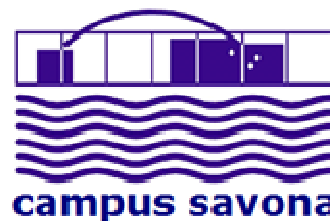




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Congenital clubfoot in infant: a conservative treatment

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Abstract

The congenital clubfoot is one of the most common deformity in newborns and is characterized by pathological changes of joints and soft tissue and malposition of bones. Two treatment techniques, the Ponseti casting method and the French Physical Therapy Method have been implemented worldwide.

The purpose of this work was to explore, among the current literature, the scientific evidence of the French Method and to compare this functional method versus the Ponseti treatment.

The research was conducted between February and March 2012 by consulting several electronic databases, with a main reply in PubMed. The keywords used were:

“clubfoot/congenital”, “Therapy”, “French Method”, “Rehabilitation”, “Ponseti”, “Bonnet”, “Diméglio” and their possible combinations.

The defined limits were publications subsequent to year 2000 in English, German or Italian language and an age limit of 0-24 months.

After all inclusion and exclusion criteria 9 articles, of vary character, were included and analyzed in this work.

The results show the need of uniform grading, before and after the treatment cycle and the importance of early triceps surae lengthening. The initial correction rates of the French Method and the Ponseti treated feet are similar and the differences are not significant. Close evaluation demonstrate significant differences, especially in very severe graded clubfoot and allow the conclusion that there is a trend towards improved results with use of the Ponseti treatment method. This improved outcome could be connected with the early and frequent triceps surae lengthening.

Currently the French Method cannot be considered to be an evidence based treatment form and larger comparative studies will be required if the French Functional (Physical Therapy) Method follows the aim of the significant evidence.

Introduction

Epidemiology:

Congenital clubfoot is one of the most common congenital skeletal pediatric orthopedic deformity with an incidence of 1–2/1000 newborns [1] (white population). Males have the deformity twice as often as females and can appear unilateral or bilateral. The pathogenesis of clubfoot deformity is still unknown despite numerous studies. [1,2]



Etiology:

This equino-varus deformity is characterized by pathological changes of joints and bone position.

Image: private contact

Especially malposition between the talus, calcaneus, os cuboideum and os naviculare. The talus tends to equinus position and to dislocation to ventral and to extra-rotate the intermalleolar straddle. Muscles, tendons (especially: Achilles tendon, M.tibialis posterior tendon), and soft tissues are shortened mainly the medial and back (calcaneus) side, which result in subtalar malpositions known as talipes equinus, varus adductus and cavus.[3]

Clubfoot classification

The severity of the deformity can vary from mild to an extremely rigid foot that is resistant to manipulation.[1] One of two mainly used classification systems was a score on a scale from 0-20 developed by Dimeglio et al. Assessing a clubfoot, especially in the neonatal period, requires a very complete checklist, which must be followed strictly. [4]

The following parameters must be assessed in terms of reducibility, without forcing the foot and a small goniometer allows one to measure angulation precisely before and after the reducibility test. [5] There are four main components to be validated: (a) equinus; (b) varus of the hindfoot; (c) internal rotation of the calcaneotarsal complex; and (d) adduction of the forefoot compared with the hindfoot

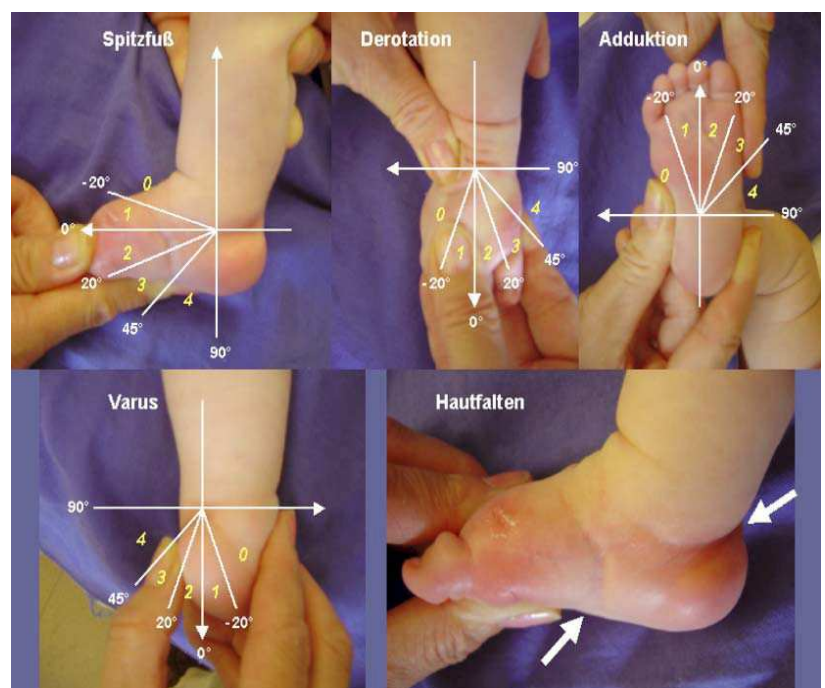
In order to establish a final score, each of this parameters receive a score from 0 to 4

- points:
- from 90° - 45°: 4 points
 - from 45° - 20°: 3 points
 - from 20° - 0°: 2 points
 - from 0 – -20°: 1 point
 - < -20°: 0 points

Additionally each of a point can be awarded in the presence of the following negative prognostic factors: posterior crease, mediotarsal crease, pes cavus component and trophic or tonic changes of muscles.

This classification allows to distinguish between four categories of feet:

- postural (soft–soft; score, 1–5; completely reducible)
- moderate (soft–stiff; score, 6–10; >50% reducible)
- severe (stiff–soft; score, 11–14; <50% reducible)
- very severe feet (stiff–stiff; score, 16–20; nonreducible) [5]



*Spitzfuss= equinus / *Hautfalten= creases Image: [3]

Treatment

In the early 1900s forceful correction of the deformity as espoused by Hugh Owen Thomas was in vogue. In the 1930s Joseph Hiram Kite, like Hippocrates (400 BC), recommended repeated gentle manipulations to achieve a correction. Instead of bandages Kite used serial plaster casts to maintain the correction. During the late 1940s Ignatio Ponseti developed his technique of correction through the normal arc of the subtalar joint. In a clubfoot the soft tissues are more resistant to pressure than the bones. With this concept in mind soft tissue procedures were developed in which the capsules and ligaments were released surgically. With safer pediatric anesthesia the 1960s, 1970s, and 1980s saw surgical approaches that were more and more aggressive even including a complete subtalar release. [6] The surgeries involved different types of soft-tissue operations. The reported good results with these techniques were around 45%. [1] The improved imaging modalities and computer graphics of the 1980s led to a better understanding of the pathoanatomy. Long-term follow-up studies demonstrating malcorrection, overcorrection, pain, and stiffness dampened the enthusiasm for very aggressive surgery. [6] The main problem with surgery is that clubfoot wounds does not heal with specific, original tissue but with a biological more simple material, the connective scar tissue.

Since 1970 another popular method of clubfoot treatment that also avoids extensive surgical treatment is the French or functional method. [1]

The two techniques, the Ponseti casting method and the French functional (physical therapy) method, have been implemented worldwide.

In America, in parts of Europe and in many underdeveloped countries, the Ponseti method is used in the majority of centers providing clubfoot care. In centers in other parts of Europe and in several North American centers, the French functional method is utilized predominantly. [7]

Two treatment Techniques

The Ponseti Method:

Ignacio Ponseti developed and refined his treatment method for clubfoot in the late 1940s and became more popular after his long-term results were published in the 1990s. [8,1]

His technique is ideally started within the first few weeks of life and consists of serial, weekly manipulations of the foot, followed by casting to achieve gradual correction.

The deformities must be corrected in a listed order to achieve a successful outcome.

At each session the foot is manipulated for approximately one to three minutes and maintained in an above-the-knee plaster cast with the knee bent to 90° until the next session, five to seven days later. [9,1]

This manipulation and casting treatment continues until the foot is externally rotated and usually it requires three to five cast changes.

