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Original Article

Orthopedic management of foot deformities due to poliomyelitis sequelae

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Abstract

Objective: To evaluate the clinical and functional outcomes of surgical approaches to foot deformities due to poliomyelitis sequelae.

Methods: This observational, retrospective, descriptive study included adult patients with poliomyelitis sequelae who underwent surgical correction of foot deformities. Functional assessment was performed using the American Orthopaedic Foot and Ankle Society (AOFAS) scale, applied descriptively during postoperative follow-up. Demographic and clinical variables, type of deformity, surgical procedures, and postoperative functional scores were analyzed without formal comparisons among techniques. Postoperative follow-up ranged from 12 to 48 months (mean, 27 months), and preoperative AOFAS scores were unavailable.

Results: Ten patients were included, with a mean age of 55.3 years; most were men. Procedures included panarthrodesis, ankle arthrodesis, midtarsal arthrodesis with soft-tissue procedures, talectomy, and arthrodesis using the Ilizarov method. AOFAS scores ranged from 56 to 83 points, with a mean of 72.5. Overall postoperative functional status was satisfactory, with good results in pain, stability, and alignment, although sagittal and hindfoot mobility remained restricted, particularly after arthrodesis. The highest AOFAS score was observed after panarthrodesis, whereas the lowest scores were observed after talectomy. Three cases of superficial skin necrosis and one case of delayed union of the tibiotarsal arthrodesis were recorded; none required reoperation.

Conclusion: Surgical treatment resulted in overall satisfactory postoperative functional status in this case series. Findings should be interpreted descriptively due to the absence of preoperative AOFAS scores, small sample size, and heterogeneity of deformities and techniques. Surgical individualization was relevant, but further comparative studies with larger sample sizes are required.

Level of evidence III; Therapeutic, Retrospective Study.

Keywords: Poliomyelitis; Treatment outcome; Foot deformities; Foot; Ankle; Arthrodesis.

Introduction

Poliomyelitis is a neurotropic viral disease that predominantly affects the motor neurons of the anterior horn of the spinal cord and may result in permanent flaccid paralysis and irreversible neuromusculoskeletal sequelae[1]. Before the widespread implementation of immunization strategies, the disease was an important cause of motor disability, with a significant impact on the function and autonomy of affected individuals. In Brazil, endemic poliovirus circulation has been interrupted since the late 1980s through systematic vaccination programs and continuous epidemiologic surveillance, resulting in a significant reduction in new cases[2]. However, eradication did not eliminate the clinical burden of late sequelae, which persist in a residual adult population that continues to require multidisciplinary follow-up[1].

From a functional standpoint, late poliomyelitis sequelae result from chronic neuromuscular deficits due to irreversible loss of motor units and compensatory adaptations over

Study performed at the Hospital Santa Marcelina, São Paulo, SP, Brazil.

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time, and may include manifestations consistent with post-poliomyelitis syndrome (PPS)[1,3]. This progressive neuromuscular impairment directly affects locomotor function, altering gait patterns, weight-bearing capacity, and the biomechanical efficiency of the lower limbs, with significant repercussions for functional independence and a predisposition to secondary musculoskeletal deformities[4].

Among the most limiting chronic manifestations of poliomyelitis sequelae are foot deformities, particularly equinus and cavus deformities, often with varus components, resulting from an imbalance between agonist and antagonist muscle groups. These changes lead to progressive structural malalignment, loss of plantigrade support, and impaired biomechanical gait efficiency, and may progress to rigid, painful deformities that are difficult to compensate for, directly affecting stability and walking ability[3,4].

