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Original article

Is non-operative management of childhood neurologic cavovarus foot effective?

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ABSTRACT

Introduction: Neurologic pes cavus is a progressive deformity that is difficult to treat during growth. The present study reports results of non-operative management, based on the pathophysiology of the deformity, by untwisting nocturnal splint, preceded in some cases by untwisting walking cast. The objective was to assess efficacy and impact on indications for surgery.
Method: Twenty-three children (35 feet) were included. All had neurologic cavovarus foot, which was progressive in 24 feet (69%) (Charcot-Marie-Tooth disease). Mean age at initiation of treatment was 8.8 years. In 13 feet (38%), treatment began with a untwisting walking cast and in 22 (62%) began directly with the splint.
Results: Mean follow-up was 4.5 years. Fifteen feet showed very good and 8 good clinical results (65%); 9 children (12 feet) had moderate or poor results, requiring renewed treatment in 11 feet at a mean 4.5 years after initiation of non-operative treatment. Thirteen patients (56.5%, 21 feet) had reached end of growth by last follow-up; 10 of these feet (48%) had good or very good results without surgery. No triple arthrodeses were required. Factors weighing against good outcome comprised young age at treatment initiation and poor compliance with the splint. Primary deformity severity did not affect outcome.
Conclusion: The present study demonstrated efficacy for non-operative treatment of childhood neurologic cavovarus foot. Surgery was either avoided (in half of the cases followed up to end of growth) or delayed by a mean 4.5 years, allowing a single procedure before end of growth. We recommend initiating non-operative treatment of childhood cavovarus foot, associating untwisting walking cast and untwisting nocturnal splint, as soon as clinical progression is detected and/or Méary angle on lateral X-ray with block reaches 15°.
Level of evidence: IV.

1. Introduction

Management of cavovarus foot is controversial [1]. Natural progression is negative, due both to the underlying neurologic pathology, which is often progressive [2–4], and to growth [5]. The deformity induces functional signs: ankle or plantar pain, and calluses under the base of the 5th and head of the 1st metatarsals. Deformity is 3-fold, associating hindfoot supination and forefoot pronation [6,7], thereby inducing torsion of the calcaneopedal unit. The classic theory is of anterior tibial muscle dysfunction [1–4,8]. However, onset of cavovarus foot is secondary to palsy in the interosseous muscles of the foot, often in a context of Charcot-Marie-Tooth disease [5,7,9]. The interosseous muscles fail to stabilize the metatarsophalangeal joints, and the antagonist action of extensor digitorum longus and extensor hallucis longus [5,9,10] causes dynamic joint hyperextension; this in turn tenses the plantar aponeurosis inserting on the extremities of the first phalanges, pulling the anterior and posterior anchorages of the foot together and increasing the height of the plantar arch [11–13]. Sagittally, given the anatomy of the plantar arch [12], this hollow flattens out from medial to lateral, resulting in medial cavus. Frontally, medial metatarsal verticalization results in forefoot pronation. To recover a stable calcaneal support, the hindfoot develops supination, resulting in torsion between forefoot and hindfoot. Coronally, hindfoot supination combines with calcaneopedal unit adduction under the tibiotalofibular unit [4–6,14–18]. The hindfoot deformity can be reduced in early stages but hardens with growth; reducibility can be assessed on Coleman and Chesnut's

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Table 1
Untwisting walking cast technique.

Deformity	Action by surgeon	Action by assistant
Cavus and equinus	Ankle at 90°	Pressure on knee
Adduction of calcaneopedal unit	Lateral rotation (abduction) of foot	Medial rotation of leg
Talar varus	Mediolateral pressure on heel	Lateromedial pressure on leg
Forefoot pronation	Forefoot supination, maintaining mediolateral pressure on heel	No specific action

block test [14], which, by eliminating the forefoot effect, corrects talar varus if the subtalar joint is still supple. In short, cavovarus foot is a primarily forefoot deformity with hindfoot adaptation.

We therefore developed a non-operative treatment in children, using an untwisting nocturnal splint, preceded in some cases by untwisting walking cast, in line with the above pathophysiology. The main hypothesis of the present study was that this treatment, applied during childhood, provides satisfactory correction, avoiding surgery. The secondary hypothesis was that using the untwisting walking cast ahead of the splint further improves results.