Once external rotation is achieved, a percutaneous tenotomy of the heel cord is performed to gain dorsiflexion of the ankle. The percutaneous heel cord tenotomy is a part of the Ponseti Method protocol. [2] A final cast application after the tenotomy is worn for three weeks and replaced with a brace to maintain the correction.

The abduction orthosis consists of two shoes connected by a removable bar, fixed in a shoulder-width distance and 70° of external rotation and 10° of dorsiflexion. The derotation splint will be



image: [9]

used full time for 4 months and then it will be removed during the day for gradually increasing periods of time for approximately 5 months. Then splint will be worn during night and sleep, until the age of walking and at night only until 3 to 4 years of age. [2]

The French Functional (Physiotherapy) Method:

The French Method, also called the French Functional (Physiotherapy) Method, developed in the late 1970s and described by Masse, Bensahel et al., Seringe, Aita and Dimeglio has seen a considerable resurgence of interest since the mid-1990s. [10,5]

The developers of this technique believed that the clubfoot deformity resulted from a contracted posterior tibialis tendon with fibrotic tissues, deviated midtarsal joints, and weakened peroneus longus and peroneus brevis muscles. Consequently, the treatment has been focused on stretching of the tight medial structures, passive reduction of the talonavicular joint, sequential correction of forefoot adduction, hindfoot varus and equinus of the calcaneus, and strengthening and stimulation of the muscles.

The toe extensors and peroneals are recruited by stimulating (tickling) the lateral border of the foot and leg and the tops of the toes. The presence of active toe extension confirms that the muscles are being stimulated.



image:[9]

The method requires daily manipulations of the newborn clubfoot by a skilled physiotherapist followed by immobilization with adhesive taping to maintain the correction achieved with stretching. Also a splint maintains the corrected position until the next day's session. Initially, the infant is seen by the therapist as many as five times each week for the first two months. Then treatment frequency decreases to three times a week until the child is six months of age. The parents may perform the exercises and taping daily at home and the frequency of visits to the therapist decreases. Each session lasts approximately thirty minutes per foot, and manipulations are performed

in a progressive gentle pattern.

A session consists of the therapist exercising the foot for ten to fifteen minutes, taping it, and then, if necessary, fabricating an ankle-foot orthosis to maintain the correction that is obtained as a result of the exercises.

» Two phases of treatment: correction and maintenance.

The correction phase begins with derotation of the calcaneopedal block and correction of forefoot adduction. This is facilitated with massage of the Achilles tendon and the gastrocnemius muscle. Next, the medial soft tissues are stretched to allow the navicular to move away from the medial malleolus and its medial position on the head of the talus. Distraction of the forefoot and midfoot helps to loosen the tightened structures, and derotation of the foot facilitates reduction of the talus.

The maintain phase consists in detaining the gain achieved in passive range of motion by stimulating the toe extensors and peroneals.

Once the talonavicular joint has been reduced, attention is directed toward the correction of varus and equinus. With the valgus maneuver, the calcaneus gradually moves to a neutral and eventually valgus position. The ankle is externally rotated at the same time that the calcaneus is being mobilized into valgus. The knee should be kept at 90° during these maneuvers. Finally, equinus is corrected with gradual dorsiflexion of the foot. The thumb must be in the arch of the foot and not under the metatarsal heads in order to prevent creating midfoot break.

After each manipulation the improvement in the foot position is maintained by taping and wearing the ankle-foot orthosis for twenty-two hours per day until walking age. Because the four pieces of tape are elastic and the orthoses is removable, parents can continue to exercise the foot.

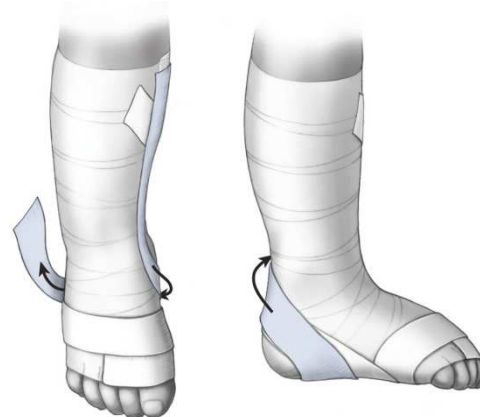


image: [9]

After correction of the deformity has been achieved, the emphasis of the French method changes to the maintenance of correction. Fewer visits to the therapist are needed as the parents assume the daily treatment exercises and taping. Periodic follow-up is needed to monitor the range of motion of the foot and the development of the infant and to fabricate new splints.

The patient visits the physician every two to three months for evaluation.

A percutaneous heel cord tenotomy can be necessary for augmentation of the equinus position, but it is not included in the treatment protocol.

In Montpellier, France, some modifications have been gradually introduced to the original French functional physical therapy protocol to improve outcome after manipulation and taping. The continuous motion machine (PMM or CPM) was introduced to the regimen in 1992. This further mobilizes the child's taped foot during the hours of sleep. [9,1,7]

Therefore the French Method sometimes is also called The Montpellier Method.

Formulation of question:

- 1) Is the French Method an evidence-based treatment form and
- 2) makes it possible to manual therapists to treat congenital clubfoot in newborns in a functional way and makes plaster treatment and surgery unnecessary?

Materials and Methods

Research strategy:

The literature research was conducted between February and March 2012 through the most appropriate database for physical therapy and medicine, in English, German and Italian. (PubMed, PEDro, Cochrane, Medline.de, Base e Heidi)

The research strings were designed to identify studies that reports about the congenital clubfoot and the conservative treatment with the French Method. The second goal was to individuate the studies which compare the French Method versus the Ponseti Method.

Based on my professional experience and my knowledge, and after extensive discussion with colleagues from the pediatrics department of the University of Reggio Emilia / Modena and colleagues from the pediatrics department of the hospital in Berlin-Steglitz, and considering that the review “The French functional physical therapy method for the treatment of congenital clubfoot” already includes many of the older articles, I decided to limit the research to the last decade.

The research provided a total of 1246 publications (table 1).

Criteria for inclusion:

- Publications in English, German, Italian.
- Studies and publications on congenital clubfoot and the conservative treatment with the French Method (limit in the search: 0-24 months).
- Works published between 2000 and 2012 to present the most updated research

A second selection was performed on the basis of the title and after the reading of the abstract.

Criteria for exclusion:

- Publications that reports about other treatments or chirurgic or conservative, not concerning the conservative treatment according to the French method.

After the second selection 16 of 1246 publications were included for the following work and two more articles were included after references tracking.

