus. In the series, it was observed only in two cases, which were managed by local treatment and stopping cast for 1 week.

## Discussion

CVT (congenital pes valgus, rigid rocker-bottom flatfoot, and congenital flatfoot with talonavicular dislocation) (CVT) is a rare deformity of the foot [7]. It has no sex predilection, is bilateral in 50% of cases, and the right foot is affected more than the left. It is an isolated deformity, but in more than 50% of cases, a secondary cause is implicated [7].

Radiologically it is defined as dorsal dislocation of the navicular bone on the talus. The exact etiology of CVT remains a mystery [8]. It may be owing to the arrest in the development of foot.

The goal of the treatment of CVT is to restore the normal anatomic relationship among talus, navicular, and calcaneus bones while maintaining a painless plantigrade foot [9].

### Using serial casting and minimal invasive surgery in comparison with extensive surgical procedures

Historically, manipulation and casting have not been fully effective in correcting CVT. According to classical texts and many previous articles, modification of this deformity usually requires releasing a large soft tissue when the patient is 3–4-year old [10]. Subtalar arthrodesis is often required in patients aged 3–8 years, but they experience postoperative stiffness and pain. According to Walker *et al.* [11], a soft tissue release operation had desirable outcomes in CVT. Previous surgical methods have been associated with some complications, including wound necrosis, talar necrosis, undercorrection of the deformity, joint stiffness, and pseudarthrosis. Many of these patients need multiple operations following the primary surgical treatments, such as subtalar and triple arthrodesis, in their future life [11]. Moreover, there is significant controversy about the number and location of ideal incisions to surgically correct the vertical talus, as well as about correcting the deformities in one or two stages. The patients also experience severe limitations of their physical activity [7].

Recent research has indicated excellent vertical talus correction with serial casting followed by a minimally invasive surgery. In the short follow-up time of patients with CVT, treatment with serial casting and minimally surgery has excellent results in the correction of deformity [12]. Eberhardt *et al.* [13] show that the Dobbs method is successful in vertical talus treatment.

The study by Aydin *et al.* [10] had similar manipulation and casting before surgery for idiopathic CVT and obtained good results. David [14] believed that talipes equinovarus (clubfoot) and vertical talus were successfully corrected with manipulation therapy and minimally invasive Achilles tenotomy.

Dobbs *et al.* [5] evaluated a new method of treating idiopathic CVT using serial manipulation and casting, followed by pinning the talonavicular joint and performing percutaneous tenotomy of the Achilles tendon in 19 feet. Their study showed excellent results in the clinical appearance of the foot, its function, and deformity correction, as measured by radiographic measurements over a period of 2 years [5].

Researchers have recently been inspired by the Ponseti method of treating clubfoot, and they developed the reverse Ponseti procedure with manipulation and casting in the talonavicular joint, pinning, and percutaneous Achilles tenotomy (called the Dobbs method), which have shown very good results with favorable short-term follow-up periods [8]. Bhaskar treated four feet among 1-month-old patients with CVT using serial manipulation and casting, Achilles tenotomy, and percutaneous pinning of the talonavicular joint, and indicated the usefulness of following this procedure in preventing the need for extensive future surgery and producing desirable results [8].

#### Discussion of our results in comparison with other studies with the same technique

This study included 25 feet in 17 patients with idiopathic CVT: eight bilateral and nine unilateral. There were nine males and eight female patients. The work was done at the new Children Hospital, Cairo University and National Institute of Neuromotor System, General Organization of Teaching Hospitals in Giza between 2013 and 2015. The follow-up period ranged from 10 to 15 months, with an average of 12.5 months. A mean of six casts were done to achieve correction. Then either closed reduction and percutaneous pinning of talonavicular joint or open reduction through small medial incision and Kirschner wire fixation, fractional lengthening was done to extensors and peronei according to tight structure resisting plantar flexion or adduction.

Results were evaluated according to Adelaar scoring as discussed before: three (12%) cases were classified as excellent, 12 (48%) cases were classified as good, eight (32%) cases were classified as fair, and two (8%) cases were classified as poor.

This study showed similarities and differences in the incidence compared with the literature regarding sex; in this series, the males predominated (nine males and eight females), whereas the literature showed no sex predilection and no relation between sex and results [15]. Regarding bilaterality, this study had eight bilateral and nine unilateral affection, whereas the literature showed that 50% of cases are bilateral [15].

Hereditary factors may play an important role in the etiology of the primary isolated form of the CVT (50% of CVT had positive family history) [6]. However in this study, 35% of the patients were found to have relatives with CVT.

As the world of medicine nowadays is directed to minimally invasive techniques, reversed Ponseti technique is gaining popularity among pediatric orthopedic surgeons since 2006 when Mathew Dobbs and his colleagues announced the results of their new technique on cases of idiopathic CVT at that time.

Aslani *et al.* [16] in their paper named this technique as Dobbs method and also stated that this technique can be done in all cases of CVT like vertical talus associated with genetic syndromes and neuromuscular conditions with a similar rate of success.

Bhaskar [8] in his study recommended early casting for idiopathic CVT along the same lines as the Ponseti technique for clubfoot, except that the forces applied are in reverse direction. This early casting method can prevent extensive surgery in the future; however, close follow-up is required to detect any early relapse.

Owing to the short follow-up time, there were some limitations in this study, such that the long-term outcomes are unknown, and the small sample volume. The mentioned limitations were inevitable because of the low incidence of vertical talus. Therefore, it is recommended to conduct a multicenter evaluation among cases with more patients using this method. The results of this study show excellent results in the treatment of CVT by reverse Ponseti technique. It allows feet corrected early to grow almost normally without occurrence of secondary bony changes.

## Conclusion

Favorable results were obtained using the reverse Ponseti method of closed manipulation and then limited open reduction and fixation with a pin in the talonavicular joint and percutaneous Achilles

tenotomy. There were also fewer complications compared with extensive operative treatments, by avoiding more extensive surgery. It is likely that patients with vertical talus will maintain more flexibility, experience less pain, and have better function, similar to results achieved with minimally invasive approaches for clubfoot. The use of serial manipulation and casting followed by minimal surgical intervention (reverse Ponseti technique) in treatment of CVT is recommended as this avoids extensive foot surgery and its complications.

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**Conflicts of interest**
There are no conflicts of interest.

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