Efficacy of local steroid injection in the treatment of idiopathic spasmodic flatfoot in pediatric and adolescent patients

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Received: 28-Mar-2024
Revised: 24-Apr-2024
Accepted: 24-Apr-2024
Published: 08-Mar-2025

The Egyptian Orthopaedic Journal 2024, 59:683–690

Background and aim
Flatfoot deformity is one of the most prevalent foot issues among juvenile and adolescent patients. Patients with the spasmodic variety typically exhibit anomalies in their gait, recent changes in foot shape, and discomfort and stiffness in the foot and ankle. The current work aimed to evaluate the functional and clinical outcome of pediatric and adolescent patients with spasmodic flatfeet without coalition following long-acting steroid injection in the sinus tarsi and cast therapy.
Patients and methods
A prospective case series study was carried out at a tertiary care facility. A total of 20 patients were enrolled. All patients were diagnosed through clinical history, physical examination, and imaging including radiographs and magnetic resonance imaging (MRI) to exclude coalitions, bony and cartilaginous. The American Orthopedic Foot and Ankle Society (AOFAS) Ankle – hind-foot score was used to evaluate all patients before and after the procedure.
Results
The results revealed significant improvement in American Orthopedic Foot and Ankle Society as regards comparison between baseline score (48.75±6.01), score at 3 months (90.55±3.26), 6 months (84.45±3.23), and 12 months (83.15±4.05) after the procedure. Also, there were significant improvements in Meary's angle (38.60±3.05 vs. 14.50±5.08), Talonavicular coverage angle (16.20±2.73 vs. 4.25±1.92), and calcaneal pitch (8.85±2.43 vs. 19.85±3.29).
Conclusion
The procedure of local steroid injection, manipulation, and cast under general anesthesia has a significant role in the improvement of functional and radiological outcomes in adolescent idiopathic spasmodic flatfoot, with a remarkable role of MRI in obtaining a high success rate.

Keywords:
American orthopedic foot and ankle society, spasmodic flatfeet, steroid injection, steroid injection

Egypt Orthop J 2024, 59:683–690

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Introduction

The 'flatfoot' deformity is one of the most prevalent foot issues in children and teenagers. Differentiating between the two primary forms of flat feet, flexible, and rigid is the main goal of clinical examination. The flexible type is a prevalent diagnosis that is typically unproblematic and usually does not need treatment [1–3]. Even though rigid flatfoot deformity is less common, it is frequently symptomatic and needs to be treated. Spasmodic flatfoot is typically associated with persistent discomfort and deformity. It displays disagreement over its incidence, aetiology, and treatment. Inter-tarsal bars or bone deformities that limit tarsal joint motion are frequently associated with it [3–8].

Our study aimed to assess the functional and clinical outcomes after long-acting steroid injection in the sinus tarsi followed by cast in adolescent patients with spasmodic flatfeet without coalition.

Patients and methods

The present study is a prospective case series. The study included 20 patients. Inclusion criteria included patients between the ages of 10 and 16 years with spasmodic flatfoot. Patients with one or more of the following conditions were excluded; neuromuscular disorders, evidence of tarsal coalitions on radiographs or MRI, the absence of correction by manipulation under general anesthesia and patients with previous surgical interventions in the foot.

All patients were subjected to thorough history taking. The local examination was done with attention to

points of tenderness, foot alignment, range of motion, and evidence of muscle spasm.

Radiological evaluation

(I) Weight-bearing AP and lateral radiography views of the foot and ankle:

(a) Meary's angle (Fig. 1a).

The angle between a line drawn along the longitudinal axes of the talus (mid-talar axis) and the first metatarsal (first metatarsal axis) [9].

(b) The calcaneal pitch angle (Fig. 1b).

This angle is formed on a weight-bearing lateral foot radiograph between the calcaneal inclination axis (i.e. most inferior part of the calcaneus) and the supporting horizontal surface [10].

(c) The talonavicular coverage angle (Fig. 1c).

On AP weight-bearing foot radiographs, it is the angle between the talar head and proximal navicular articular surfaces [11].