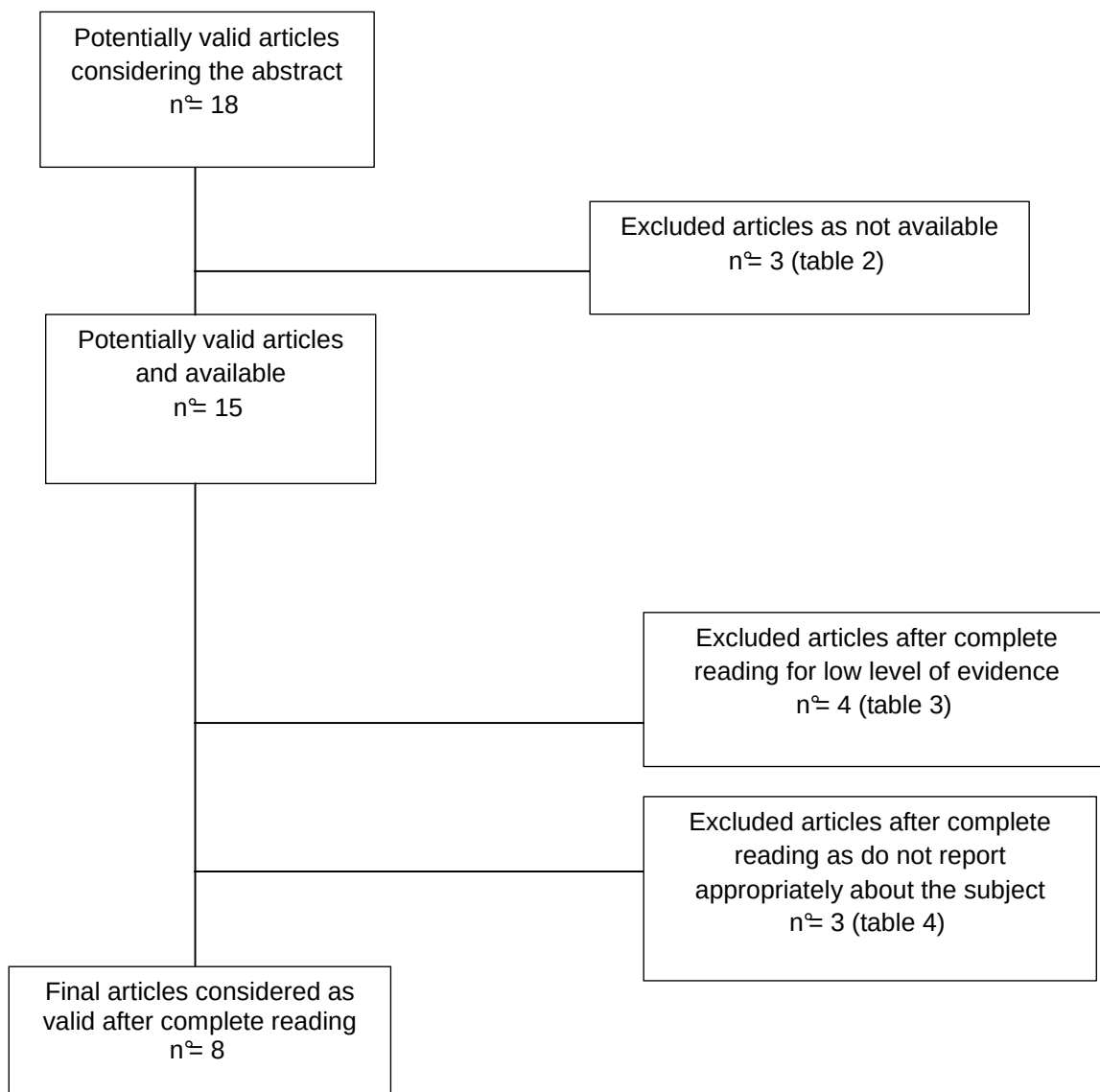
(table.1)

Search Keys	Database					
	PubMed	PEDro	Cochrane	Medline.de	*Base (Uni Bielefeld)	*Heidi (Uni Heidelberg)
clubfoot	-	4	-	-	-	-
„congenital clubfoot“	-	-	14	323	3	14
„congenital clubfoot“ AND „French Method“	-	-	0	1	0	0
„clubfoot/congenital“ [MESH] OR „clubfoot/therapy“ [MESH]	818	-	-	-	-	-
„clubfoot/congenital“[MESH] OR „clubfoot/therapy [MESH] AND „French Method“	2	-	-	-	-	-
clubfoot/rehabilitation [MESH] AND „French Method“	0	-	-	-	-	-
clubfoot [MESH] AND „French Method“	2	-	-	-	-	-
clubfoot AND Ponseti AND French Method	14	-	-	-	-	-
clubfoot AND „French Method“	30	-	-	-	-	-
Bonnet[au] AND Dimeglio[au]	2	0	0	-	0	0
Bonnet[au] AND clubfoot	2	0	0	0	0	0
Dimeglio[au] AND clubfoot	7	0	5	0	0	5
* search keys in German						
Search results	877	4	19	324	3	19
Total search results	1246					
Articles after inclusion and exclusion criterion	16					
Articles Reference Tracking	2					
Total Articles	18					

Flow Chart:

The following flowchart presents the 18 included articles after the second selection and the final (third) selection. This third selection is based on availability of the article and the complete reading and evaluation of the article. The article was evaluated according to the level of evidence (table 1; Appendix). Adapted from material published by the Center for Evidence-Based Medicine, Oxford, UK.

After the final selection 8 of 18 publications were included for the thesis development.



(table 2)

Clubfoot in the twentieth century: where we were and where we may be going in the twenty-first century. Author: Carroll NC. J Pediatr Orthop B. 2012 Jan;21(1):1-6	Exclusion as not available
Results of Treatment of Idiopathic Clubfoot with Functional French Method combined with Achilles tenotomy in selected cases. Author: Al Khoury SH, Seringe R.,Glorion C., Wicart P.	Exclusion as not available
Nonsurgical Management of Idiopathic Clubfoot. Author: Kenneth J. Noonan, Richards BS J Am Acad Orthop Surg. 2003 Nov-Dec.;11(6): 392-402	Exclusion as not available

(table 3)

Clubfoot treatment: Ponseti and French functional methods are equally effective. Author: Faulks S., RN, MSN, CNS, Richards BS, MD Clin Orthop Relat Res (2009) 467:1278-1282	Exclusion for low level of evidence (V), therapeutic study, expert opinion report.
A comparison of two nonoperative methods of idiopathic clubfoot correction: the Ponseti method and the french functional (physiotherapy) method. Surgical technique. Author: Steinmann S., MD, Richards BS.,MD, Faulks S.,RN,CNS, Kaipus K., PT, MPT J bone Joint Surg Am. 2009;91 Suppl 2 (part 2): 299-312	Exclusion because it is copying the original article: explanation of the Ponseti and French Method without any result. Low level of evidence (V), expert opinion.
Early functional treatment of congenital clubfoot. [Article in German] Author: Pfeil J., Weber U. Orthopaede 2006; 53:665-674	Exclusion for low level of evidence (V), expert opinion report.
Update of clubfoot: Etiology and Treatment. Author: Dobbs MB. MD, Gurnett A. MD, PhD Clin Orthop Relat Res (2009) 467:1146-1153	Exclusion for low level of evidence (V), therapeutic study, expert opinion report.

(table 4)

Evaluation of the treatment of clubfoot with the Dimeglio score. Author: van Mulken Jeroen MJ., Drs., Bulstra SK.,MD, PhD, Hoefnagels NHM., MSc Journal of Pediatric Orthopaedics 21:642-647	Exclusion: does not report about the French Method.
Gait analysis in children with severe clubfoot: early results of physiotherapy versus surgical release. Author: Karol LA.,MD, O'Brien SE.,BS, Wilson H., BS, Johnston CE., MD, Richards BS.,MD J of Pediatric Orthop 200552:236-240	Exclusion: reports about comparison versus surgical release.
A 14-year longitudinal comparison study of two treatment methods: Ponseti versus traditional. Author: Boden RA., Nuttall GH., Paton RW. Acta Orthop.Belg.,2011,77,522-528	Exclusion: does not report about comparison with the "French Method".

