Gait Analysis of Children Treated for Clubfoot with Physical Therapy or the Ponseti Cast Technique

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Gait Analysis of Children Treated for Clubfoot with Physical Therapy or the Ponseti Cast Technique

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Background: Currently, clubfoot is initially treated with nonoperative methods including the Ponseti cast technique and the French functional physical therapy program. Our goal was to evaluate the function of children treated with these techniques.

Methods: We reviewed the cases of 182 patients with idiopathic clubfoot (273 feet) who were initially treated nonoperatively. Seventy-seven patients (119 feet) were excluded because they had either received a combination of nonoperative treatments or had undergone surgery prior to testing. Gait analysis was performed when the children were approximately two years of age. Temporal and kinematic data were classified as abnormal if they were more than one standard deviation from normal.

Results: Gait analysis was performed on 105 patients (fifty-six treated with casts and forty-nine treated with physical therapy) with 154 involved feet (seventy-nine treated with casts and seventy-five treated with physical therapy). These patients were an average of two years and three months of age, and their initial Diméglio scores ranged between 10 and 17. No significant differences in cadence parameters were found between the two groups. The rate of normal kinematic ankle motion in the sagittal plane was higher in the group treated with physical therapy (65% of the feet) than it was in the group treated with the Ponseti cast technique (47%) (p = 0.0317). More children treated with physical therapy walked with knee hyperextension (37% of the feet) (p < 0.0001), an equinus gait (15%) (p = 0.0051), and footdrop (19%) (p = 0.0072); only one patient treated with casts walked with an equinus gait, and only three demonstrated footdrop. In contrast, more of the patients in the cast-treatment group demonstrated excessive stance-phase dorsiflexion (48% of the feet) (p < 0.0001) and a calcaneus gait (10%). More feet in the physical therapy group had an increased internal foot progression angle (44% compared with 24% in the cast-treatment group; p = 0.0144) and increased shank-based foot rotation (73% compared with 57% in the cast-treatment group; p = 0.05).

Conclusions: While the rate of normal kinematic ankle motion in the sagittal plane was 65% in the group treated with physical therapy, the gait abnormalities that were seen in that group were characterized by mild equinus and/or footdrop. The rate of normal kinematic ankle motion in the sagittal plane was 47% in the cast-treatment group, but the most common gait abnormality in this group was mildly increased dorsiflexion in the stance phase. The rates of calcaneus gait and equinus gait were ≤15% in each nonoperative group. The differences between the physical therapy and cast-treatment groups may, in part, be the result of the percutaneous Achilles tendon lengthening that is performed as part of the Ponseti cast technique but not as part of the physical therapy program.

Level of Evidence: Therapeutic Level II. See Instructions to Authors for a complete description of levels of evidence.

Historically, the treatment of clubfoot deformity was primarily surgical\(^1\). More recently, it has been reported that these operative treatments involving extensive soft-tissue releases do not always produce satisfactory long-term clinical results\(^2,3\). In addition, gait disturbances such as knee hyperextension, ankle stiffness, and decreased gastrocnemius-soleus power and strength have been documented\(^4\). As a consequence of these clinical and functional results, there has been a renewed interest in the nonoperative treatment of clubfoot deformity\(^5,6\).

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A commentary is available with the electronic versions of this article, on our web site (www.jbjs.org) and on our quarterly CD-ROM (call our subscription department, at 781-449-9780, to order the CD-ROM).
Ponseti’s method of using serial casts was first developed in the 1940s but did not become popular until his long-term results were published in the 1990s. His techniques are now in widespread use and include application of a series of corrective long leg casts, followed by a period of bracing with a foot abduction orthosis.

Masse introduced the French functional (physical therapy) technique in the 1970s, and Bensahel et al. and Diméglìo et al. reported the results of this technique more recently. The French method includes intensive daily stretching, manipulation, and taping of the infant’s foot by a physical therapist.