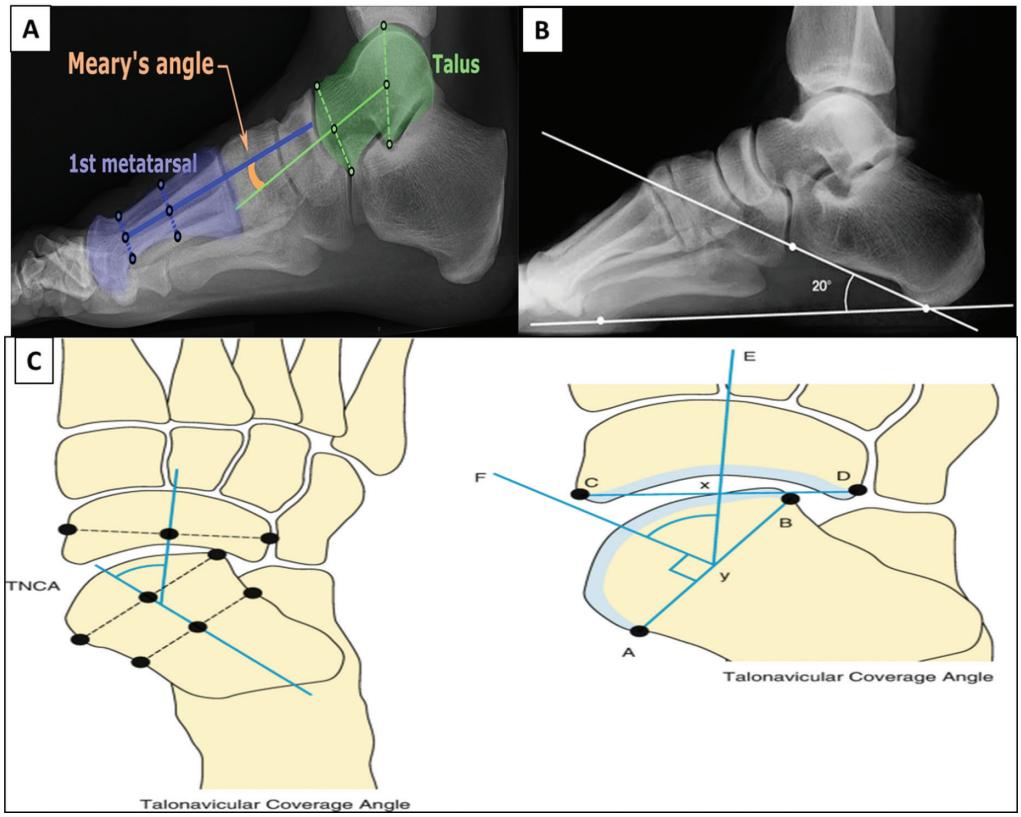
(II) MRI on foot and ankle:

Aiming at visualization of any existing cartilaginous or fibrous coalitions or evidence of injury to a pre-existing bar with intraosseous edema explaining the peroneal muscle spasm.

Anesthesia and manipulation (Fig. 2)

Patients received general anesthesia and the foot was gently and gradually manipulated into inversion/eversion and plantar flexion/dorsiflexion. Full relaxation of muscle spasms and restoration of foot flexibility were confirmed. The procedure entailed the injection of a mixture of long-acting corticosteroids (Betamethasone 1amp, 2 ml) combined with a local anesthetic (Lidocaine 3 ml) into the sinus tarsi. The sinus tarsi was palpated just anterior and inferior to the lateral malleolus. The needle was inserted in a posteromedial direction along the estimated path of the sinus tarsi. A walking below-the-knee plaster cast with the foot in the neutral position was put and kept in place for 6 weeks. The first clinical indication of improvement that was seen when the patient awoke from general anesthesia was the reduction of the preoperative foot pain. Patients with bilateral spasmodic flatfoot were asked to choose the more painful side, injection and casting of one foot at a time was done.

Figure 1



(a) Meary's angle, (b) Calcaneal pitch, (c) The talonavicular coverage angle.

Figure 2

(a) Injection of sinus tarsi; B) Manipulation into inversion and eversion

Outcome Measurements and follow-up

(I) Primary (main): Evaluation of the functional outcome according to the American Orthopedic Foot and Ankle Society (AOFAS) Ankle-hindfoot score. The score consists of nine questions and is divided into three categories: pain, function, and alignment. The total score is calculated by adding scores from each section. The maximum score is 100, which indicates normal function and no pain (Appendixs 1, 2).
(II) Secondary: Radiological correction in weight bearing radiography after cast removal.

(a) Meary's angle.
(b) Calcaneal pitch.
(c) Talonavicular coverage angle.

Subsequent follow-up visits were performed at 3 months, 6 months and one year. Patients are instructed to start foot exercises immediately after cast removal; including heel stretches, arch lifts, towel curls [12,13], and foot roller [12,14].