table of included articles:

author	title	Level of evidence	magazine/year	sample size	treatment
Richards B.St.,MD Faulks S.,RN, CNS Rathjen K.E.,MD Karol L.A.,MD Johnston C.e.,MD Jones S.A.,PT, MSPT	A Comparison of Two Non operative Methods of Idiopathic Clubfoot Correction: The Ponseti Method and the French Functional (Physiotherapy) Method	II A prospective, non- randomized, cohort study	J Bone Joint Surg Am. 2008;90 p.2313-21	Patients (pat.) under 3 months PM*: 176 pat. 267 feet FM*: 80 pat. 119 feet	Patients followed Ø 4.3 years and treated in the same institution, using PM* in one group and FM* in the second group. Both groups had similar severity scores before treatment. Difference was not significant: p= 0.28; 95% CI (-1.6 to 3.0) 194 feet (73%) of the PM* group received a primary percutaneous heel-cord tenotomy and 183 of the 194 tenotomies were performed during the initial cast treatment program. 38 feet (32%) of the FM* group received a later primary percutaneous heel-cord tenotomy. Goals to determine: 1) the initial correction achieved with each method 2) the frequency of relapses that occurred 3) whether one method achieved better clinical outcomes after a two- year minimum follow-up period 4) whether rating the severity of the clubfoot deformity before treatment was predictive of the clinical outcome after

					minimum follow-up
Chotel F.,MD,PhD Parot R.,MD Sergine R.,MD Berard J.,MD Wicart P.,MD,PhD	Comparative Study: Ponseti Method Versus French Physiotherapy for Initial Treatment of Idiopathics Clubfoot Deformity	III A retrospective cohort study	J Pediatr Orthop 2011;31; p.320-325	146 patients 219 feet PM*:103 feet FM*:116 feet	Patients presented during a 3 year period, after graduation of the severity, were treated in two different centers, which were strictly separated. One group was treated according to the FM*, the second group was treated according to the PM*. The hypothesis was that the French Method produces identical medium term results as the Ponseti Method.
El-Hawary R.,MD Karol L.A.,MD Jeans K.A.,MS Richards B. St.,MD	Gait Analysis of Children Treated for Clubfoot with Physical Therapy or the Ponseti Cast Technique	II	J Bone Joint Surg Am. 2008;90 p.1508-16	105 patients (Ø 2 years 3 month old) 154 feet PM*:79 feet FM*:75 feet CG*:15 feet (Ø initial Diméglio score 13.1)	The parents of patients treated between February 1998 and May 2004 at a single center were invited to have their child participate in a gait analysis when the child was approximately two years of age. The children were treated with one of two (PM*/FM*) methods chosen by the parents at those time. During the gait analysis kinematic data were collected and analyzed. Temporal and gait parameters were identified and compared with those of fifteen normal children (CG*) Because the Achilles tendon lengthening was not initial part of the FM*, the patients who had been treated with FM* and had tendon lengthening were excluded.

					As tendon lengthening is part of the PM*, the patients who had tendon lengthening remained included.
Gottschalk H.P.,MD Karol L.A.,MD Jeans K.A.,MS	Gait Analysis of Children Treated for Moderate Clubfoot with Physical Therapy Versus the Ponseti Cast Technique	II	J Pediatr Orthop 2010;30; p.235-239	33 patients (Ø2 years and 4 months old) 40 feet PM*:17 feet FM*:23 feet CG*:15 feet	The purpose of this study was to compare the gait patterns of children with less severe clubfoot and treated with one of two non-operative methods (PM*/FM*) that the parents chose. At approximately 2 years of age children returned for gait analysis and were asked to walk barefoot at a self-selected speed, while kinematic data wear collected. Group data were compared with a group of 15 normal children (CG*). The one of two hypotheses were: no difference in gait parameters of moderate clubfoot treated with the PM* compared with the FM*. The Ø initial Diméglio score were 8.2 PM* group and 8.3 FM* group. No significance for the difference (p=0.576)
Jeans K.A.,MS Karol L.A.,MD	Plantar Pressures Following Ponseti and French Physiotherapy Methods for Clubfoot	II	J Pediatr Orthop 2010;30; p.82-89	151 feet (2 years old, 2.3 ± 0.2 and 2.2 ± 0.3; p=0.2751) PM*:79 feet FM*:72 feet CG*:17 feet	The parents of patients treated between February 1998 and May 2004 were invited to have their child participate in this plantar pressure study. The children were treated with one of the two methods (PM*/FM*) chosen by the parents at that time. At approximately 2 years of age they participated on gait analysis, which included 3-dimensional kinematics and

				pedobarograph data collection. Pedobarograph data were collected as patients walked across a Platform System for a minimum of 5 trials per foot to ensure repeatability. A minimum of 3 steps were taken prior to data collection but due to the young age of the patients, it was not possible to standardize the number of lead-up steps. [11] Exclusion of feet scored < 10 and > 17 (Diméglio scale). Excluded patients who underwent surgical management before gait testing and patients who switched treatment protocol. The Ø initial Diméglio score was not different between PM* and FM* groups (13.1 ± 2.0 and 13.3 ± 1.9; $p=0.4281$) Standing lateral ankle radiographies, for measurement of the tibiocalcaneal angle, were available for 78 PM* feet and 59 FM* feet (Figure 2: Appendix) The aim of this study: 1) to compare the differences in plantar pressure in feet treated with PM* versus FM* 2) to compare the differences in plantar pressure in non-operatively treated feet with age-matched controls; 3) determine whether radiographic measures correlate with pertinent
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					pedobarograph parameter.
Dimeglio Alain Canavese Federico	The French functional physical therapy method of congenital clubfoot	II Systematic review of Level-II studies	J Pediatr Orthop B 2012;21; p.28-39	Review of articles	Overview of literature and development of the conservative treatment (especially "The French Method") of congenital clubfoot and the necessity of mini-invasive surgery.
Richards B. St.,MD Johnston C., MD Wilson H.,PT	Non-operative Clubfoot Treatment Using the French Physical Therapy Method	IV A retrospective review of clinical results (as case studies)	J Pediatr Orthop 2005;25; p.98-102	98 patients 142 feet	142 congenital clubfoot were treated between February 1998 and February 2001 by the French Method and reviewed to determine the effectiveness of this treatment. All children were 3 month of age or younger when treatment started. The follow-up age was averaged 35 months. Before treatment all feet were rated at the initial visit by the physician or the physical therapist using the Dimeglio scale. 2000 CPM (continuous passive motion) machines became available and were incorporated into the program for use at home during the first 12 weeks of treatment for 51 of 142 feet.
Richards B. St.,MD Dempsey M., MD	Magnetic Resonance Imaging of the Congenital Clubfoot With the French Method	III	J Pediatr Orthop 2007;27; p.214-219	6 patients 6 feet	This study reports the assessment of magnetic resonance imaging (MRI) changes that occur in clubfoot after treatment with the French Method. The MRI were obtained in 6 children before the treatment and 3 months later. Sedation of the patient during the MRI

				procedure to provide immobilization of the foot was not allowed. A soft-roll fiberglass cast was applied on the non-treated foot without modification of the initial foot position. For the final MRI examination after 12 weeks the foot was encasted over the taped position foot. The MRI scanning time requires 30 minutes, consequently only 1 foot per children were analyzed. It was impossible to maintain the children quiet for a longer time. Four major measurement variables were evaluated: 1) equinus and displacement of the talonavicular relationship 2) assessment of the medial deviation of the talonavicular relationship 3) assessment of the medial displacement of the midfoot 4) assessment of the hind-foot varus [12]
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* Ponseti Method (PM) / French Method (FM) / control group/children (CG)

summary of the results of the included articles:

title	Result
A Comparison of Two Non-operative Methods of Idiopathic Clubfoot Correction: The Ponseti Method and the French Functional (Physiotherapy) Method	1) The initial correction rates were 94.4% for the Ponseti method and 95% for the French functional method. PM*: The 15 feet which had not achieved satisfactory initial correction had vary casting problems. FM*: Two of the six feet that failed initial correction crossed over to the Ponseti Method because of slow progress. All six feet that failed, eventually required a posteromedial release. A small number (38) of feet had a heel-cord tenotomy and there was no significant difference found among the feet that had tenotomy within the first four months of treatment, after four months of treatment or the feet that had no tenotomy. 2) PM*: 37% of the satisfactorily initial corrected feet had a relapse within the first two years. This 93 feet received vary continuous treatment (PM* up to three treatment series, FM* or surgery) with good, fair and poor outcome. FM*: 29% of the satisfactorily initial corrected feet had a relapse and received a following surgery treatment. 3) The feet managed with PM* demonstrated a trend towards a better clinical outcome ($p=0.31$). Good outcomes were slightly more common in the PM*. But the difference between good, fair and poor outcomes between the two methods are not significant. 4) The clinical outcomes for moderate and severe rated feet were nearly identical between the two treatment methods. ($p=0.92$, moderate feet / $p=0.15$, severe feet) For the very severe subgroup there was a trend toward more favorable clinical outcome in the PM*, but not considered as significant ($p=0.19$) The more severely involved the foot, the higher the likelihood of a worse outcome. [7]