2. Material and method

2.1. Patients

A single-center retrospective study included all patients managed for cavovarus foot by two of the present authors (RS and PW) between 2002 and 2010, systematically using an untwisting nocturnal splint, preceded in some cases by 6 weeks' untwisting walking cast. Twenty-three children (15 girls, 8 boys; 35 feet) were included. Etiology was in all cases neurologic: Charcot-Marie-Tooth disease (15 patients, 22 feet), encephalopathy (3 patients, 5 feet), cerebral palsy (2 patients, 3 feet), spinal dysraphia (1 patient, 1 foot), chromosomal abnormality (1 patient, 2 feet) or medullary trauma (1 patient, 2 feet). Mean age at treatment initiation was 8.8 years (range: 5–15 years). Parents confirmed the progressive nature of the deformity. The hindfoot was systematically in varus. All patients complained of calluses under the 5th metatarsal base or 1st metatarsal head, with iterative ankle sprain. Lateral weight-bearing X-ray [5,7], with the hindfoot on a block [14], allowed precise measurement of the Méary angle (between the talar and 1st metatarsal axes), which was a mean 16° (range: 12–30°) at treatment initiation.

2.2. Non-operative treatment

Treatment began with 2 successive walking casts, for 3 weeks each, to achieve progressive correction, followed by custom-made nocturnal splints, molded when the first cast was replaced by the second (13 feet, 37%). In the other 22 cases (63%), treatment began with the splint, as the family refused the plaster cast.

2.2.1. Untwisting walking cast production (Fig. 1)

A plaster of Paris walking cast was produced, with the lower limb on a knee bar, leaving the proximal two-thirds free so that the assistant could maintain correction. Table 1 presents the respective actions of the operator and the assistant and the correction achieved. Once the distal part of the cast had dried, the proximal part was added.

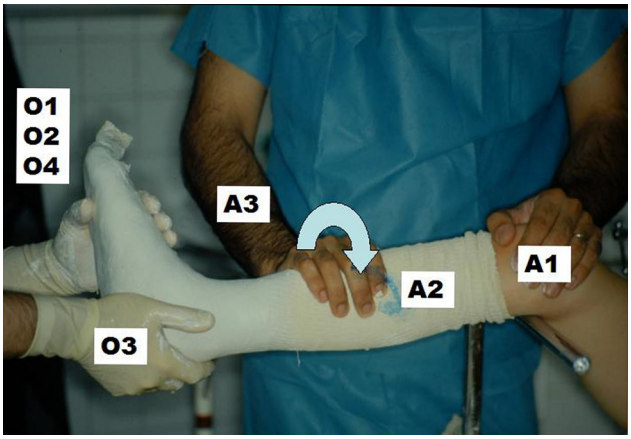

Fig. 1. Untwisting walking cast technique. Action by assistant to correct: cavus and equinus = axial pressure on leg = A1; calcaneopedal unit adduction = medial rotation of leg = A2; talar varus = lateromedial pressure on leg = A3. Action by surgeon to correct: cavus and equinus = O1; calcaneopedal unit adduction = O2; talar varus = O3; forefoot pronation = O4.

Fig. 2. Untwisting nocturnal splint: ankle held at 90°, lack of ankle dorsiflexion enabling counter-pressure and helping correction of cavus; forefoot supination: correction of forefoot pronation; hindfoot valgus: correction of hindfoot varus; oblique dorsal strap, providing lateromedial pressure (correction of cavus, dorsal hump and calcaneal varus).

Table 2
Untwisting nocturnal splint technique.

Effect of splint	Deformity component corrected
Ankle at 90°	Cavus and equinus
Forefoot supination	Forefoot pronation
Hindfoot valgus	Hindfoot varus
Dorsolateral strap	Cavus, dorsal hump and hindfoot varus

2.2.2. The untwisting nocturnal splint

The untwisting nocturnal splint (Fig. 2) was intended to counter the natural position of the foot during the night, which aggravates deformity by combining hindfoot varus, cavus, forefoot pronation, ankle equinus and claw-toe. The splint was in leather, for optimal skin tolerance, as sensitivity is often affected in these patients, and was reinforced by resin. Table 2 presents the effects of the splint and its impact on deformity. The splint was maintained until end of growth.

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