Both of these nonoperative techniques have been employed at our institution for a number of years. The purpose of this study was to evaluate and compare the gait patterns of two-year-old children who had been treated since infancy with these nonoperative techniques.

Materials and Methods

The parents of patients treated for a clubfoot deformity with either the Ponseti cast technique or the French functional (physical therapy) method between February 1998 and May 2004 at a single center were invited to have their child participate in this prospective study, which was approved by an institutional review board. The inclusion criteria consisted of a diagnosis of idiopathic clubfoot and an initial Diméglìo classification rating of severe or very severe (10 to 17). Teratologic clubfeet, patients initially treated outside of our institution, mild and moderate Diméglìo types, and patients who required surgical intervention were excluded.

Treatment

Both methods of treatment were described in detail in an unbiased manner at the infant’s initial visit, and the parents chose which treatment their child would receive.

The Ponseti cast treatment included application of a series of long leg casts, with the cast changed weekly for five weeks, after which a final long leg cast was applied and worn for an additional three weeks. All of the casts were applied by physicians. Before each new cast was applied, the foot was gradually stretched into an improved position with use of the precise sequence of maneuvers described by Ponseti. Percutaneous Achilles tendon lengthening was performed on selected patients in order to facilitate correction of ankle equinus prior to application of the final cast. Since an Achilles tendon lengthening is considered a routine procedure in the Ponseti protocol, the patients who had undergone that procedure were not considered to have had surgery and were therefore included in this study. After the clubfoot deformity was corrected and the cast-treatment phase was complete, a foot abduction orthosis was applied and was worn full-time for three months; it was then worn at night and during naps until the child was at least two years of age.

The French functional (physical therapy) method included stretching and manipulation by a skilled physical therapist five days per week. Between sessions, the foot was temporarily immobilized with adhesive tape in an effort to maintain maximal correction. Since 2000, some of the infants have been treated with a continuous passive motion machine designed specifically for the infant foot (Kinetec, Tournes, France). Daily therapy continued for the first few months of life, until the deformity was corrected. The parents were then trained to continue the program at home, with periodic visits with the physical therapist. This home protocol continued until the patients were two to three years of age.

Evaluation

The parents were invited to have their child participate in a gait analysis when the child was approximately two years of age. Kinematic data were collected with use of a Vicon motion capture system and analyzed with use of Vicon Clinical Manager (Oxford Metrics Group, Oxford, United Kingdom). If it was not possible to complete testing because of the child’s uncooperative behavior, a second attempt was made to collect the data.

Both temporal and gait parameters were identified and compared with those of fifteen normal two-year-old children. Values were considered abnormal if they were more than one standard deviation from the average normal data (Table I).

Standing anteroposterior and lateral radiographs of the feet were made when the patients were two years of age. The tibiocalcaneal angle, defined as the angle formed between the longitudinal axes of the tibia and the plantar surface of the calcaneus, was compared with published normative data to determine whether there was radiographic evidence of an ankle equinus or ankle calcaneus gait.

Statistical Methods

Two-way repeated-measures analysis was used to perform comparisons between the treatment groups as well as with normal data. Chi-square testing was used to compare the distributions of proportions between the groups. Significance was defined as p < 0.05.
**Results**

We reviewed the cases of 182 patients with idiopathic clubfoot (273 feet) (Table II). Feet were then excluded from the analysis if they (1) had undergone a combination of cast treatment and physiotherapy or had undergone botulinum toxin A (Botox) treatment or (2) had had a failure of nonoperative treatment and had undergone surgery prior to gait analysis. Because the Achilles tendon lengthening was not initially part of the French physical therapy method, the patients who had been treated with that method and had undergone Achilles tendon lengthening for management of residual equinus deformity (nine feet) were considered to have received surgical treatment and therefore were excluded from the study. Thirty-nine patients (fifty-seven feet) who had had a percutaneous Achilles tendon lengthening as a part of the Ponseti cast-treatment protocol were included.