Comparative Study: Ponseti Method Versus French Phsiotherapy for Initial Treatment of Idiopathics Clubfoot Deformity	Percutaneous heel-cord tenotomy was performed in 17% of the FM* feet at $\bar{X} 6 \pm 3$ month of age. The rate of tenotomy increased from 10% (2000) to 18% (2001) to 24%(2002) In the group PM* the heel-cord tenotomy was performed in 94% of feet, at $\bar{X} 5$ weeks of age. The rate of recurrence was 17% in the FM* group (at $\bar{X} 3.9$ years of age) and 22% in the PM* group (at $\bar{X} 2.7$ years of age). This difference was not statistically significant ($p= 0.09$). At mean follow-up of 5.5 years, similar rate of surgery was performed in both groups (21% in group FM*/ 16% PM*). Complete posteromedial release was mainly done in group FM* and limited surgery in group PM*. The rate of surgery in FM* treated feet decreased between 2000 and 2002 from 23% to 10%. A statistically significant outcome ($p< 0.00001$) were observed for the performed surgery in both groups (figure a). A higher rate of excellent results was observed for the PM* and a higher poor rate for the FM* ($p=0.0003$)(figure b). This percentage corresponds approximately to the operated feet. A significant difference show the results according to the severity of clubfoot (figure c). Results for grade II (Diméglio score) were not different between PM* and FM* ($p=0.56$). Results for grade III and IV were better after PM* ($p=0.0015/0.01$) [2]
Gait Analysis of Children Treated for Clubfoot with Physical Therapy or the Ponseti Cast Technique	No significant difference in cadence parameters (walking speed, cadence and stride length) were found ($p>0.05$). Several mild, non-significant ($p=0.0317$), deviations in sagittal plane ankle kinematics pro PM* were observed. Equinus gait (midstance-phase dorsiflexion $< 3^\circ$) showed a significant difference between FM* (15%) and PM* (1%) ($p=0.0051$) Increased dorsiflexion in stance-phase were observed in FM*(12%) and PM*(48%) ($p<0.0001$) A significant kinematic difference were observed in stance-phase knee hyperextension with higher %-outcome (feet associated with knee

	hyperextension) in the FM* group ($p=0.029$) than it was after treatment with PM* <i>without</i> Achilles tendon lengthening. Footdrop during the final 25% of the swing-phase were observed in PM* (4%) and FM* (19%) ($p=0.0072$). Normal ankle kinematics in sagittal plane (no equinus gait, no calcaneus gait, no increased stance-phase dorsiflexion and no foot drop) were evaluate for PM* (47%) and FM* (65%) ($p=0.0317$) Intoing during stance-phase were observed in PM* (24%) and FM* (44%) ($p=0.0144$) For the normal gate (strict definition: normal ankle kinematics in the sagittal plane, a normal foot progression angle and normal shrank-based foot rotation) there were no significant difference ($p=0.895$) between the PM*(14%) and FM*(15%) groups. [8]
Gait Analysis of Children Treated for Moderate Clubfoot with Physical Therapy Versus the Ponseti Cast Technique	No significant difference were observed for the following parameters: Ankle equinus was present in FM* feet (17%) and PM* (6%) ($p=0.280$) Increased stance-phase ankle dorsiflexion were present in FM* feet (17%) and PM* feet (18%) ($p=0.649$) Calcaneus gait were observed in FM* (4%) and none in PM* group ($p=0.575$) Achilles tenotomy was performed in (41%) PM* feet and (13%) of the FM* feet ($p=0.066$) Internal foot progression angle of $> 5^\circ$ is present in PM* feet (35%) and FM* feet (35%) ($p=0.616$) Normal gate was defined as normal ankle kinematics in the sagittal plane, a normal foot progression angle and normal shrank-based foot rotation. There was no significant difference ($p=0.388$) in normal gate between PM*(35% feet with normal gate) and FM* (26% feet with normal gate) groups. Significant difference were analyzed for: Foot drop during the final 25% of swing-phase in FM* feet (26%) and

	none foot in PM* group (p=0.026) Normal ankle sagittal plane kinematics: defined as the absence of equinus, excessive stance-phase dorsiflexion, calcaneus at push-off, and foot drop. PM* group (82%) and FM* group (48%) (p=0.027) (A complete set of results is listed in table 2; Appendix) [13]
Plantar Pressures Following Ponseti and French Physiotherapy Methods for Clubfoot	1) At 2 years of age the tibiocalcaneal angle was significantly greater in feet treated with the FM* ($90.1^{\circ} \pm 9.4$) than feet treated with the PM* ($84.2^{\circ} \pm 11.6$) (p=0.0013) This indicates less dorsiflexion of the ankle joint in FM* feet. (Plantar pressure results can be found in table 3, Appendix) Significant differences were found in the medial and lateral hindfoot and the medial midfoot (figure d; subdivision of the foot) The FM* feet had lower peak pressure, less maximum force (max force) and a decreased PTI (pressure time integral) than PM* feet (p<0.0001) in the medial hindfoot. FM* feet had lower max force in lateral hindfoot region than PM* (p=0.0019) The medial midfoot had significant smaller peak pressure in the FM* treated feet than the PM* treated feet. (p=0.0011) No significant differences were found in the lateral midfoot, or in any of the forefoot regions between FM* and PM* feet. 2) In a comparison of FM* and PM* patients to age-matched controls, significant differences were found across parameters [11]. Medial hindfoot: PM* and FM* feet demonstrated lower peak pressure, max force and decreased PTI (p<0.0001) than in the CG*. FM* feet showed decreased contact time compared with CG* (p=0.0173). Lateral hindfoot: PM* and FM* feet demonstrated lower peak pressure and PTI (p<0.0001) and lesser max force in FM* treated feet (p=0.0019) compared with CG*. Medial midfoot: FM* feet showed significant decrease in peak pressure (p=0.0011) compared with CG*.

	Lateral midfoot: PM* and FM* feet demonstrated significant differences compared with CG* for all parameters: peak pressure, max force, contact area %, contact time % and PTI ($p<0.0001$). Forefoot region: In the first metatarsal region all parameters were decreased in FM* and PM* groups compared with CG*: peak pressure, max force and PTI ($p<0.0001$), less contact time % ($p=0.0022$) and less contact area % ($p=0.0002$) Second metatarsal region: peak pressure, max force and PTI were significantly lower for FM* and PM* feet compared with CG* ($p<0.0001$) Lateral forefoot (3rd-5th metatarsal region) showed significantly <i>greater</i> max force, contact area% and contact time% for both FM* and PM* groups compared with CG* ($p=0.0059$, $p=0.0048$ $p<0.00001$, respectively) similar to findings in the lateral midfoot . Assessment of the geometry of the forefoot relative to the hindfoot: No significant difference between the PM* and FM* treated feet . Compared with the CG* both groups (FM* and PM*) had a significantly greater forefoot angle ($p<0.0001$) COP (center of pressure; figure e): comparing FM* feet with PM* feet there was no difference in the lateral COP ($p=0.2795$), but the medial COP was significantly less in the FM* than in the PM* feet ($p=0.0036$). Compared with the CG* both groups (FM* and PM*) had significantly greater lateralization of the COP ($p=0.0006$). [11]
The French functional physical therapy method of congenital clubfoot	It is very important to differentiate clubfoot according to their degree of severity when assessing the results of clubfoot treatment. The results are not always classified and the studies often are not homogeneous, therefore comparison and clear conclusions are difficult to establish [5]. The French Method is a functional physical treatment that aims to avoid surgery as much as possible. Average 50% of the patients obtained good results with conservative treatment. Including the PMM in the therapy the necessity of surgery has been reduced or changed in less extensive

