**Name of Journal: *World Journal of Orthopedics***

**Manuscript NO: 47448**

**Manuscript Type: ORIGINAL ARTICLE**

***Retrospective Study***

**Functional physiotherapy method results for the treatment of idiopathic clubfoot**

García-González NC *et al*. Physiotherapy of clubfoot

**Noriela Carmen García-González, Jorge Hodgson-Ravina, Armando Aguirre-Jaime**

**Noriela Carmen García-González, Jorge Hodgson-Ravina, Armando Aguirre-Jaime,** Servicio de Rehabilitación, Servicio de Ortopedia y Traumatología, Unidad de Investigación Clínica y Experimental, Hospital Universitario Nuestra Señora de Candelaria, Santa Cruz de Tenerife 38010, Spain

**Armando Aguirre-Jaime,** Colegio de Enfermería, Laureate International Universities, Santa Cruz de Tenerife 38001, Spain

**ORCID number:** Noriela Carmen García-González (0000-0001-8274-9653); Jorge Hodgson-Ravina (0000-0001-6351-5827); Armando Aguirre-Jaime (0000-0002-0749-4993).

**Author contributions:** García-González NC conceived the study and helped with design, performed procedures, acquired data, analyzed results and wrote the manuscript; Aguirre-Jaime A helped with study conception and designed the study, and with the writing of the manuscript, processed data, and interpreted results; Hodgson-Ravina J performed procedures and collected data; All authors reviewed and approved the final version of manuscript prior to submission.

**Institutional review board statement:** This study was reviewed and approved by The Ethics Committee of Nuestra Señora de Candelaria University Hospital.

**Informed consent statement:** Parents were not required to give informed consent to the study because the analysis used anonymous clinical data that were obtained after each parent agreed to standard treatment by verbal consent.

**Conflict-of-interest statement:** All authors declare no conflicts-of-interest related to this article.

**Open-Access:** This article is an open-access article that was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

**Manuscript source:** Unsolicited manuscript

**Corresponding author: Noriela Carmen García-González, BSc, MSc, Physiotherapist,** Servicio de Rehabilitación, Hospital Universitario Nuestra Señora de Candelaria, Carretera del Rosario 145, Santa Cruz de Tenerife 38010, Spain. ngargon@gobiernodecanarias.org

**Telephone:** +34-92-2602310

**Fax:** +34-92-2600597

**Received:** March 18, 2019

**Peer-review started:** March 19, 2019

**First decision:** April 15, 2019

**Revised:** May 9, 2019

**Accepted:** May 21, 2019

**Article in press:** May 22, 2019

**Published online:** June 18, 2019

**Abstract**

***BACKGROUND***

Idiopathic clubfoot is a congenital deformity of multifactorial etiology. The initial treatment is eminently conservative; one of the methods applied is the Functional physiotherapy method (FPM), which includes different approaches: Robert Debré (RD) and Saint-Vincent-de-Paul (SVP) among them. This method is based on manipulations of the foot, bandages, splints and exercises adapted to the motor development of the child aimed to achieve a plantigrade and functional foot. Our hypothesis was that the SVP method could be more efficient than the RD method in correcting deformities, and would decrease the rate of surgeries.

***AIM***

To compare the RD and SVP methods, specifically regarding the improvement accomplished and the frequency of surgery needed to achieve a plantigrade foot.

***METHODS***

Retrospective study of 71 idiopathic clubfeet of 46 children born between February 2004 and January 2012, who were evaluated and classified in our hospital according to severity by the Dimeglio-Bensahel scale. We included moderate, severe and very severe feet. Thirty-four feet were treated with the RD method and 37 feet with the SVP method. The outcomes at a minimum of two years were considered as very good (by physiotherapy), good (by percutaneous heel-cord tenotomy), fair (by limited surgery), and poor (by complete surgery).

***RESULTS***

Complete release was not required in any case; limited posterior release was done in 23 cases (74%) with the RD method and 9 (25%) with the SVP method (*P* < 0.001). The percutaneous heel-cord tenotomy was done in 2 feet treated with the RD method (7%) and 6 feet (17%) treated with the SVP method (*P* < 0.001). Six feet in the RD group (19%) and twenty-one feet (58%) in the SVP group did not require any surgery (*P* < 0.001).

***CONCLUSION***

Our study provides evidence of the superiority of the SVP method over the RD method, as a variation of the FPM, for the treatment of idiopathic clubfoot.

**Key words:** Congenital clubfoot; Clubfeet; Talipes equinovarus; Conservative treatment; Physical therapy; Physiotherapy techniques; Conservative methods

**© The Author(s) 2019.** Published by Baishideng Publishing Group Inc. All rights reserved.

**Core tip:** We have compared the clinical results of the treatment of idiopathic clubfoot in the context of the improvement accomplished and the frequency of surgery needed to achieve a plantigrade foot with two Functional physiotherapy methods: Robert Debré (RD) and Saint-Vincent-de-Paul (SVP). Both approaches managed to avoid complete surgery, which shows that the physiotherapies achieve a more flexible foot, allowing a more conservative surgery. Our data indicate that the SVP method achieves prolonged correction of deformities more efficiently than the RD method; the best advantage of the SVP method over the RD method was the greater number of cases without any surgery.