One hundred and five patients (fifty-six treated with casts and forty-nine, with physical therapy) with 154 involved feet (seventy-nine treated with casts and seventy-five, with physical therapy) were included in the gait analysis. Twenty-four (23%) of 103 feet treated with the Ponseti method and forty-eight (36%) of 132 feet treated with physical therapy had undergone surgery that included more than an Achilles tendon release or lengthening. At the time of gait analysis, the patients were an average age of two years and three months (range, two years to three years and four months). There was no significant difference in age between the two treatment groups.

The average initial Diméglio scores were 13.1 (range, 10 to 17) in the Ponseti cast-treatment group and 13.3 (range, 10 to 17) in the physical therapy group, a difference that was not significant (p = 0.52).

Cadence parameters, including walking speed, cadence, and stride length, did not differ between the two study groups (p > 0.05). There were several mild deviations in sagittal plane ankle kinematics in both groups (Table III).

An equinus gait was defined as midstance-phase (second-rocker) dorsiflexion of <3°. Eleven feet (15%) in the physical

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*The values are given as the number of feet with the percentage in parentheses.
therapy group and one foot (1%) in the cast-treatment group were associated with an equinus gait. This difference was significant ($p = 0.0051$) (Fig. 1).

Increased stance-phase ankle dorsiflexion was defined as dorsiflexion that differed from normal by greater than one standard deviation (i.e., that was $>15^\circ$). Thirty-eight feet (48%) in the Ponseti cast-treatment group and nine feet (12%) in the physical therapy group were associated with increased stance-phase ankle dorsiflexion ($p < 0.0001$) (Fig. 2). A calcaneus gait was defined as increased stance-phase dorsiflexion and terminal-stance-phase (third-rocker) plantar flexion of $<3^\circ$. Eight feet (10%) in the cast-treatment group and three feet (4%) in the physical therapy group were associated with a calcaneus gait, but this difference did not reach significance ($p = 0.245$). All eight feet in the cast-treatment group that were associated with a calcaneus gait were also associated with increased stance-phase ankle dorsiflexion.

The patients who had undergone an Achilles tenotomy as part of the Ponseti cast treatment were compared with those who had not. Of the thirty-eight feet associated with increased ankle dorsiflexion in the Ponseti cast-treatment group, thirty-two (84%) had had a tenotomy and six (16%) had not. This difference was significant ($p = 0.022$). Thirty-two (56%) of the fifty-seven feet for which the treatment had included an Achilles tendon release as part of the Ponseti protocol were associated with increased dorsiflexion during stance phase. All eight feet in the Ponseti treatment group that were associated with a calcaneus gait had undergone a tenotomy.

The twenty-two clubfeet treated with the Ponseti method but not with an Achilles tenotomy were compared with the seventy-five feet treated with physical therapy. The only significant kinematic difference between the two groups was in stance-phase knee hyperextension: the percentage of feet associated with knee hyperextension was higher in the physical therapy group than it was after treatment with the Ponseti method without an Achilles tendon lengthening ($p = 0.029$). An equinus gait was associated with one foot (5%) treated with the Ponseti method without an Achilles tendon lengthening and with eleven feet (15%) in the physical therapy group. This difference was not significant.

Footdrop is the inability to dorsiflex the ankle during the swing phase. We defined footdrop as increased ankle plantar flexion ($>9^\circ$ of plantar flexion) during the final 25% of the swing phase. Three feet (4%) in the cast-treatment group and fourteen feet (19%) in the physical therapy group exhibited footdrop when the child walked ($p = 0.0072$).

Normal ankle kinematics in the sagittal plane was defined as an absence of an equinus gait, of a calcaneus gait, of increased stance-phase dorsiflexion, and of footdrop. Thirty-seven feet (47%) in the cast-treatment group and forty-nine feet (65%) in the physical therapy group were associated with normal sagittal plane ankle kinematics ($p = 0.0317$).

