



The ‘Hybrid method’ for the treatment of congenital clubfoot

Federico Canavese^{1,2^}, Mounira Mansour³, Léa Souchon³, Antoine Samba³, Alain Dimeglio^{4^}

¹Department of Pediatric Orthopedic Surgery, Lille University Center, Jeanne de Flandre Hospital, Rue Eugène Avinée, Lille, France; ²Nord-de-France University, Faculty of Medicine Henri Warembourg, 2 rue Eugène Avinée, Lille, France; ³Clermont Ferrand University Center, Estaing Hospital, Department of Pediatric Orthopedic Surgery, Clermont Ferrand, France; ⁴University of Montpellier, Faculty of Medicine, 2 Rue de l'École de Médecine, Montpellier, France

Contributions: (I) Conception and design: F Canavese, A Dimeglio; (II) Administrative support: F Canavese, M Mansour; (III) Provision of study materials or patients: M Mansour, L Souchon, A Samba, F Canavese; (IV) Collection and assembly of data: L Souchon, M Mansour; (V) Data analysis and interpretation: F Canavese, A Dimeglio, M Mansour; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Prof. Federico Canavese, MD, PhD. Lille University Center, Jeanne de Flandre Hospital, Department of Pediatric Orthopedic Surgery, Rue Eugène Avinée, 59000 Lille, France; Nord-de-France University, Faculty of Medicine Henri Warembourg, 2 rue Eugène Avinée, 59000 Lille, France. Email: canavese_federico@yahoo.fr.

Background: The hybrid method combines the advantages of the Ponseti technique and of the French Physical Therapy method. The main goal of this study is to present our results on 139 consecutive newborns with clubfoot (n=212 feet) treated at our Institution with the hybrid method.

Methods: From May 2010 until August 2020, 139 consecutive newborns with congenital clubfoot (66 unilateral; 73 bilateral) were treated by the hybrid method protocol and were retrospectively reviewed. All patients were admitted via the maternity ward with their family and personal history records, i.e., parental age, parity, gender, birth weight, involved side and presence/absence of associated medical conditions. At birth, all clubfeet were graded in ascending order of severity according to Dimeglio *et al.*'s classification system. AP and lateral radiographs of each foot are taken every 5 to 6 months from age 6 months to 2 years, then once a year until age 4 years, to assess divergence between talus and calcaneus on both projections

Results: The cohort counted a total of 100 boys (71.9%) and 39 girls (28.1%). Clubfoot was unilateral in 66 patients (47.5%) and bilateral in 73 (52.5%). All but 10 patients had idiopathic clubfoot deformity (92.8%). Mean number of casts per patient was 8 (range: 4–11). One hundred and thirty patients out of 139 underwent percutaneous Achilles tenotomy under general anesthesia (93.5%). Overall, tibialis anterior transfer was performed in 6/212 feet (2.8%), posterior release in 9/212 (4.2%) and medial release in 1/212 foot (0.05%).

Conclusions: Our experience with the hybrid method has allowed us to constantly reduce the number of patients requiring surgery over the years, as well as the extent of surgical release. These results are encouraging, but larger cohorts of patients from different institutions and with longer follow up are needed to confirm our findings.

Keywords: Clubfoot; congenital; hybrid method; manipulation; cast

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[^] ORCID: Federico Canavese, 0000-0002-6114-5372; Alain Dimeglio, 0000-0003-1371-1189.

Introduction

Conservative treatment is the first-line treatment for congenital clubfoot deformity correction (1-3). The two main methods of treating congenital clubfoot are the Ponseti's technique (PoT) and the French functional physiotherapy method (FFPT). Serial casting and manipulations are at the core of the PoT and of the FFPT, respectively (4,5). Although these two techniques revolve around different clinical approaches, both protocols have shown good efficacy, reliability, and lasting outcomes, and are reported to perform comparably with initial correction rates of up to 90% (4-6). Both protocols aim to achieve a pain-free supple plantigrade foot with as little surgery as practicably possible as long-term studies on outcomes of surgical releases have reported high rates of painful and stiff feet with poor functional outcomes (3). However, these protocols are not able to completely eliminate the need for surgery. In an effort to further reduce the rate of surgery, Canavese *et al.* have developed the so-called *hybrid method*, which combines the advantages of both techniques (3,7). In particular, the hybrid method brings together the strengths of PoT, i.e., serial casting, with the strengths of the FFPT, i.e., manipulations and radiographs, to achieve long-term correction with a foot that is fully functional and pain free (1,3,7). In their preliminary report of 2017, Canavese *et al.* reported 8.7% of posterior release in a cohort of 92 clubfeet treated by the *hybrid method* (7). In particular, they found that gentle manipulation by a skilled physiotherapist before and after cast application is likely to improve the final outcome, to decrease the rate of surgery and to eventually speed up the reduction of the foot (3,7).