**Citation**: García-González NC, Hodgson-Ravina J, Aguirre-Jaime A. Functional physiotherapy method results for the treatment of idiopathic clubfoot. *World J Orthop* 2019; 10(6): 235-246 Available from:

**URL**: https://www.wjgnet.com/2218-5836/full/v10/i6/235.htm

**DOI**: https://dx.doi.org/10.5312/wjo.v10.i6.235

**INTRODUCTION**

Idiopathic clubfoot is a common birth defect that occurs in one per 1,000 births. The etiopathogenesis has been linked to several genes and environmental factors, such as consanguinity of the parents, smoking during pregnancy, maternal age, alcohol consumption, oligohydramnios, among others. Approximately 20% of clubfeet are associated with distal arthrogryposis, myelomeningocele, amniotic bands, or other genetic syndromes, and in some cases with talar vertical. In 80% of cases, the etiology is unknown and are referred to as idiopathic clubfoot, of which almost 25% have family history[1-5]. Children with idiopathic clubfeet may have problems with balance, coordination, gross motor function, strength and agility. Neurological developmental difficulties should also be taken into account at the time of assessment, since knowledge of these conditions could facilitate the management of treatment, and the support needed for the patient and their families. The perception of difficulties in mobility, day-to-day activities, pain and discomfort negatively affect the quality of life. The diagnosis of clubfoot has a negative psychological impact for the parents; therefore, it is important that they receive emotional support, information and education about the pathology[6-10]. Currently, the initial treatment of clubfoot is eminently conservative. Among the best-known conservative methods, we highlight the Ponseti method (PM) and the Functional physiotherapy method (FPM), also called the French method. The PM includes manipulation, serial casting, Achilles tendon tenotomy and foot abduction brace. Several studies have reported that PM achieved the initial correction in a shorter time (3 to 13 castings), and 79%-96% of cases are subjected to tenotomy. Some problems have been reported, which include plaster, the above-knee cast making the perineal hygiene more difficult, the removal of cast making it stressful for the child and parents, skin wounds that can be produced by the cast knife or saw, and even skin burns caused by exothermic reaction[11-14]. The FPM is based on manipulations of the foot, bandages, splints and exercises adapted to the motor development of the child aimed to achieve a plantigrade and functional foot. The treatment is extended after the correction phase (around 3 mo) until the child reaches independent walking. The thermoplastic splints are light and of variable rigidity, easy to place by the parents, have good acceptance by the family and child, allow adequate perineal hygiene, and adapt to the phases of motor development. The FPM provides comprehensive care; it deals with very important aspects such as proprioception, coordination, balance, flexibility, muscular reinforcement, resistance, facilitates the acquisition of motor skills, in addition to educating and training parents for the management of the pathology. The different approaches of the FPM[15] have enriched the working context of the different multidisciplinary teams, including Bensahel *et al*[16] [Robert Debré (RD) method], Seringe *et al*[17,18] [Saint Vincent de Paul (SVP) method] and Dimeglio *et al*[19] (Montpellier method). However, there is a lack of comparative studies between them. Our hypothesis was that the SVP method could achieve prolonged correction of deformities more efficiently than the RD method and decrease the rate of surgeries. The goal of this study was to compare the clinical results of the treatment of idiopathic clubfoot regarding both the improvement accomplished and the frequency of surgery needed to achieve a plantigrade foot with two FPM: the RD and SVP.

**MATERIALS AND METHODS**

***Patients***

This is a retrospective study of a series of cases of clubfeet (*n* = 71). The review of the therapeutic outcome was carried out on 46 children born between February 2004 and January 2012 with idiopathic clubfoot. The feet were treated in a public hospital with the RD method (*n*1 = 34, before 2009) and the SVP method (*n*2 =37, from 2009). Data were taken from the medical records. The children were between 11 and 45 d old when they began treatment, and had a minimum follow-up of two years. Before starting the treatment, feet were photographed (to observe the conditions of the feet in detail and the sequential progress during the treatment, serving as support of the information obtained with the scale), evaluated and then classified according to the severity based on the Dimeglio-Bensahel scale[20] by physicians or physiotherapists experienced with this rating system. This scale ranges from 0 to 20 points (0, 1-5, 6-10, 11-15 and 16-20, corresponding to normal, benign, moderate, severe, and very severe foot, respectively). This scale is widely used, and has proven to be reliable and reproducible in preceding intra-observer and interobserver studies[21,22]. We included children that were treated in our hospital with moderate, severe and very severe idiopathic clubfoot; those who attended the treatment sessions and complied with good observance of the protocol (these data was reflected in the clinical records through the care control sheet carried out by the physiotherapist responsible for each case), and we excluded those classified as benign or non-idiopathic, those previously treated with another method in other hospitals, and those who did not perform the sessions or did not properly comply with the protocol. The Ethics Committee of the Nuestra Señora de Candelaria University Hospital approved this study.

***Interventions***

Trained physiotherapists with over ten years of experience working with the RD method performed the treatment. Our experience with the SVP method started in 2009 after the team received training in Paris.

The RD group was treated according to the approach proposed by Bensahel *et al*[16], and also followed by Souchet *el al*[23]. We manipulated the foot daily and sequentially, and then applied elastic and nonelastic taping (closing the taping with a cohesive bandage to give greater consistency) between the sessions to maintain the correction obtained, until the pre-standing stage. When the child began to walk, a straight shoe was worn during the day and the Denis-Browne bar at nighttime. After correction of the foot was obtained, the parents continued the stretching, the splinting and exercises daily. The SVP group was treated according to the approach proposed by Seringe *et al*[17,18] with an additional manipulation for the correction of the cavus, as previously described[11]. This additional manipulation consisted in slightly supinate position with the forefoot moving into its proper alignment with the hindfoot. We manipulated the foot daily and globally, applied an inextensible taping on a rigid plantar plate between the sessions, and then a splint was placed full-time to keep the foot aligned with respect to the leg. The physiotherapist shaped the splint according to the correction achieved and the growth of the child. When the child began to walk, a straight shoe was worn during the day and the short splint during naps, with an above-knee splint overnight. After correction of the foot was achieved, the parents continued the stretching, placing the taping, splinting and exercises daily.