In-toeing was defined as an internal foot progression angle of $>5^\circ$ in the stance phase. Nineteen feet (24%) in the cast-treatment group and thirty-three feet (44%) in the physical therapy group had an internal foot progression angle of $>5^\circ$ ($p = 0.0144$) (Fig. 3). Shank-based foot rotation is a measure of the rotation of the forefoot relative to the position of the knee. It represents tibial torsion, medial spin of the hindfoot, and metatarsus adductus, but it does not isolate the tibia from the foot. Forty-five feet (57%) in the cast-treatment group and fifty-five feet (73%) in the physical therapy group had an internal shank-based rotation of $>0^\circ$ ($p = 0.05$).
An external foot progression angle was present in eleven lower extremities. Ten of the eleven were in the Ponseti treatment group and accounted for 13% of the limbs in that group. One was in the physical therapy group and accounted for 1% of the limbs in that group. Six of the ten feet treated with the Ponseti method were associated with increased stance-phase dorsiflexion, and three of the six were associated with a calcaneus gait.

Fig. 2
Sagittal plane ankle kinematic data over one complete gait cycle, obtained from a representative patient with increased stance-phase dorsiflexion in the Ponseti cast-treatment group. As the third-rocker plantar flexion was within one standard deviation of normal, this patient was not considered to have a calcaneus gait. Positive values represent dorsiflexion (DF), and negative values represent plantar flexion (PF). The shaded region represents one standard deviation above and below the average age-matched normal data.

Fig. 3
Average foot progression data over one complete gait cycle for both treatment groups. The solid line represents the values for the Ponseti treatment group, and the dashed line represents the values for the physical therapy group. Positive values represent internal rotation (INT), and negative values represent external rotation (EXT). The shaded region represents one standard deviation above and below the average age-matched normal data.
We used a strict definition of normal gait that included normal ankle kinematics in the sagittal plane, a normal foot progression angle, and normal shank-based foot rotation. Eleven feet (14%) in the cast-treatment group and eleven feet (15%) in the physical therapy group were associated with a completely normal gait ($p = 0.895$).

Kinematic data and cadence parameters were compared between unilateral and bilateral clubfeet in both the physical therapy and the Ponseti cast-treatment group. There was no significant difference in cadence parameters or in the prevalence of kinematic abnormalities between the unilateral and bilateral clubfeet in the Ponseti treatment group. In the physical therapy group, the unilateral cases were associated with a lower initial Diméglio score (12.43 compared with 13.57 for the bilateral cases), a greater walking speed, and an increased stride length. However, there was no difference in the likelihood of kinematic abnormalities between the unilateral and bilateral cases in the physical therapy group.

The tibiocalcaneal angle was measured on a lateral radiograph of the foot. As ankle dorsiflexion improved, the tibiocalcaneal angle decreased. Radiographs of seventy-eight feet in the cast-treatment group and sixty-two feet in the physical therapy group were assessed. (Fourteen radiographs were excluded because of a lack of cooperation by the child.) The mean tibiocalcaneal angle in the cast-treatment group was 84° (range, 56° to 110°), which was significantly different from the mean of 90° (range, 72° to 116°) in the physical therapy group ($p = 0.0023$).

**Discussion**

In the past, few investigators have used gait analysis as a tool to evaluate the outcome of treatment of clubfeet\textsuperscript{14-22}. Aronson and Puskarich examined patients who had been followed for more than ten years after treatment of a clubfoot deformity with either cast immobilization or surgery\textsuperscript{15}. Regardless of which treatment had been performed, ankle dorsiflexion was reduced by an average of 65%. In addition, there was an average 24% decrease in normal ankle plantar flexor muscle strength, which correlated with the number of Achilles tendon lengthenings that had been performed in the foot. Karol et al. performed gait analysis and muscle strength testing on patients at an average of ten years after surgical release for the treatment of clubfoot\textsuperscript{6}. Their findings were in agreement with those of Aronson and Puskarich in that ankle sagittal plane kinematics and plantar flexion power were substantially affected in the majority of the subjects. Furthermore, genu valgum, knee hyperextension, an internal foot progression angle, and inappropriate activation of the tibialis anterior muscle were observed. Davies et al. studied the cases of twenty-five children, with a mean age of twelve years, who had had previous posteromedial release for the treatment of clubfoot\textsuperscript{18}. All patients were evaluated at least five years after their last intervention. The ankle kinematic and kinetic data reported by