	release. Further the conclusion was found that early triceps surae lengthening is effective and may decrease the need for future posterior release.
Nonoperative Clubfoot Treatment Using the French Physical Therapy Method	The outcome for all 142 feet, at an average follow-up of 35 months, was 42.3% excellent, 8.4% good, 28.9% fair and 20.4 % poor outcomes. When each category was examined separately, the outcomes correlated with the initial foot severity grade, using the Dimeglio scale of severity. The difference in outcomes between feet rated <i>moderate</i> and <i>severe</i> was not significant ($P= 0.18$) But both the feet rated <i>moderate</i> and the feet rated <i>severe</i> had significantly better outcomes than the feet rated <i>very severe</i> ($P< 0.001$). Thus, the initial Dimeglio severity score was shown to be prognostic for the eventual clinical outcome. The use of CPM (PMM) was shown to be beneficial for feet graded as moderate before treatment ($P<0.01$) but made no difference for the severe or very severe graded feet. [10]
Magnetic Resonance Imaging of the Congenital Clubfoot With the French Method	The severity of the 3-dimensional clubfoot deformities before treatment made it difficult to assess the joints relationship on single MRI projections (figure f) [12]. Even visualizing accurately the images, taken in 4 oriented planes, it was not always possible assess clearly the joint relationship. Nevertheless, after 12 weeks of treatment all feet clinically had a slight limitation in ankle dorsiflexion and with the achievement of a more plantigrade clinical foot position, the MRI images demonstrated more normal alignment of the tibiotalar joint, the navicular joint, the calcaneocuboid joint and improvement in the varus position of the calcaneus. The wedge shape of both the navicular and distal end of the calcaneus that occasionally was noted on the MRI before treatment improved after therapy. The one area of the foot that did not show significant MRI improvement after treatment involved the equinus position of the calcaneus. At the 12 week examination, equinus had not completely resolved. The limited amount of improvement in equinus noted proved to

be consistent with the patients' clinical findings as evidenced by four of them requiring heel-cord tenotomy. [12]

Figure a:

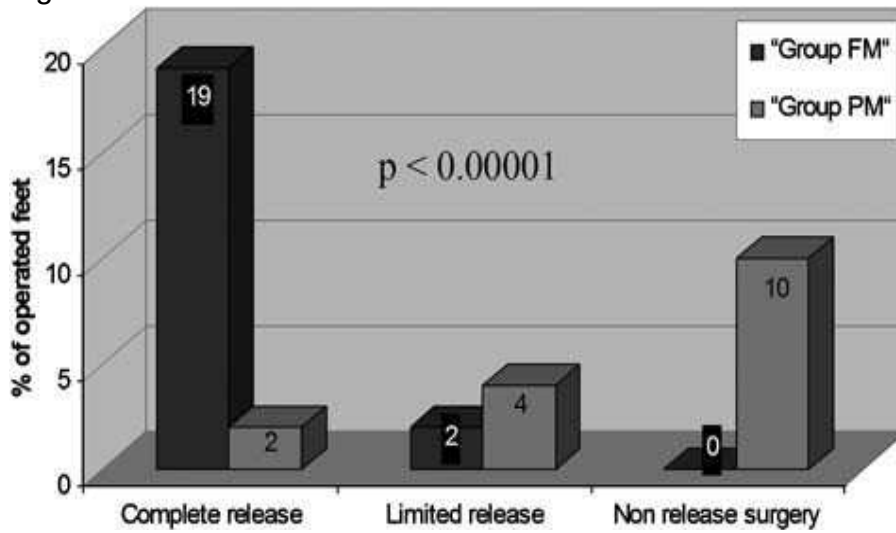


Figure b:

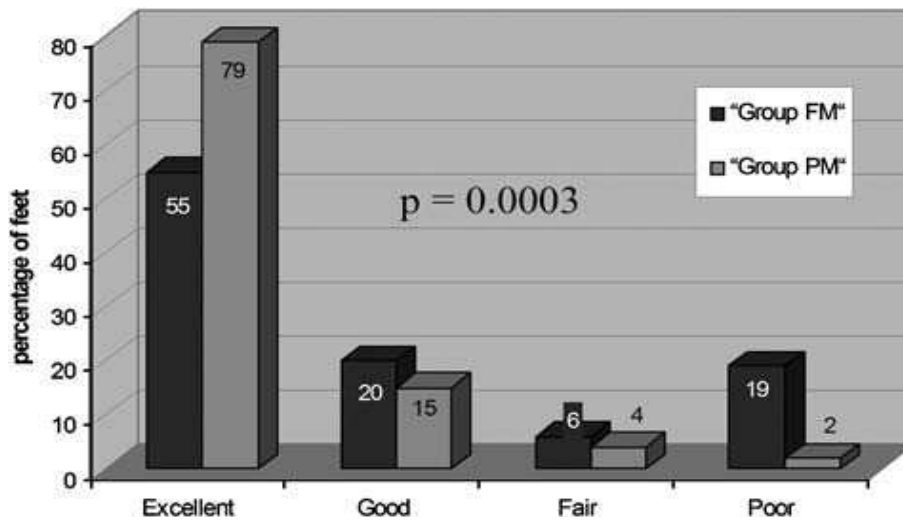
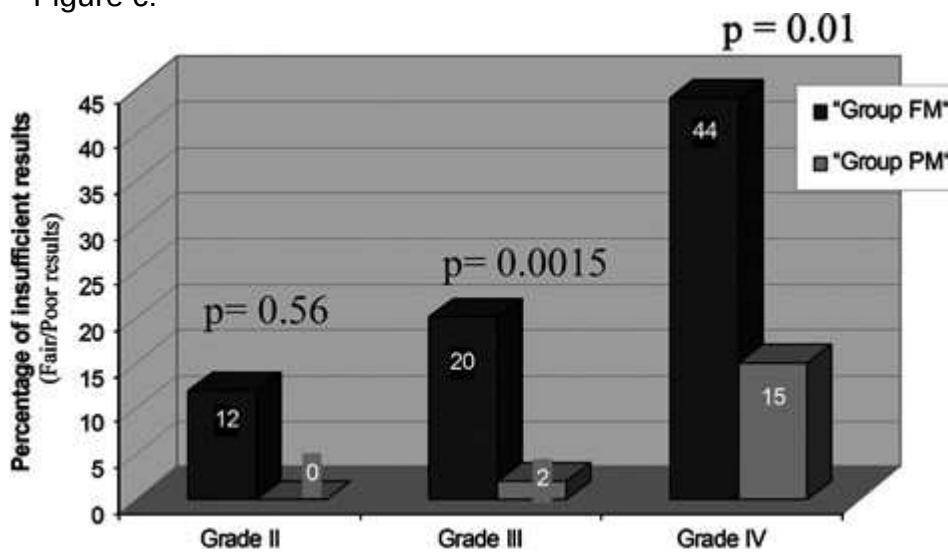


Figure c:



Figures a-c extract from [2]