Both interventions were similarly performed. Before starting the treatment, the team explained to the parents the procedure and the care needs. We also stressed that the adhesion of parents to the treatment is a prerequisite for success. Therefore, they were given clear instructions about the use of the splint and the importance of rigorously complying with the protocol. During the sessions, the parents were asked if they complied with the guidelines given and if they experienced any difficulty. The treatment was divided by stages, always adapted to each case: (1) Stage of deformities reduction: the first 3 mo, with physiotherapy daily; (2) Stage of maintenance: from 4th month until pre-standing, with physiotherapy two or three times a week. The parents were trained by the physiotherapist to perform daily stretching, taping, splinting and exercises; and performed these tasks in some sessions in order to check the training; (3) Stage of standing and walking: passive mobilizations, with active physiotherapy one or two times a week, adapted to the motor development of the child (some manipulations and active physiotherapy are shown in Figures 1 and 2, respectively). In those cases in which we observed a slight adduct of the forefoot when the child walked, a flexible bandage was applied to use with the footwear in order to improve the support and realign the foot with the leg.

The manipulations were performed daily with gentle joint tractions with the child stress-free, each session lasted 30 min per foot and was done by the same physiotherapist. In each bimonthly consultation, the feet were rated again using the Dimeglio-Bensahel scale[20] in order to objectify the improvement achieved (also, a series of photographs of the feet were taken); a score ≤ 5 was considered good enough, and > 5 not good enough. If at 8 mo of age the treatment was no longer effective, the evolution was considered stabilized and two surgeons evaluated the need for surgery and the optimal time to perform it. In our hospital, it was generally between 10-11 mo old; the surgeon considered that upon re-initiation of physiotherapy post-surgery, the child would be prepared to stand up, and this contributed to maintaining the correction of the equine of the calcaneus. According to the clinicalassessment, we estimated that for the feet that did not exceed 90 degrees ankle dorsiflexion, a percutaneous heel-cord tenotomy was scheduled. When the calcaneus remained elevated with contracture of the posterior soft tissues without reaching 90 degrees of dorsiflexion of the ankle, a limited release was scheduled (Achilles tendon lengthening, with subtalar and tibiotalar capsulotomy). In specific cases, limited surgery could be supplemented with release of the adductor hallucis, and/or plantar fascia through a mini-incision; these were noted as nonrelease surgeries). When the foot was not corrected, and kept triple deformation and stiffness, a complete release (extensive posteromedial release) would be indicated. The surgery was a complementary intervention and was tailored to the specific needs of each case, with an intent to be as conservative as possible. The feet were not X-rayed at the time of revision.

The immobilization was performed with long plaster in knee flexion at 90 degrees for 4-6 wk. At 3 wk, the cast was changed in the operating room under anesthesia to check the correctness achieved, the skin and the scar. The physiotherapy post-surgery was immediately provided to stabilize the correction achieved, including in cases of surgery for recurrence. When the child walked properly, the treatment was considered complete. Then the child was discharged and was controlled each month, then eventually every 3-6 mo, and throughout the growth to detect any functional impairment. If there was any deterioration, it was again referred to physiotherapy. We recommended using the splints up to 4-5 years old, according to severity and evolution.

We could not complete the data for three patients (four feet) because they did not follow the treatment properly for various reasons: three feet in the RD group (two of which developed an allergy to the taping and had to stop the treatment, and one of a child who was changed to another hospital) and one foot in the SVP group also due to a change of residence. Therefore, we did not get considered for the results.

***Assessment of outcome***

The primary outcome measure was the rate of the severity of deformity by the Dimeglio-Bensahel scale[20]. To get this scoring, the degrees of reducibility of the internal rotation of the calcaneo-forefoot block, the adduction of forefoot relative to hindfoot, the equinus and the varus of the hindfoot were measured using a small goniometer and the charts. These four components can add a maximum of 16 points. It was also taken into account whether the foot presented medial and posterior creases, cavus, and the poor muscle condition (hypertonic, contracture, amyotrophic). Each of these conditions adds one more point. A second outcome measure was the need of complementary surgery to achieve a plantigrade foot. Other data recorded were the affected laterality, gender, and date of birth. To achieve a plantigrade foot, patient outcome were defined as: (1) very good, when obtained only by physiotherapy; (2) good, complemented by percutaneous heel-cord tenotomy; (3) fair, complemented by limited release; and (4) poor, complemented by complete release.

***Statistical analysis***

A biomedical statistician performed a statistical review of the study. The sample characteristics were summarized as relative frequencies of their component categories for nominal variables and as median (range) for numerical variables due to its non-normal distribution. Comparisons between treatments were performed with the *χ*2 tests for nominal variables and the *U* test for numerical ones. The odds-ratio (OR) analysis was used to determine the relapse rate of the approaches. We observed a 25% success rate (good and very good results) with the RD method; so in order to detect a clinically relevant difference of at least 40% more success with the SVP method, a sample of 31 feet in each treatment group would be required to achieve a study power of 90% in bilateral hypothesis testing with a level of statistical significance *P* ≤ 0.05. All calculations were carried out using the statistical software package IBM SPSS 24.0® for Windows NT®.