![Fig. 4](https://example.com/fig4.png)
Davies et al. were similar to ours. They also observed differences in hip and knee kinematics and kinetics, and they thought that these differences were secondary to a lack of motion at the ankle joint. Theologis et al. studied the cases of patients between the ages of six and sixteen years who were considered to have had a good clinical result of the surgical treatment of clubfoot deformity. These patients were found to walk with residual intoeing, footdrop, decreased plantar flexor muscle power, increased midfoot dorsiflexion, and external hip rotation.

Given the imperfect clinical and functional results of surgical treatment of clubfoot, there has been a resurgence of interest in the nonoperative management of this deformity. Both Ponseti’s serial cast technique and the French functional (physical therapy) technique have been reported to have excellent clinical results; however, there have been few reported analyses of the gait of patients treated with these nonoperative methods. Alkjaer et al. examined the gait of nine adult men who had been treated for clubfoot as children with a combination of physical therapy, bracing, and surgery. As compared with a control group, these patients had smaller ankle moments secondary to weak plantar flexors and they compensated with larger-than-normal moments at the knee and hip joints.

In 2005, Karol et al. performed a gait analysis of two-year-old children treated with either physical therapy or surgical release. Internal rotation was common in both treatment groups, but surgical release resulted in a higher likelihood of a calcaneus gait. The most frequent gait disturbances in the physical therapy group were limited ankle dorsiflexion and footdrop. Overall, normal kinematic ankle motion in the sagittal plane was observed in 54% of the feet treated with physical therapy compared with only 39% of the feet treated with complete posteromedial releases.

In the present study, a graphic comparison of ankle kinematics in the sagittal plane showed very little difference between the two treatment groups (Fig. 4), although the Ponseti cast-treatment group tended to have greater dorsiflexion throughout the gait cycle than the physical therapy group. As a result, the kinematics in the physical therapy group appeared to be superior; however, this may be secondary to the “averaging” of the feet associated with an equinus gait (15% of the feet) with the feet associated with increased dorsiflexion in the stance phase (12%) in this group. This highlights the importance of defining criteria for pathological gait deviations.

With use of our definitions of abnormal gait parameters, the results identified two clear kinematic patterns. One subset of children treated with the functional (physical therapy) method walked with knee hyperextension (37% of the feet), an equinus gait (15% of the feet), and footdrop (19% of the feet), while only one foot treated with Ponseti’s method had residual equinus and only three demonstrated footdrop. In contrast, more patients in the Ponseti treatment group demonstrated increased stance-phase dorsiflexion (48% of the feet) and a calcaneus gait (10% of the feet).

The large number of patients with mild knee hyperextension in the functional (physical therapy) group may be related to the plantar flexion-knee extension couple, as there was also a high prevalence of equinus gait in this group. This limitation in ankle dorsiflexion may have been a result of the fact that Achilles tendon lengthening was not performed as part of the physical therapy protocol; however, given this rate of equinus, some patients treated with physical therapy may potentially benefit from an Achilles tendon lengthening. Diméglio et al. recently reported incorporation of an early lengthening of the triceps surae (with use of the Vulpian technique) in the French physical therapy regimen for babies. We have similarly begun performing an Achilles tendon tenotomy in babies being treated with the French method if 25% of dorsiflexion is not achieved; our hope is to reduce the number of children with residual equinus and knee hyperextension in the future.