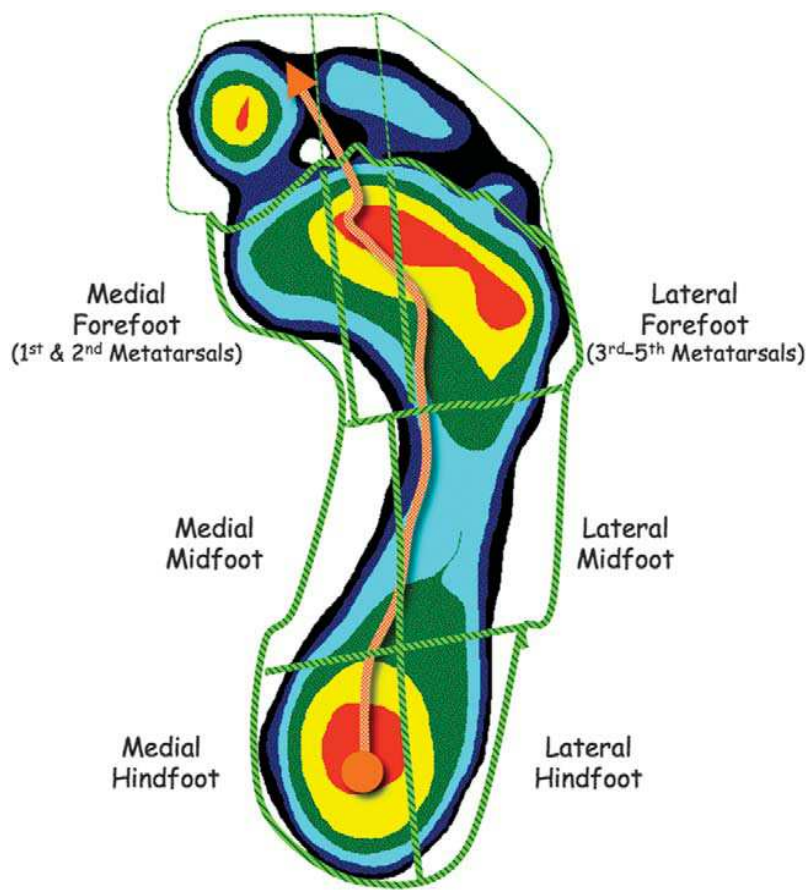


Figure d:
Subdivision of the foot: medial and lateral hindfoot, medial and lateral midfoot, medial forefoot (1st and 2nd metatarsal regions), and the lateral forefoot region (3rd-5th metatarsal region).

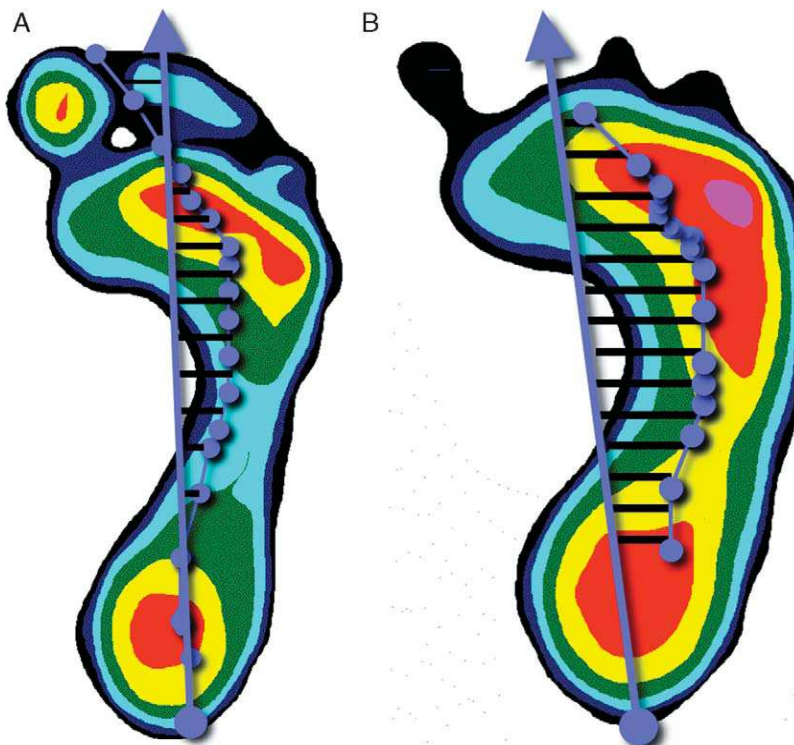


Figure e:
A and B, The center of pressure (COP) line was analyzed using the axis of the foot (determined by bisecting the heel through the second toe) assessing the medial and lateral COP displacement, for a normal foot (A) and for a treated clubfoot (B).

Figures d-e extract from [11]

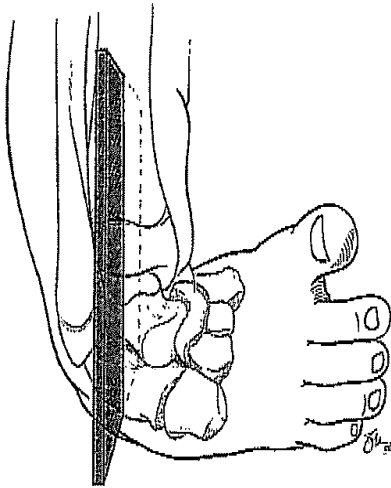


figure f:
the 3-dimensional deformity in the untreated clubfoot requires multiplane assessment as joint relationships vary so greatly from normal, as seen in this diagram. The MR images must be scrolled through to gain an accurate understanding of the relationships.

Figure f extract from [12]

Discussion

The conducted literature search revealed only a small number of recent publications which report exactly about the French Physical Therapy Method for congenital clubfoot treatment in newborns and these are partly of poor evidence. The literature search for the comparison of the two non-operative methods for idiopathic clubfoot treatment was more successful.

The studies, described in this work, show that it is very important to differentiate clubfeet according to their degree of severity, following a common grading score and to grade the feet before and after the completed treatment.

The use of CPM (PMM) seems to be beneficial for clubfeet, but more for moderate graded feet than for severe or very severe graded feet.

The early triceps surae lengthening (tenotomy) seems to be effective and may decrease the need for a future posterior release. MR images support this suspicion after noting that, in absence of a heel-cord tenotomy, equinus of the calcaneus persisted. [12]

The initial correction rates of the FM* treated feet, the normal gait, cadence parameters and ankle equinus seem very close to the PM* treated feet and do not demonstrate significant differences. The accurate analysis showed instead some important and significant differences in treatment outcomes, gait analyzes and plantar pressure. Grading after long-term follow-ups, especially for the very severe graded clubfoot, showed a better outcome in the Ponseti treated feet, a trend toward favorable clinical outcome in the PM*. This trend is supported by the gait analysis, plantar pressure analysis.

The modern literature does not offer a clear and uniform opinion of the best treatment form for congenital clubfoot. The differences in the results of vary publications can be the evaluation methods, the criteria of surgical indications, differences in follow-up term, cross-over treatments in multicenter studies versus single center studies, retrospective study versus prospective study, different sample sizes and last but not least the dependence of parent's compliance.

Conclusion

1) Is the French Method an evidence-based treatment form?

Due to the small number of publications and after working out these studies, the French Physical Therapy Method cannot be considered an evidence-based treatment form for Manual Therapists in Physiotherapy.

2) Is it possible to manual therapists to treat congenital clubfoot in newborns in a functional way and makes plaster treatment and surgery unnecessary?

At this point of time the French Physical Therapy Method is not a reliable treatment form that secure a good clinical outcome for all grades of congenital clubfoot.

Diméglio et al. itself concluded that early triceps surae lengthening is effective and

decreases the rate and the extent of surgery [5] and actually the rate of percutaneous heel-cord tenotomy increased from 10% in year 2000 to 24% in year 2002 [2]. The findings in MR imaging helped recognizing the need for more frequent heel-cord tenotomy in clubfoot treated with the French Method, too. [12]

Rather than comparing the French Method and the Ponseti casting treatment, as competitive treatments, the time has come to reconcile the differences between the two methods in order to combine the advantages of both and apply them in the same strategy to reduce the frequency and extent surgery, to decrease the risk of relapse and to achieve good anatomical, clinical and functional outcomes for the congenital clubfoot. Some literature already mentioned the “third way” [5], as the possible future treatment form for congenital clubfoot treatment.

It is not to forget the important role and compliance of the patient’s parents. The French Method is more depending on motivated, active parents and a well-trained physiotherapist with his expertise and motivation status.

Future, statistically significant, studies to analyze further evolution of the French Method, including frequent heel-cord tenotomy, is inevitable to improve the French Functional Physical Therapy Method and to become an evidence based treatment form for Manual Therapists.

Psychological long-term studies for analyzing the parent-children relationship, after a parent’s long-term co-therapist’s role, could be interesting and an important element for the treatment choice, as well as economic analyses.