Statistical analysis

Data was recorded and analyzed using SPSS (Statistical Package for the Social Science, version 20, IBM, and Armonk, New York). The Shapiro–Wilk test was used to determine the compliance of the data to normal distribution. All quantitative data in the current study were normally distributed.

Data were expressed as numbers and percentages for qualitative variables, compared using χ^2 test, and mean ± SD for continuous ones, compared using Student *t* test (two different means) and paired *t* test (baseline and follow-up data) as needed. The level of confidence was kept at 95% and hence, *P* value was significant if less than 0.05.

Results

The demographics of our study are shown in Table 1. Our study included 20 patients. The mean age was (13 ± 3) years. Fifty-five percent of patients were males.

There was a significant improvement in AOFAS as regards comparison between baseline data (48.75 ± 6.01) with AOFAS at 1.5 months (91.20 ± 2.35), 3 months (90.55 ± 3.26), 6 months (84.45 ± 3.23) and 12 months (83.15 ± 4.05) after the procedure (Table 2, Fig. 3).

There was significant improvement after the procedure in Meary's angle, Talonavicular coverage angle and calcaneal pitch (Table 3, Fig. 4).

Discussion

For symptomatic flatfoot, which primarily affects younger patients and adolescents, all efforts should be focused on nonoperative treatment. It is critical to establish specific treatment goals in consultation with the patient and the parents [5].

Even in patients with tarsal coalitions, up to 90% of patients have been shown to respond to nonoperative treatment for spasmodic valgus foot. However, the recurrence of the symptoms could happen at any point and call for ongoing immobilization or surgery [15].

Varner and Michelson evaluated 33 feet in 27 adults with tarsal coalition. They found that that the majority of their patients responded well to activity modification

Table 1 Baseline data of the studied patients

	N=20 [*n* (%)]
Age (years)	13.05 ± 1.87
Range	10–16
Sex	
Male	11 (55)
Female	9 (45)
Affected side	
Right	12 (60)
Left	8 (40)

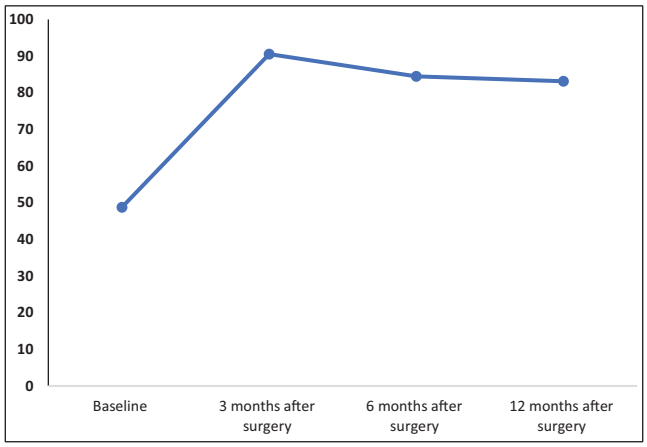
Data expressed as mean±SD, range, and frequency (percentage).

Table 2 Baseline and follow-up American Orthopedic Foot and Ankle Society of the studied patients

	N=20	
AOFAS Score		
Baseline	48.7 ± 6.01	
3 months after surgery	90.5 ± 3.26	*P*1 value < 0.001
6 months after surgery	84.4 ± 3.23	*P*2 value < 0.001
12 months after surgery	83.1 ± 4.05	*P*3 value < 0.001
Significance		
*P*4 value		< 0.001
*P*5 value		0.27

Data expressed as mean±(SD. AOFAS: American Orthopedic Foot and Ankle Society. *P* value was significant if less than 0.05.
***P*1** value compares between AOFAS at baseline and 3 months after surgery.
***P*2** value compares between AOFAS at baseline and 6 months after surgery.
***P*3** value compares between AOFAS at baseline and 12 months after surgery.
***P*4** value compares between AOFAS at 3 months and 6 months after surgery.
***P*5** value compares between AOFAS at 6 months and 12 months after surgery.

Figure 3



American Orthopaedic Foot and Ankle Society score at baseline and during follow-up

and anti-inflammatory drugs. Out of the 33 feet, only five needed surgery [16].

Numerous clinical investigations assessed the surgical result of tarsal coalitions, and there have been a few reports of successful nonsurgical treatments. Jayakumar and Cowell reported that ~25–30% of their patients showed improvement after casting, with middle facet talocalcaneal coalitions benefiting the most [17].