**RESULTS**

Due to the lack of data from 3 patients (4 feet), the final sample consisted of 67 idiopathic clubfeet from 43 children (29 males and 14 females). Thirty-one feet (46%) were treated with the RD method and thirty-six feet (54%) were treated with the SVP method. The comparison of both groups at baseline is shown in Table 1. Both groups showed homogeneity at baseline for all the considered factors; although the average age of the children in the SVP group was lower, the differences were not statistically significant. The comparison of the improvement achieved by category with RD and SVP groups at 8 mo with respect to baseline is shown in Table 2. It has been found that the percentage of moderate feet that reached normality was lower in the group treated with the RD method (40%) compared to those who were treated with the SVP method (80%); the percentage of severe feet that managed to reclassify as benign was lower in the group treated with the RD method (16.6%) compared to those who were treated with the SVP method (100%); the percentage of very severe feet that managed to reclassify as benign was null in the group treated with the RD method (0%) compared to those who were treated with the SVP method (44.4%). A statistically significant difference was reached *P* = 0.001. The comparison of the results obtained by category at two years of age for the RD and SVP groups to achieve a plantigrade foot according to the procedure that was necessary is shown in Table 3. It has been seen that only 60% of moderate feet treated with the RD method were corrected with physiotherapy *versus* 100% of those treated with the SVP method. The 100% of severe feet treated with RD needed limited surgery; while of those treated with SVP, 65% were corrected with physiotherapy and 35% with hell-cord tenotomy. With both methods, all very severe feet required limited surgery. The outcomes were very good for 19% (only physiotherapy), good for 7% (with heel-cord tenotomy), fair for 74% (limited posterior release), and poor for 0% (complete release); and very good for 58% (only physiotherapy), good for 17% (with heel-cord tenotomy), fair for 25% (limited posterior release), and poor for 0% (complete release) for the feet treated with RD and SVP methods, respectively (*P* < 0.001). In the RD group, surgery was supplemented with release of the adductor hallucis and/or plantar fascia in 11 feet, and in the SVP group it was supplemented only in two feet. Examples of the progression of the clubfeet with the RD and SVP methods are shown in Figures 3 and 4, respectively.

In the RD group, the relapses occurred between two and three years old in five very severe feet that initially had fair outcomes; these were treated again with physiotherapy, but required another limited surgery. In the SVP group, the relapses occurred at 3 years old in five feet. Four of these feet were initially very severe and one foot was severe. Three of these feet initially had a fair outcome; two feet required another limited surgery, and one foot at the time of review was undergoing physical therapy; and the remaining two feet that initially had good outcomes were rescued with physiotherapy. An OR = 1.20 indicates that the probability of relapse in the RD group is 1.2 times more than in the SVP group. It is shown in Table 4.

**DISCUSSION**

We compared two approaches of the FPM regarding the improvement accomplished and the frequency of surgery needed to achieve a plantigrade foot. Our data indicate that the SVP method achieved prolonged correction of deformities more efficiently than the RD method, and substantially decreased the rate of surgeries. In this study, we revealed that both approaches managed to avoid complete surgery, which points to the overall effectiveness of the FPM. This shows that the physiotherapy achieved a more flexible foot, allowing a more conservative surgery. This is particularly significant because it has been shown that extensive surgery results in long-term overcorrection, stiffness, pain and osteoarthritis of the foot and ankle; a lesser correction is well-tolerated and easier to treat in adulthood than a hypercorrection[24]. Our major difficulty with the RD method was the failure to satisfactorily correct the equinus of the calcaneus; most children did not keep the feet inside the shoes with the Denis-Browne bar, despite the adjustments made inside the shoes. In these cases, we had to use only a simple taping. The taping was not enough to maintain the correction achieved in the sessions, and this therefore led to a high frequency of surgeries. In the RD group, two moderate feet improved and became benign**,** but required a limited release at 15 mo of age due to the persistence of the equine ankle; perhaps in this case, an early hell-cord tenotomy could have prevented it, but we thought that it was due to the lack of efficacy of the containment available. With the SVP method, we more effectively maintain the corrections, and this aspect defines its success. Our result was not due to a reflection of experience with the RD method, however the success rate of the SVP was a consequence of the SVP protocol itself. In the first place, the bandage used on the rigid plate has a greater consistency than just a simple bandage; the strips of tape are more effective because we can achieve a better traction over the calcaneus and fix them to the plate. Second, the rigid plate has the advantage of being angled to 20 degrees on the back in order to continue the descent of the calcaneus. Third, the splints we used were very effective to maintain the correction, adapting completely to each foot. Despite frequent checks and the education received by parents, who assured us that they had followed the instructions received, some families reported that they were unable to achieve compliance post-treatment of the splinting, and these were the cases that relapsed. The relapse rates had a negative association with the applied approach. We want to show when the first relapse appeared in each group, and to determine which approach was able to maintain the correction for a longer period. In the recurrent cases that required surgery, the limited surgery was considered the best option at this stage of growth, and also because the physical therapy was able to maintain the foot with degrees of flexibility, allowing us to consider a more conservative surgery. The improvement achieved with the RD method by category was similar to that described by Souchet *et al*[23] in the evaluation of the results at the end of the conservative treatment. They compared the outcomes of conservative treatment to the at-birth classification, and found that 50% of moderate feet had a reclassification to benign; 100% of severe feet improved and became moderate; the very severe feet improved and 60% became moderate. Our results with the RD group also correlated with those obtained by Van Campenhout *et al*[25]. In this study, 75% of the cases require an operation in order to achieve a plantigrade foot. Rampal *et al*[26] report that more than half of the cases treated with the SVP method do not require surgery; we obtained similar results with our SVP group (58% without any surgery). Different teams had compared the results of the FPM with the PM. Richards *et al*[27] define their good results as plantigrade foot with or without heel-cord tenotomy; they reported good results for 72% of thefeet treated with the PM. Although they obtained better results with the PM than with the FPM, the differences did not reach statistical significance. Inour SVP group, we found good results in 75% of the feet. The results obtained by Chotel *et al*[28] with the FPM showed 17% of hell cord tenotomy and 21% of surgeries (correlates with our SVP group, 17% and 21% respectively). However, theseauthors found that94% of the feet treated with PM were subjected to hell-cord tenotomy and 16% required surgery. In this study, the difference between FPM and PM was the type of surgery applied, and this was also due to the criterion of surgical indication in each team. They showed that the increase in the ratio of hell-cord tenotomy in the FPM (24%) managed to decrease the ratio of need for surgery (10%). Two studies of magnetic resonance imaging (MRI) showedsimilar corrections achieved with the PM and the FPM, except for the persistence of the equine of the calcaneus on the feet treated with the FPM[29,30]. We must bear in mind that these feet had not suffered any hell-cord tenotomy at the time of the last MRI study, contrary to the feet treatedwith the PM, and all feet had been subjected to the hell-cord tenotomy before the last MRI study. There is still controversy as to which method is better, but it has been demonstrated that both methods achieve similar results; the FPM is as effective as the PM, and the differences between them do not reach statistical significance[8,31-33]. Regarding the learning curve of FPM approaches, we want to point out that learning and mastering the necessary skills to successfully apply the method takes time and requires knowledge. Thanks to its repetitive and extensive process, learning and experience are facilitated until reaching the stability that allows maintaining an adequate rhythm of work.