The main goal of this study is to present our results on 139 consecutive newborns with clubfoot (n=212 feet) treated at our Institution with the *hybrid method*.

We present the following article in accordance with the STROBE reporting checklist (available at <http://dx.doi.org/10.21037/atm-20-7526>).

Methods

From May 2010 until August 2020, 139 consecutive newborns with congenital clubfoot (66 unilateral; 73 bilateral) were treated by the *hybrid method* protocol as described by Canavese *et al.* (7), and were retrospectively reviewed. The same surgical team at the pediatric orthopedic surgery department of our institution performed all the procedures and followed all the patients.

All patients were admitted via the maternity ward with their family and personal history records, i.e., parental age, parity, gender, birth weight, involved side (right, left or bilateral) and presence/absence of associated medical conditions (*Table 1*).

At birth, all clubfeet were graded in ascending order of severity according to Diméglio *et al.*'s classification system (8); postural feet (Dimeglio score $\leq 5/20$) were excluded from the analysis. The feet were reviewed at regular intervals to monitor evolution and impact of treatment, and to evaluate the outcome.

As described by Canavese *et al.*, casts are applied according to the PoT rules and are changed on a weekly basis (7,9), with manipulations performed at each cast change following the FFPT principles; manipulations are performed by a skilled physiotherapist (3,7). Number of cast changes varied according to the severity of the clubfoot deformity.

Between 2 and 3 months of age, Achilles' tenotomy under general anesthesia is performed if one or more of the following elements persist: (A) equinus; (B) empty heel; (C) posterior crease; or d) lack of divergence between talus and calcaneus on anterior-posterior (AP) and lateral foot radiographs. Following Achilles' tenotomy, a long leg cast is applied for 4 to 6 weeks, with feet externally rotated and knee flexed at 90°; at this stage, casts are changed every two weeks and manipulations are performed at each cast change (7).

After the last cast removal, feet are placed in Ponseti-Mitchell's splints with 60° to 70° of external rotation. The splints are worn 23 hours a day during the first year of life, then only during naps and at night until age 4 years (7). At this stage, manipulations are performed 3 to 5 times a week and continued until the child starts walking, then one to twice a week until 4 years of age (3,7).

As described by Dimeglio *et al.*, Charles *et al.* and Canavese *et al.* manipulations should mobilize the feet gently in all planes, and should regularly stimulate lateral peroneal muscles in order to prevent internal rotation (3,7,10-13). As soon as the patients are able to walk, complementary exercises such as heel and toe walking and stimulation of elevator and evtor muscles complete the rehabilitation protocol (7).

AP and lateral radiographs of each foot are taken every 5 to 6 months from age 6 months to 2 years, then once a year until age 4 years, to assess divergence between talus and calcaneus on both projections (3,7).

Ethical statement

The study was conducted in accordance with the

Table 1 Patients treated during the years 2010–2014 and 2015–2020

	2010–2014	2015–2020	Total
Number of feet [patients]	92 [66]	120 [73]	212 [139]
Mean Dimeglio <i>et al.</i> 's score	13.5/20	12.8/20	13.1/20
Achille's tenotomy	85/92 (92.4%)	120/120 (100%)	205/212 (96.7%)
Tibialis anterior transfer	–	6/120 (5%)	6/212 (2.8%)
Posterior release	8/92 (8.7%)	1/120 (0.08%)	9/212 (4.2%)
Postero medial release	–	–	–
Medial release	–	1/120 (0.08%)	1/212 (0.05%)

Declaration of Helsinki (as revised in 2013). IRB approval was waived as this is a chart review only and individual consent for this retrospective analysis was waived as well.

Results

This retrospective study included a total of 100 boys (71.9%) and 39 girls (28.1%); patients were consecutive. Clubfoot was unilateral in 66 patients (47.5%) and bilateral in 73 (52.5%); the total number of clubfeet was 212. All but 10 patients had idiopathic clubfoot deformity (92.8%).

Mean age at start of treatment was 8 days (range: 6–11). All patients had clinical and radiographic follow-up for at least 1 year (mean: 4 years; range: 1–10). Mean Dimeglio *et al.*'s score at the beginning of treatment was 13.5/20 (range: 6/20–19/20) for patients treated between 2010 and 2014 and it was 12.8/20 for those treated between 2015 and 2020 (range: 6/20–19/20).