Table 3 Baseline and follow-up radiological angles among the studied patients

	Baseline	Follow-up	*P* value
Meary's angle	38.60 ± 3.05	14.50 ± 5.08	< 0.001
Talonavicular coverage angle	16.20 ± 2.73	4.25 ± 1.92	< 0.001
Calcaneal pitch	8.85 ± 2.43	19.85 ± 3.29	< 0.001

Data expressed as mean±SD. *P* value was significant if less than 0.05.

In the current study, we aimed to evaluate the functional and clinical outcomes after long-acting steroid injection in the sinus tarsi followed by cast in pediatric and adolescent patients with spasmodic flatfeet without coalition. A total of 20 patients were enrolled in the study. Mean age of studied patients was 13.05 years with range being 10 to 16 years and 55% of patients were males.

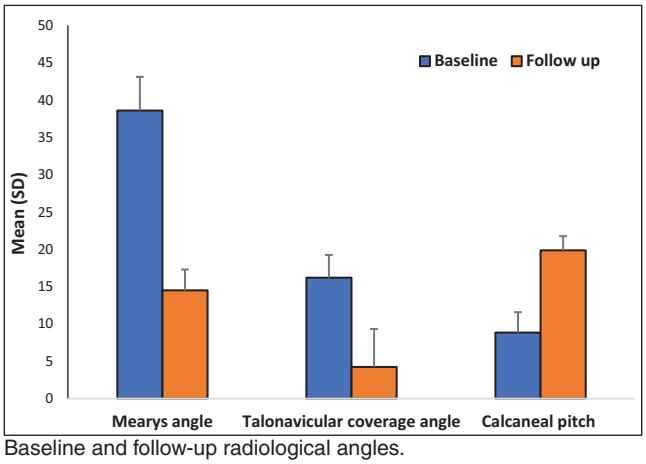
The main findings in the current study were that there was significant improvement in AOFAS as regards comparison between baseline score (48.75 ± 6.01), score at 3 months (90.55 ± 3.26), 6 months (84.45 ± 3.23) and 12 months (83.15 ± 4.05) after the procedure.

Radiologic parameters also showed significant improvement after the procedure; seen in the measurement of Meary's angle (38.60 ± 3.05 vs. 14.50 ± 5.08; *P*< 0.001), Talonavicular coverage angle (16.20 ± 2.73 vs. 4.25 ± 1.92; *P*< 0.001), and calcaneal pitch (8.85 ± 2.43 vs. 19.85 ± 3.29; *P*< 0.001).

In agreement with the current study; Rizk and Kandil found that the mean AOFAS score significantly improved from 40.9 at presentation to 73.56 at the last follow-up. Only 14 (28%) feet, even without the exclusion of tarsal coalitions, had unsatisfactory results with a total relapse. Satisfactory results (with complete or partial recovery) had been obtained in 36 (72%) feet [5].

Di Gennaro *et al.* found that in patients with talocalcaneal coalitions, 55% of cases, nonoperative care of patients with talocalcaneal coalitions resulted in satisfactory outcomes (total AOFAS-AHS >80). However, 15% of patients needed surgery following nonoperative care. Another study by Luhmann and colleagues included 13 feet in nine patients who underwent injection and manipulation under general anesthesia for spasmodic flat feet after exclusion of tarsal coalitions. Nine feet showed a significant improvement in subtalar motion, while four feet (when peroneal fractional lengthening was included) showed

Figure 4



Baseline and follow-up radiological angles.

moderate improvement. At the time of the last follow-up, 50% of their patients were free from pain and could engage in any activity [4].

Recently, Zide and colleagues said that although subtalar steroid injection can help certain patients with symptomatic talocalcaneal coalitions, when compared with conventional nonoperative therapy, this strategy does not seem to reduce the requirement for surgery. Subtalar steroid injections can postpone surgery for individuals who are not responding to other conservative treatment modalities by ~ 2 years on average [18].

Also, Hadano and colleagues stated that they placed a cast on the foot with complete plantar flexion and an inverted position when conservative therapy failed. The patient's foot range of motion was normal after 4 weeks, the pain was completely gone, and the peroneal spasticity disappeared [19].

The current study noticed that the radiographic parameters were not totally restored to the normal anatomical values, but most of them improved compared with the pre-procedure values in the majority of cases.