This study has limitations; the change from one treatment method to another resulted in an inherent bias in the techniques, since the onset of the SVP approach concurred with the learning curve of the latter by the physiotherapists. However, this did not appear to affect the comparability of groups, nor to the SVP group. In any case, the bias would have been produced against the SVP method, meaning that if our experience with the SVP protocol had matched the experience gained with the RD method, and if we had applied randomization, this would have generated even better results for the SVP group. Moreover, the rehabilitation department organization did not allow us to perform both treatment protocols simultaneously; for that reason, we carried out a retrospective study. Due to the high rate of surgery required for complete correction of idiopathic clubfoot using the RD method, we discarded the RD method in favor of the SVP method. In conclusion, the SVP method achieves prolonged correction of deformities more efficiently than the RD method; the best advantage of the SVP method is the greater number of cases without any surgeries. The SVP method should be regarded as a clearly beneficial option for the treatment of idiopathic clubfoot. Further studies are needed to corroborate or refute our results.

**ARTICLE HIGHLIGHTS**

***Research background***

Idiopathic clubfoot is a common birth defect that affects the musculoskeletal system. The initial treatment is conservative. The Functional physiotherapy method (FPM) is based on manipulations of the foot, bandages, splints, and exercises adapted to the motor development of the child to achieve a plantigrade and functional foot with the smallest surgical gesture possible. There are different approaches to the same method, but there is a lack of comparative studies between them. This study describes the results obtained with two approaches of this method [Robert Debré (RD) and Saint-Vincent-de-Paul (SVP)] revealing a significant difference in the ratio of surgeries before and after implementing the SVP method

***Research motivation***

The motivation behind this study was to detect the most effective FPM approach for maintaining corrections and reducing the rate of surgeries. This is very important because it would translate into saving resources, and would determine whether our institution should continue supporting the application of this method. The results of this study can encourage the implementation of FPM for us by other professionals who are seeking to both improve their interventions in clubfoot and reduce the ratio of surgeries.

***Research objectives***

The objective of this study was to compare two approaches of the FPM (RD and SVP) with regard to the improvement achieved and the frequency of surgery necessary to achieve a plantigrade foot, and to determine if the choice of one method or another would generate a substantial decrease in the rate of surgeries of clubfoot.

***Research methods***

A retrospective review of the therapeutic outcome was carried out for a series of 71 idiopathic clubfeet on 46 children born between February 2004 and January 2012. Data were taken from the medical records. The clubfeet were evaluated and classified according to severity by the Dimeglio-Bensahel scale; we included moderate, severe and very severe feet. Thirty-four feet were treated with the RD method, and 37 feet with the SVP method. The outcomes at a minimum of two years were considered as very good (by physiotherapy), good (by percutaneous hell-cord tenotomy), fair (by limited surgery), and poor (by complete surgery). Comparisons between treatments were performed with the *χ*2 tests for nominal variables, and *U* test for numerical ones. The OR test was used for relapse rates. A two-tailed *P*-value ≤ 0.05 was considered statistically significant.

***Research results***

Complete release was not required in any case; limited posterior release was done in 23 cases (74%) with the RD method and 9 (25%) with the SVP method (*P* < 0.001). The percutaneous heel-cord tenotomy was done in 2 feet treated with the RD method (7%) and 6 feet (17%) treated with the SVP method (*P* < 0.001). Six feet in the RD group (19%) and twenty-one feet (58%) in the SVP group did not require any surgery (*P* < 0.001). The Dimeglio-Bensahel scale is useful for reflecting the severity of the deformity, and for analyzing the results category by category.

***Research conclusions***

Our hypothesis that the SVP method could achieve prolonged correction of deformities more efficiently than the RD method, as well as decrease the rate of surgeries, was confirmed in this study. The best advantage of the SVP method was the greater number of cases without any surgeries. No new methods were proposed in this study, but we would like to highlight that the SVP method is a clearly beneficial option for the treatment of idiopathic clubfoot.