Mean number of casts per patient was 8 (range: 4–11). One hundred and thirty patients out of 139 underwent percutaneous Achilles tenotomy under general anesthesia (93.5%). If orthopedic treatment was ineffective and feet showed no improvement, further surgery was given. Overall, tibialis anterior transfer was performed in 6/212 feet (2.8%), posterior release in 9/212 (4.2%) and medial release in 1/212 foot (0.05%). *Table 1* outlines the extent of surgery in patients treated between 2010 and 2014 and those treated between 2015 and 2020 (*Table 1*).

Clinical evaluation at last follow-up found a mean dorsal flexion of $20^{\circ} \pm 5^{\circ}$ (range: 5–35°).

Discussion

The results of our study show that the *hybrid method* is effective in the management of clubfoot deformity, and that

the number of patients requiring surgical management—excluding Achilles tendon lengthening—is low. It is interesting to note that compared to our previous cohort of 61 children treated between 2010 and 2014 which had a surgical rate of 8.7% (7), the current series (134 children treated between 2015 and 2020) has an even lower surgical rate (6%). In this respect, it is important to point out that in children treated between 2015 and 2020 the *hybrid method* not only reduced the overall rate of surgery, but also contributed to a decrease in the extent of surgical release. Indeed, all complementary surgeries performed in patients treated between 2010 and 2014 were posterior releases (8/61; 8.7%) while the majority of surgeries performed between 2015 and 2020 consisted in anterior tibialis transfer (6/134; 4.6%), posterior release (1/134; 0.7%) and internal release (1/134; 0.7%); no cases of posteromedial release were recorded in any of the series.

The *hybrid method* adds manipulations and feet radiographs to the PoT protocol (12). The frequent manipulations allow to stimulate the foot at the end of each period of cast immobilization while the regular foot radiographs are essential to objectively evaluate the impact of the conservative treatment on the foot anatomy. In our opinion, it is not possible to check the foot clinically without taking into account the underlying radiological anatomy. Any lack of divergence between talus and calcaneus is sign of incomplete correction.

Souchet *et al.* reported the rate of good clinical and functional outcome in 350 clubfeet (mean follow up 14 years) treated by the FFPT increased up to 77% compared with their previously published series (48%) while the rate of extensive surgical release decreased significantly from 52% to 23% (14,15). Seringe *et al.* and Richards *et al.* found that the more severe the foot the higher the risk for extensive surgical release. In particular, Seringe *et al.* and Richards *et al.* reported 67% and 75% of extensive

surgery in feet rated 16 to 20 according to Dimeglio *et al.*, respectively (6,16).

Richards *et al.*, Faulk *et al.* and Wicart and Chotel have all compared the PoT and the FFPT and found both techniques can reduce the need for extensive surgical release although neither method can completely eliminate it (6,12,13,17,18). It is important to point out that the rate of posterior release in our series (9/205; 4.4%) is lower than that reported by Bensahel *et al.* (4), Richards *et al.* (6), Bensahel *et al.* (15), Seringe *et al.* (16), Wicart and Chotel (17), Faulks *et al.* (18) and Steinman *et al.* (19). In our hand, the *hybrid method* was able to correct all clubfoot deformities rated 12/20 and below while posterior release was performed only in feet rated 13/20 or above (3,7,8). We believe manipulations can help improve results for feet treated with the PoT alone because the stimulate muscles that are otherwise immobilized by serial casting and foot abduction orthosis (3,12). Gentle manipulation by a skilled physiotherapist before and after cast application is likely to improve the final outcome, to decrease the rate of surgery and to eventually speed up the reduction of the foot.

There were several limitations in the analysis of our results. (I) First, this was a single-center retrospective study, and the number of patients was relatively small. We are able, however, to offer some evidence on outcomes of ‘hybrid method’ in children with congenital clubfoot. Interestingly, we found that the technique decreased the overall rate of surgery over the years. (II) Second, patients were not followed until skeletal maturity, some feet could potentially recur, and some patients may become symptomatic. Therefore, it is possible that a multicenter longer follow-up study might be necessary to predict the long-term outcome of this specific treatment option.

In conclusion, the aim of the *hybrid method* is to correct the deformity, to minimize the need and the extent of surgery and to improve the functional and radiological outcome of children with congenital clubfoot. Our ten years’ experience with the *hybrid method* has allowed us to constantly reduce the number of patients requiring surgery over the years, as well as the extent of surgical release (*Table 1*); importantly, none of the patients managed by the *hybrid method* required a posteromedial release. These results are encouraging, but larger cohorts of patients from different institutions and with longer follow up are needed to confirm our findings.

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Footnote

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