Contradicting findings have been reported in the literature as regards mobility of the hindfoot under general anesthesia. Rizk and Kandil established that a foot's ability to move when under general anesthesia did not always imply the presence of tarsal abnormalities, and vice versa. However, in the cases under study, there is a significant correlation between radiographic results indicating tarsal abnormalities and the occurrence of partial or total relapse over the follow-up period [5].

In the current study, none of the enrolled patients showed failure to regain full range of motion of the subtalar joint under general anesthesia. An explanation could be the use of MRI prior to the procedure in all patients, MRI proved to be an excellent tool for exclusion of nonossified coalitions.

Braddock examined 56 cases of peroneal spastic flatfeet (aged 10–15) that were managed with brief leg casts and treatment while under anesthesia. At the time of the last follow-up, 20% of the 10 talocalcaneal coalitions had no pain, 60% had mild symptoms, and 20% had severe symptoms. Following treatment, 58% of the 12 calcaneonavicular coalitions experienced no discomfort, and 42% experienced minor pain [20].

The current study reported higher success rates in comparison to previous studies as regards symptom alleviation. This could be explained by the use of general anaesthesia in all patients compared with nerve block in other published studies. Secondly, in some reports, the cast was applied without manipulation, in contrast to our cohort. Thirdly, combined local injection of long-acting steroids and local anesthetic in the sinus tarsi was done in all patients which had an anti-inflammatory action, improving the pain and stiffness.

From a different perspective, our procedure was more expensive than other nonoperative strategies (for instance, analgesia, physiotherapy, and orthotics) since it needed hospitalization with surgical room occupation for a considerable time. Therefore, we believe that this treatment may be reserved only to those cases in which other nonoperative treatments failed, or those that need but refuse surgery.

Early results are often important to families as well as the long-term outcomes. Factors such as the need to complete a school year, sports season, or insurance plan prior to undergoing surgery are often taken into consideration. In addition, while pain relief and requiring surgery are subjective, these data can still be helpful when educating families about results in other patients.

Some limitations are recognizable in our study, including the relatively small sample size (coronavirus disease 2019 flare-ups decreased number of elective cases managed at a single center) and the lack of a control group or another intervention. Lastly, we report the results of this nonoperative procedure at an early follow-up. To determine whether the nonoperative measures delay or prevent the need for surgery, a longer follow-up period is required.

Conclusion

Our study confirmed the short-term beneficial effect of local steroid injection, manipulation, and cast under general anesthesia on the improvement of functional and radiological outcomes in adolescent idiopathic spasmodic flatfoot without coalition, with remarkable role of magnetic resonance imaging in obtaining a high success rate. Future studies are warranted to support our findings.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

IRB approval: institutional review board of Faculty of Medicine Assiut University (No. 17101540)

Clinical trails: (NCT 05381558)

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Appendix

Appendix 1 The AOFAS (American Orthopaedic Foot and Ankle Society) Ankle-hindfoot scale

AOFAS Ankle-Hindfoot Scale

Patient Name: _____
Patient MRN: _____
Date: _____

I. Pain (40 points)

☐ None	+40
☐ Mild, occasional	+30
☐ Moderate, daily	+20
☐ Severe, almost always present	+0

II. Function (50 points)

Activity limitations, support requirements

☐ No limitations, no support	+10
☐ No limitation of daily activities, limitations of recreational activities, no support	+7
☐ Limited daily and recreational activities, cane	+4
☐ Severe limitation of daily and recreational activities, walker, crutches, wheelchair, brace	+0

Maximum walking distance, blocks

☐ Greater than six	+5
☐ Four-six	+4
☐ One-three	+2
☐ Less than one	+0

Walking surfaces

☐ No difficulty on any surface	+5
☐ Some difficulty on uneven terrain, stairs, inclines, ladders	+3
☐ Severe difficulty on uneven terrain, stairs, inclines, ladders	+0

Gait abnormality

☐ None, slight	+8
☐ Obvious	+4
☐ Marked	+0

Sagittal motion (flexion plus extension)

☐ Normal or mild restriction (30° or more)	+8
☐ Moderate restriction (15° - 29°)	+4
☐ Severe restriction (less than 15°)	+0

Hindfoot motion (inversion plus eversion)

☐ Normal or mild restriction (75% - 100% normal)	+6
☐ Moderate restriction (25% - 74% normal)	+3
☐ Marked restriction (less than 25% of normal)	+0

Ankle-hindfoot stability (anteroposterior, varus-valgus)