Key Point

Congenital clubfoot, French Method, comparison, evidence based, Ponseti, heel-cord tenotomy

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Appendix:

Levels of Evidence for Primary Research Question Types of Studies

Table 1:

L E V E L	Therapeutic Studies/ Investigating the Results of Treatment	Prognostic Studies/ Investigating the Effect of a Patient Characteristic on the Outcome of Disease	Diagnostic Studies/ Investigating a Diagnostic Test	Economic and Decision Analyses/ Developing an Economic or Decision Model
I	• High-quality randomized controlled trial with statistically significant difference or no statistically significant difference but narrow confidence intervals • Systematic review 2 of Level-I randomized controlled trials (and study results were homogeneous 3)	• High-quality prospective study⁴ (all patients were enrolled at the same point in their disease with ≥80% follow-up of enrolled patients) • Systematic review² of Level-I studies	• Testing of previously developed diagnostic criteria in series of consecutive patients (with universally applied reference "gold" standard) • Systematic review 2 of Level-I studies	• Sensible costs and alternatives; values obtained from many studies; multiway sensitivity analyses • Systematic review 2 of Level-I studies
II	• Lesser-quality randomized controlled trial (e.g., <80% follow-up, no blinding, or improper randomization) • Prospective 4 comparative study 5 • Systematic review 2 of Level-II studies or Level-I studies with inconsistent results	• Retrospective 6 study • Untreated controls from a randomized controlled trial • Lesser-quality prospective study (e.g., patients enrolled at different points in their disease or <80% follow-up) • Systematic review 2 of Level-II studies	• Development of diagnostic criteria on basis of consecutive patients (with universally applied reference "gold" standard) • Systematic review 2 of Level-II studies	• Sensible costs and alternatives; values obtained from limited studies; multiway sensitivity analyses • Systematic review 2 of Level-II studies
III	• Case-control study 7 • Retrospective 6 comparative study 5 • Systematic review 2 of Level-III studies	• Case-control study 7	• Study of nonconsecutive patients (without consistently applied reference "gold" standard) • Systematic review 2 of Level-III studies	• Analyses based on limited alternatives and costs; poor estimates • Systematic review 2 of Level-III studies
IV	Case series	Case series	• Case-control study • Poor reference standard	• No sensitivity analyses
V	Expert opinion	Expert opinion	Expert opinion	Expert opinion

1. A complete assessment of the quality of individual studies requires critical appraisal of all aspects of the study design.
2. A combination of results from two or more prior studies.
3. Studies provided consistent results.
4. Study was started before the first patient enrolled.
5. Patients treated one way (e.g., with cemented hip arthroplasty) compared with patients treated another way (e.g., with cementless hip arthroplasty) at the same institution.
6. Study was started after the first patient enrolled.
7. Patients identified for the study on the basis of their outcome (e.g., failed total hip arthroplasty), called "cases," are compared with those who did not have the outcome (e.g., had a successful total hip arthroplasty), called "controls."
8. Patients treated one way with no comparison group of patients treated another way.

This chart was adapted from material published by the Centre for Evidence-Based Medicine, Oxford, UK. For more information, please see www.cebm.net.

*extract from: <http://jbj.org/public/instructionsauthors.aspx#LevelsEvidence>



Figure 2
An example of a clubfoot with residual radiographic equinus (on standing lateral radiograph), following nonoperative treatment.

Figure 2 extract from [11]

TABLE 2. Demographic and Kinematic Data for the 2 Treatment Groups

	Ponseti Cast	Physical Therapy	<i>P</i>
No. patients	15	18	
No. feet	17	23	
Average Dimeglio score (range)	8.2 (6-9)	8.3 (6-9.5)	0.576
Equinus gait	1 (6%)	4 (17%)	0.280
Foot drop	0 (0%)	6 (26%)	0.026
Increased ankle dorsiflexion	3 (18%)	4 (17%)	0.649
Calcaneus gait	0 (0%)	1 (4%)	0.575
Internal foot progression angle	6 (35%)	8 (35%)	0.616
Internal shank-based foot rotation*	10 (67%)	10 (59%)	0.262
Normal sagittal plane ankle motion	14 (82%)	11 (48%)	0.027
Normal gait	6 (35%)	6 (26%)	0.388
No. feet requiring TAL	7 (41%)	3 (13%)	0.066

The values are the number of feet identified, with the percentage of the total number of feet in parentheses.

*Eight feet (6 PT and 2 Ponseti cast) did not have measurements for internal shank-based rotation. Percentages for this measurement reflect 15 Ponseti cast and 17 PT feet.

PT indicates physical therapy; TAL, tendo-achilles lengthening.

Table 2 extract from [13]

Table 3

Plantar Pressures Comparing Cast (n=79), PT (n=72) and Control (n=28)																					
	 Hindfoot						 Midfoot						 Forefoot								
	Medial			Lateral			Medial			Lateral			1st Met.			2nd Met.			3-5th Mets		
	Mean	± SD	P	Mean	± SD	P	Mean	± SD	P	Mean	± SD	P	Mean	± SD	P	Mean	± SD	P	Mean	± SD	P
Peak Pressure																					
CAST	9.68	2.91		9.82	2.76		8.22	2.67		10.34	2.72		5.48	2.76		9.23	3.20		12.11	3.94	
PT	8.15*	2.19	< 0.0001	8.69	2.09	< 0.0001	6.90*	2.51	0.0011	11.08	3.79	< 0.0001	4.84	2.72	< 0.0001	8.27	2.89	< 0.0001	13.28	5.80	0.1851
Control	17.80†	5.01		15.75†	4.05		8.68‡	2.37		7.98†	1.84		10.55†	4.32		11.41†	2.61		11.364	3.79	
Max Force																					
CAST	28.22	9.16		29.15	9.81		15.94	12.79		49.65	13.83		9.79	7.12		16.17	5.57		44.31	14.15	
PT	21.44*	7.25	< 0.0001	24.50*	9.32	0.0019	11.71	8.47	0.0305	51.18	11.91	< 0.0001	9.42	7.58	< 0.0001	13.79	5.60	< 0.0001	43.58	14.68	0.0059
Control	38.75†	8.82		30.70‡	8.42		11.93	6.35		19.91†	6.90		20.68†	7.94		19.14†	4.46		34.59†	12.19	
Contact Area %																					
CAST	11.48	1.27		11.77	1.95		8.65	4.10		20.09	3.28		7.58	3.37		8.75	1.43		19.39	4.27	
PT	10.93	1.34	0.0389	12.04	3.55	0.4426	7.64	3.78	0.2539	21.50	3.07	< 0.0001	8.06	4.20	0.0002	8.62	1.81	0.6108	20.13	2.84	0.0048
Control	11.22	1.26		11.29	1.14		8.67	4.25		15.14†	2.85		10.85†	1.96		8.98	1.69		16.92†	3.12	
Contact Time %																					
CAST	48.11	14.65		53.32	13.38		58.33	16.37		79.19	6.21		64.00	22.51		81.31	11.24		89.19	6.19	
PT	42.74	18.10	0.0173	51.43	14.66	0.6325	53.74	22.16	0.0770	81.18	7.12	< 0.0001	66.31	24.53	0.0022	82.89	12.49	0.5779	91.52	7.76	< 0.0001
Control	51.82‡	9.96		51.29	9.55		49.72	12.27		63.14†	9.51		80.86†	9.22		83.53	9.21		82.61†	10.97	
PTI																					
CAST	1.35	0.68		1.51	0.62		1.41	0.71		2.60	0.74		1.01	0.62		1.81	0.63		2.73	0.94	
PT	1.02*	0.57	< 0.0001	1.31	1.61	< 0.0001	1.16	0.74	0.0885	2.79	0.95	< 0.0001	0.97	0.58	< 0.0001	1.72	0.60	< 0.0001	2.91	1.13	0.1068
Control	2.43†	0.69		2.20†	0.60		1.30	0.48		1.50†	0.47		2.39†	1.14		2.35†	0.56		2.44	0.81	
Significant differences are as follows: *Cast different from PT. †Cast/PT different from Control. ‡PT different from Control. PT indicates physiotherapy; PTI, pressure time integral.																					

Table 3 extract from [11]