***Research perspectives***

This study helped emphasize the importance controlling the equine of the calcaneus to avoid the need for surgery, and showed the efficacy of the FPM (the physiotherapy achieves a flexible, functional and painless clubfoot, and substantially reduces the need for surgery). The results obtained correlate with the initial severity of the deformity and with the protocol applied. The success of the treatment is based on two basic pillars: the adherence of parents to treatment and team training. It is essential to inform, educate and train the family, accompanied by a follow-up throughout the growth. We believe that it is necessary to carry out a future prospective investigation applying the SVP method with long-term follow-up. It is important to note that the current results obtained by different teams with the FPM correlate with those reported in the literature of the Ponseti method, and their differences do not reach statistical significance.

**ACKNOWLEDGMENTS**

We thank Mónica Hernández Caraballo, Alicia Quintana Coello, and Maria J. Huertas Clemente for collaborating with the treatment of the children and the fabrication of the first thermoplastic splints, Dianelis Castillo Gort for performing the periodic assessments of children and Dr. Félix Claverie Martín for the help with the English translation.

**REFERENCES**

1 **Wang H**, Barisic I, Loane M, Addor MC, Bailey LM, Gatt M, Klungsoyr K, Mokoroa O, Nelen V, Neville AJ, O'Mahony M, Pierini A, Rissmann A, Verellen-Dumoulin C, de Walle HEK, Wiesel A, Wisniewska K, de Jong-van den Berg LTW, Dolk H, Khoshnood B, Garne E. Congenital clubfoot in Europe: A population-based study. *Am J Med Genet A* 2019; **179**: 595-601 [PMID: 30740879 DOI: 10.1002/ajmg.a.61067]

2 **Siapkara A**, Duncan R. Congenital talipes equinovarus: a review of current management. *J Bone Joint Surg Br* 2007; **89**: 995-1000 [PMID: 17785734 DOI: 10.1302/0301-620X.89B8.19008]

3 **Gurnett CA**, Boehm S, Connolly A, Reimschisel T, Dobbs MB. Impact of congenital talipes equinovarus etiology on treatment outcomes. *Dev Med Child Neurol* 2008; **50**: 498-502 [PMID: 18611198 DOI: 10.1111/j.1469-8749.2008.03016.x]

4 **Merrill LJ**, Gurnett CA, Siegel M, Sonavane S, Dobbs MB. Vascular abnormalities correlate with decreased soft tissue volumes in idiopathic clubfoot. *Clin Orthop Relat Res* 2011; **469**: 1442-1449 [PMID: 21042891 DOI: 10.1007/s11999-010-1657-1]

5 **Pavone V**, Chisari E, Vescio A, Lucenti L, Sessa G, Testa G. The etiology of idiopathic congenital talipes equinovarus: a systematic review. *J Orthop Surg Res* 2018; **13**: 206 [PMID: 30134936 DOI: 10.1186/s13018-018-0913-z]

6 **Coppola G**, Costantini A, Tedone R, Pasquale S, Elia L, Barbaro MF, d'Addetta I. The impact of the baby's congenital malformation on the mother's psychological well-being: an empirical contribution on the clubfoot. *J Pediatr Orthop* 2012; **32**: 521-526 [PMID: 22706470 DOI: 10.1097/BPO.0b013e318257640c]

7 **Karol LA**, Jeans KA, Kaipus KA. The Relationship Between Gait, Gross Motor Function, and Parental Perceived Outcome in Children With Clubfeet. *J Pediatr Orthop* 2016; **36**: 145-151 [PMID: 25705802 DOI: 10.1097/BPO.0000000000000410]

8 **Zapata KA**, Karol LA, Jeans KA, Jo CH. Gross Motor Function at 10 Years of Age in Children With Clubfoot Following the French Physical Therapy Method and the Ponseti Technique. *J Pediatr Orthop* 2018; **38**: e519-e523 [PMID: 29965933 DOI: 10.1097/BPO.0000000000001218]

9 **Lööf E**, Andriesse H, Broström EW, André M, Böhm S, Bölte S. Neurodevelopmental difficulties negatively affect health-related quality of life in children with idiopathic clubfoot. *Acta Paediatr* 2018 [PMID: 30588661 DOI: 10.1111/apa.14709]

10 **Lööf E**, Andriesse H, Broström EW, André M, Bölte S. Neurodevelopmental difficulties in children with idiopathic clubfoot. *Dev Med Child Neurol* 2019; **61**: 98-104 [PMID: 30132825 DOI: 10.1111/dmcn.13996]

11 **Ponseti IV**, Smoley EN. The classic: congenital club foot: the results of treatment. 1963. *Clin Orthop Relat Res* 2009; **467**: 1133-1145 [PMID: 19219519 DOI: 10.1007/s11999-009-0720-2]

12 **Ganesan B**, Luximon A, Al-Jumaily A, Balasankar SK, Naik GR. Ponseti method in the management of clubfoot under 2 years of age: A systematic review. *PLoS One* 2017; **12**: e0178299 [PMID: 28632733 DOI: 10.1371/journal.pone.0178299]

13 **Brewster MB**, Gupta M, Pattison GT, Dunn-van der Ploeg ID. Ponseti casting: a new soft option. *J Bone Joint Surg Br* 2008; **90**: 1512-1515 [PMID: 18978275 DOI: 10.1302/0301-620X.90B11.20629]

14 **Hui C**, Joughin E, Nettel-Aguirre A, Goldstein S, Harder J, Kiefer G, Parsons D, Brauer C, Howard J. Comparison of cast materials for the treatment of congenital idiopathic clubfoot using the Ponseti method: a prospective randomized controlled trial. *Can J Surg* 2014; **57**: 247-253 [PMID: 25078929 DOI: 10.1503/cjs.025613]