☐ Stable	+8
☐ Definitely unstable	+0

III. Alignment (10 points)

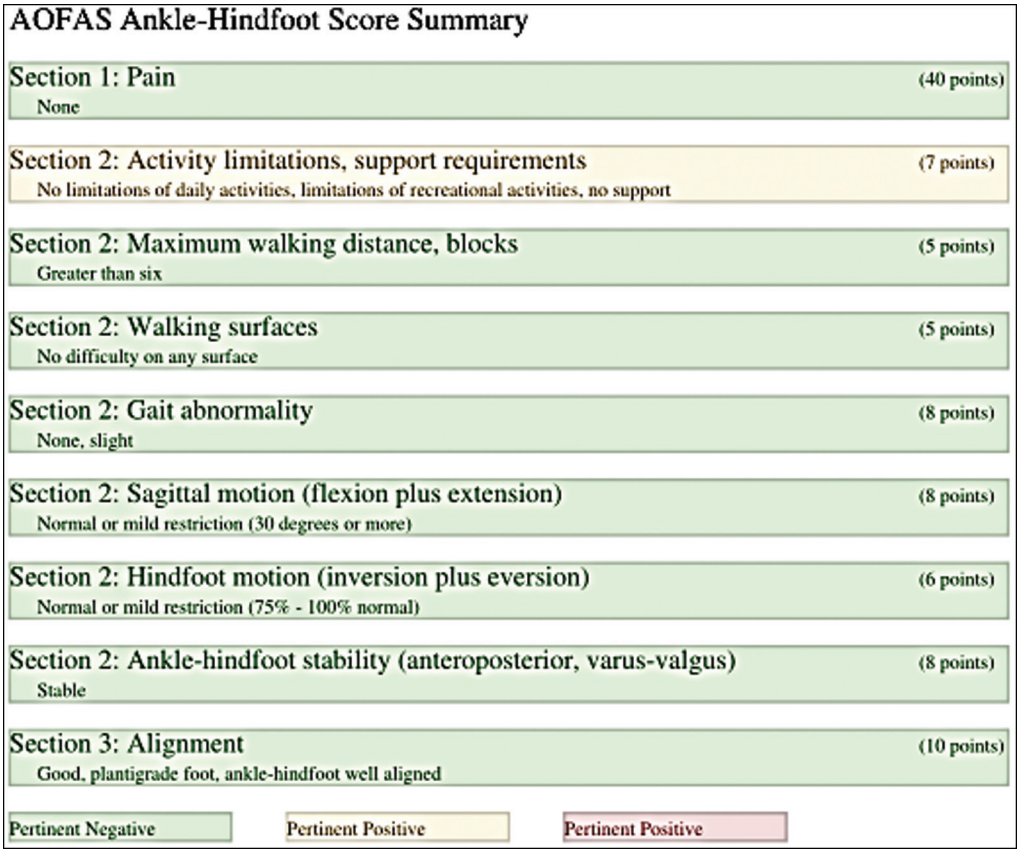
☐ Good, plantigrade foot, ankle-hindfoot well aligned	+10
☐ Fair, plantigrade foot, some degree of ankle-hindfoot malalignment observed, no symptoms	+5
☐ Poor, nonplantigrade foot, severe malalignment, symptoms	+0

IV. Total Score (100 points):

_____ Pain Points +
_____ Function Points +
_____ Alignment Points =

_____ Total Points/100 points

Appendix 2 The AOFAS (American Orthopaedic Foot and Ankle Society) Ankle-hindfoot scale summary.



AOFAS Ankle-Hindfoot Score Summary

Section 1: Pain None	(40 points)
Section 2: Activity limitations, support requirements No limitations of daily activities, limitations of recreational activities, no support	(7 points)
Section 2: Maximum walking distance, blocks Greater than six	(5 points)
Section 2: Walking surfaces No difficulty on any surface	(5 points)
Section 2: Gait abnormality None, slight	(8 points)
Section 2: Sagittal motion (flexion plus extension) Normal or mild restriction (30 degrees or more)	(8 points)
Section 2: Hindfoot motion (inversion plus eversion) Normal or mild restriction (75% - 100% normal)	(6 points)
Section 2: Ankle-hindfoot stability (anteroposterior, varus-valgus) Stable	(8 points)
Section 3: Alignment Good, plantigrade foot, ankle-hindfoot well aligned	(10 points)

Pertinent Negative | Pertinent Positive | Pertinent Positive