The higher rate of increased stance-phase dorsiflexion in the Ponseti cast-treatment group may be related to the use of Achilles tendon lengthening prior to the application of the final cast in 72% of the feet in this group. This rate of Achilles tenotomy is lower than that reported by Morcuende et al. but is consistent with the results reported by Ponseti. In our study, 54% of the feet in the Ponseti treatment group that had had an Achilles tendon lengthening were associated with either increased stance-phase dorsiflexion or a calcaneus gait. Judicious use of Achilles tendon lengthening in patients undergoing Ponseti cast treatment may help to improve ankle dorsiflexion at the age of two years but also may predispose the ankle to excessive dorsiflexion as a result of postlengthening weakness. Some of these patients with increased dorsiflexion in the Ponseti treatment group also were unable to plantar flex the ankle at the end of the stance phase and had a calcaneus gait. We believe that the plantar flexor insufficiency seen in patients with increased dorsiflexion is less severe than that in patients with a calcaneus gait. It will be important to follow these children and analyze ankle power at push-off as they grow to determine the long-term effects on function following a tenotomy.

The percentage of feet associated with normal kinematic ankle motion in the sagittal plane was greater in the physical therapy group (65%) than in the cast-treatment group (47%). However, both rates were better than the 39% rate observed in patients treated with a posteromedial release.

More feet treated with the French functional method had an increased internal foot progression angle (44% compared with 24% in the cast-treatment group). This difference may be the result of the routine use of a foot abduction bar in the Ponseti treatment group. Because external rotation of the lower extremity as well as abduction of the foot was maintained with the orthosis full-time for three months and part-time for two to three years, it is reasonable to expect that fewer patients in the cast-treatment group would have residual intoeing at the age of two years. Intoeing by patients with clubfoot has been found to be secondary mainly to forefoot adductus and to internal tibial torsion, and it remains present in a large proportion of children...
who have been treated with extensive surgical release. The use of foot abduction bars likely decreased the prevalence of intoeing in our Ponseti cast-treatment group, but an internal foot progression angle was still observed in 24% of the feet in this group. As we have no objective data on compliance with use of the abduction bar, we cannot comment on the presence or absence of a correlation between use of an orthosis and intoeing. This residual intoeing, observed in some patients treated nonoperatively with either technique, may require correction with an anterior tibial tendon transfer or a tibial derotation osteotomy in the future.

As seen radiographically, the physical therapy group had a significantly higher tibiocalcaneal angle than did the Ponseti treatment group (90° compared with 84°; p = 0.0023). In both groups, this measurement varied considerably from the mean of 70° for age-matched controls. The higher tibiocalcaneal angle observed in the physical therapy group represents radiographic equinus and is in agreement with our kinematic data, which showed ankle equinus in association with 15% of the feet in this group. The radiographic finding of equinus and the lack of dorsiflexion during stance phase prompted our center to utilize early Achilles tendon lengthening in patients being treated with physical therapy if dorsiflexion is not achieved. We anticipate that this will also decrease the need for more extensive surgery, such as posterior or posteroomedial release, which was necessary in 36% of the clubfeet treated with physical therapy but only 23% of the feet treated with the Ponseti method.

In conclusion, approximately half of our two-year-old patients who had been successfully treated with either the Ponseti or the French functional nonoperative method had normal kinematic ankle motion in the sagittal plane. When deviations from normal ankle kinematics occurred, they generally consisted of a mild limitation in dorsiflexion in the physical therapy group or a slight increase in dorsiflexion in the Ponseti cast-treatment group. These differences may have been the result of the frequent performance of a percutaneous Achilles tendon lengthening as part of the Ponseti cast technique but not as part of the French functional program. However, despite these differences, both of these nonoperative methods resulted in rates of normal ankle kinematics that were higher than what had been previously reported following the surgical correction of clubfoot. Therefore, we continue to recommend nonoperative treatment, with either method, for babies with idiopathic clubfoot. Future studies comparing the gait and function of these two treatment methods are warranted as early treatment of ankle equinus becomes a part of the physical therapy protocol.

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References