15 **Bergerault F**, Fournier J, Bonnard C. Idiopathic congenital clubfoot: Initial treatment. *Orthop Traumatol Surg Res* 2013; **99**: S150-S159 [PMID: 23347754 DOI: 10.1016/j.otsr.2012.11.001]

16 **Bensahel H**, Guillaume A, Czukonyi Z, Desgrippes Y. Results of physical therapy for idiopathic clubfoot: a long-term follow-up study. *J Pediatr Orthop* 1990; **10**: 189-192 [PMID: 2312698 DOI: 10.1097/01241398-199010020-00010]

17 **Seringe R**, Atia R. [Idiopathic congenital club foot: results of functional treatment (269 feet)]. *Rev Chir Orthop Reparatrice Appar Mot* 1990; **76**: 490-501 [PMID: 2150711]

18 **Seringe R**, Chedeville R. Traitement non-chirurgical. Le pied bot varus équin congenital. In: Cahiers d'enseignement de la SOFCOT, nº43. París: Expansion Scientifique Française, 1993: 41-53

19 **Diméglio A**, Bonnet F, Mazeau P, De Rosa V. Orthopaedic treatment and passive motion machine: consequences for the surgical treatment of clubfoot. *J Pediatr Orthop B* 1996; **5**: 173-180 [PMID: 8866282 DOI: 10.1097/01202412-199605030-00007]

20 **Diméglio A**, Bensahel H, Souchet P, Mazeau P, Bonnet F. Classification of clubfoot. *J Pediatr Orthop B* 1995; **4**: 129-136 [PMID: 7670979 DOI: 10.1097/01202412-199504020-00002]

21 **Flynn JM**, Donohoe M, Mackenzie WG. An independent assessment of two clubfoot-classification systems. *J Pediatr Orthop* 1998; **18**: 323-327 [PMID: 9600557 DOI: 10.1097/01241398-199805000-00010]

22 **van Mulken JM**, Bulstra SK, Hoefnagels NH. Evaluation of the treatment of clubfeet with the Diméglio score. *J Pediatr Orthop* 2001; **21**: 642-647 [PMID: 11521034 DOI: 10.1097/01241398-200109000-00017]

23 **Souchet P**, Bensahel H, Themar-Noel C, Pennecot G, Csukonyi Z. Functional treatment of clubfoot: a new series of 350 idiopathic clubfeet with long-term follow-up. *J Pediatr Orthop B* 2004; **13**: 189-196 [PMID: 15083120 DOI: 10.1097/01202412-200405000-00009]

24 **Besse JL**, Leemrijse T, Thémar-Noël C, Tourné Y; Association Française de Chirurgie du Pied. [Congenital club foot: treatment in childhood, outcome and problems in adulthood]. *Rev Chir Orthop Reparatrice Appar Mot* 2006; **92**: 175-192 [PMID: 16800074 DOI: 10.1016/S0035-1040(06)75703-8]

25 **Van Campenhout A**, Molenaers G, Moens P, Fabry G. Does functional treatment of idiopathic clubfoot reduce the indication for surgery? Call for a widely accepted rating system. *J Pediatr Orthop B* 2001; **10**: 315-318 [PMID: 11727375 DOI: 10.1097/01202412-200110000-00009]

26 **Rampal V**, Chamond C, Barthes X, Glorion C, Seringe R, Wicart P. Long-term results of treatment of congenital idiopathic clubfoot in 187 feet: outcome of the functional "French" method, if necessary completed by soft-tissue release. *J Pediatr Orthop* 2013; **33**: 48-54 [PMID: 23232379 DOI: 10.1097/BPO.0b013e318270304e]

27 **Richards BS**, Faulks S, Rathjen KE, Karol LA, Johnston CE, Jones SA. A comparison of two nonoperative methods of idiopathic clubfoot correction: the Ponseti method and the French functional (physiotherapy) method. *J Bone Joint Surg Am* 2008; **90**: 2313-2321 [PMID: 18978399 DOI: 10.2106/JBJS.G.01621]

28 **Chotel F**, Parot R, Seringe R, Berard J, Wicart P. Comparative study: Ponseti method versus French physiotherapy for initial treatment of idiopathic clubfoot deformity. *J Pediatr Orthop* 2011; **31**: 320-325 [PMID: 21415694 DOI: 10.1097/BPO.0b013e31820f77ba]

29 **Pirani S**, Zeznik L, Hodges D. Magnetic resonance imaging study of the congenital clubfoot treated with the Ponseti method. *J Pediatr Orthop* 2001; **21**: 719-726 [PMID: 11675543 DOI: 10.1097/01241398-200111000-00004]

30 **Richards BS**, Dempsey M. Magnetic resonance imaging of the congenital clubfoot treated with the French functional (physical therapy) method. *J Pediatr Orthop* 2007; **27**: 214-219 [PMID: 17314649 DOI: 10.1097/BPO.0b013e31803179c0]

31 **Jeans KA**, Erdman AL, Jo CH, Karol LA. A Longitudinal Review of Gait Following Treatment for Idiopathic Clubfoot: Gait Analysis at 2 and 5 Years of Age. *J Pediatr Orthop* 2016; **36**: 565-571 [PMID: 25985372 DOI: 10.1097/BPO.0000000000000515]

32 **El Batti S**, Solla F, Clément JL, Rosello O, Oborocianu I, Chau E, Rampal V. Initial treatment of congenital idiopathic clubfoot: Prognostic factors. *Orthop Traumatol Surg Res* 2016; **102**: 1081-1085 [PMID: 27765520 DOI: 10.1016/j.otsr.2016.07.012]

33 **Richards BS**, Faulks S, Razi O, Moualeu A, Jo CH. Nonoperatively Corrected Clubfoot at Age 2 Years: Radiographs Are Not Helpful in Predicting Future Relapse. *J Bone Joint Surg Am* 2017; **99**: 155-160 [PMID: 28099306 DOI: 10.2106/JBJS.16.00693]

**P-Reviewer:** Pavone P, Ünver B **S-Editor:** Ji FF **L-Editor:** Filipodia **E-Editor:** Ma YJ

**Specialty type:** Orthopedics

**Country of origin:** Spain

**Peer-review report classification**

Grade A (Excellent): 0

Grade B (Very good): B

Grade C (Good): C

Grade D (Fair): 0

Grade E (Poor): 0

  

  

**Figure 1 Manipulations of the clubfoot.** A: Reduction of the talo-navicular joint subluxation; B: Derotation of the calcaneo-forefoot block; C: Achilles tendon stretching; D: Achilles tendon stretching with midtarsal protection; E: Stretch the median groove and plantar fascia; F: Passive mobilizations in plantar flexion and dorsiflexion.

   

   

**Figure 2 Physiotherapy adapted to motor development of the child.** A: Strengthening of the fibularis muscles; B: Squat for active stretching of the Achilles tendon; C: Incline support to stretch the triceps surae; D: Support by four points to stretch the entire posterior muscle chain; E: Propiocepción on an air cushion; F: Sitting down in a toy car to stimulate support and propulsion; G: Going up and down stairs; H: Squat at four points to stretch the Achilles tendon with feet abduction.

   

   

**Figure 3 Progression of clubfeet treated with the Robert Debré method.** A, B: Derotation of the calcaneo-forefoot block; C: Simple taping closed with an cohesive bandage; D: Denis-Browne bar; E: Severe foot at the start of treatment; F: At 3 mo of age; G: The feet required posterior release; H: Plantigrade feet.

  

   

**Figure 4 Progression of clubfeet treated with the Saint Vincent de Paul method.** A: Reduction of the cavus (the forefoot is slightly supinated to align with the hindfoot); B: Performing the taping on plantar sole; C: Above-knee splints; D: Below-knee splint; E: Severe foot at the start of treatment; F: At 3 mo of age; G: Foot front view; H: Foot back view (plantigrade foot without surgery).

 **Table 1 Comparisons at baseline of Robert Debré and Saint Vincent de Paul groups**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Robert Debré group** | **Saint Vincent de Paul group** | ***P* value3** |
| Number of feet | 31 | 36 | 0.747 |
| Number of feet by gender, boys/girls | 23/8 | 25/11 | 0.667 |
| Number of laterality affected feet, R/L | 16/15 | 20/16 | 0.809 |
| Number of moderate feet1, % | 10 (32) | 10 (28) | 0.782 |
| Number of severe feet1, % | 12 (39) | 17 (47) | 0.782 |
| Number of very severe feet1, % | 9 (29) | 9 (25) | 0.782 |
| Age at start of treatment in d2 | 14 (2-30) | 10 (1-45) | 0.050 |

1According to the classification of Dimeglio; 2Median (range); 3Estimatedwith *χ*2 test. R: Right; L: Left.

**Table 2 Comparison by category at 8 mo with respect to baseline1**

|  |  |  |
| --- | --- | --- |
| **Group** | **Severity at baseline, *n* (%)** | **Severity 8 mo after, *n* (%)** |
|  |  | **Normal** | **Benign** | **Moderate** |
|  | Moderate 10 (32) | 4 (13) | 6 (19) | 0 (0) |
| Robert Debré | Severe 12 (39) | 0 (0) | 2 (7) | 10 (32) |
|  | Very severe 9 (29) | 0 (0) | 0 (0) | 9 (29) |
|  | Moderate 10 (28) | 8 (22) | 2 (6) | 0 (0) |
| Saint Vincent de Paul | Severe 17 (47) | 0 (0) | 17 (47) | 0 (0) |
|  | Very severe 9 (25) | 0 (0) | 4 (11) | 5 (14) |

1*P* = 0.001 estimated with *χ*2 test (Extended method).

**Table 3 Comparison by category at two years of age to achieve a plantigrade foot**

|  |  |  |
| --- | --- | --- |
| **Group** | **Severity at baseline ,*n* (%)** |  **Results, *n* (%)1****Very good2 Good3 Fair4 Poor5** |
|  | Moderate 10 (32) | 6 (20) | 2 (6) | 2 (6) | 0 (0) |
| Robert Debré | Severe 12 (39) | 0 (0) | 0 (0) | 12 (39) | 0 (0) |
|  | Very severe 9 (29) | 0 (0) | 0 (0) | 9 (29) | 0 (0) |
|  | Moderate 10 (28) | 10 (28) | 0 (0) | 0 (0) | 0 (0) |
| Saint Vincent de Paul | Severe 17 (47) | 11 (30) | 6 (17) | 0 (0) | 0 (0) |
|  | Very severe 9 (25) | 0 (0) | 0 (0) | 9 (25) | 0 (0) |

1*P* < 0.001 compared with *χ*2 test (Extended method); 2Only physiotherapy; 3Heel-cord tenotomy; 4Limited posterior release; 5Complete release.

**Table 4 Relapse rates**

|  |  |  |  |
| --- | --- | --- | --- |
| **Group** | **Relapses****Yes** | **Relapses****No**  |  **Total** |
| Saint Vincent de Paul Robert Debré Total |  5  510 |  31  26 31 |  36  31 67 |

OR = 1.20. OR estimated with OR test. OR: Odds ratio.