Although currently rare, severe foot deformities related to poliomyelitis sequelae continue to be observed in specialized orthopedic practice. Previous Brazilian studies have identified poliomyelitis as an etiology in surgical series of severe foot deformities, reinforcing the clinical presence of these conditions even after disease control. Given the heterogeneity of deformities, the variable degree of joint stiffness, and differing functional demands, surgical treatment requires an individualized approach, with strategies tailored to each case. In this context, presenting a case series is particularly relevant for documenting the diversity of clinical manifestations, the therapeutic options adopted, and the functional evolution observed in clinical practice, while also enabling a systematic analysis of the functional outcomes achieved with different surgical techniques. Therefore, the objective of this study is to clinically and functionally evaluate the outcomes of the different surgical approaches used to treat foot deformities resulting from poliomyelitis sequelae by analyzing data from medical records and postoperative AOFAS scores.

Methods

This observational, retrospective, descriptive study was based on clinical and functional analysis of patients who underwent surgical treatment for foot deformities resulting from poliomyelitis sequelae and were followed at a specialized orthopedic service. Functional data were derived from AOFAS scores recorded during postoperative follow-up. The study was descriptive rather than comparative or inferential, and aimed to describe the clinical characteristics, deformities presented, surgical approaches employed, and functional outcomes recorded during postoperative follow-up. Given the condition's rarity and the heterogeneity of deformities and therapeutic strategies, cases were presented descriptively and individually, without formal comparisons among techniques.

The sample comprised adult patients with orthopedic poliomyelitis sequelae affecting the lower limbs who underwent surgery to correct foot deformities at a specialized orthopedic service. Patients with a clinical diagnosis of poliomyelitis sequelae who presented with foot deformities associated with functional limitation and difficulty walking were included. The treating team determined surgical indication individually, and patients underwent corrective surgery provided sufficient clinical and functional data were available for analysis. Postoperative follow-up ranged from 12 to 48 months (mean, 27 months). Patients with incomplete electronic medical records, no postoperative functional records, or foot deformities attributed to other neuromuscular etiologies other than poliomyelitis were excluded. The study was conducted in accordance with current ethical principles, after approval by the Institutional Review Board.

Once the study population was defined, the indication for surgical treatment was determined individually based on each patient's clinical evaluation, considering the type of foot deformity, the degree of joint stiffness, the pattern of muscle imbalance, and the functional demands identified at the time of treatment decision-making. Treatment decisions were made by the assisting team as part of routine clinical practice. The techniques employed included soft-tissue procedures, corrective osteotomies, and isolated or combined arthrodeses, depending on the specific characteristics of each deformity. In cases of rigid deformity or significant joint instability, joint stabilization procedures were selected to achieve a stable, plantigrade foot for weight bearing during gait, even at the expense of joint mobility. Considering the heterogeneity of deformities and surgical approaches, no formal comparisons were performed among techniques; the main objective was to correct alignment and improve functional stability.

To document the functional effects of the approaches used, functional performance was assessed using the AOFAS scale, which is used exclusively as a descriptive instrument and assesses domains related to pain, function, and foot and ankle alignment. Postoperative scores were used to describe functional status throughout the clinical follow-up, without comparative or inferential analyses among surgical techniques. The AOFAS scale is not an instrument specifically validated for patients with neuromuscular diseases; therefore, its results should be interpreted cautiously and only within the descriptive context of the present case series. No preoperative AOFAS scores were available in the retrospective records, making preoperative-to-postoperative comparisons impossible. The available records did not allow standardization of the exact timing of the AOFAS evaluation relative to surgery; therefore, the scores were treated only as descriptive measures during postoperative follow-up.

Clinical and functional data from these evaluations were organized and stored in Microsoft Excel® spreadsheets for tabulation and analysis. The variables analyzed included age, sex, date of infection, operated side, and previous physical activity, obtained from clinical records in the electronic medical records; participants were identified by sequential numbers, and no names were collected. Table 1 presents the sample characteristics, including clinical and demographic data for the ten included patients. For age, minimum, maximum, mean, and standard deviation values were calculated. For the AOFAS score, the mean, median,

Table 1. Characterization of the analyzed sample

Patient ID	Age	Sex	Profession	Side	Procedure	AOFAS
1	60	M	Retired	Right	Panarthrodesis	68
2	55	M	Store clerk	Right	Panarthrodesis	73
3	50	M	Office clerk	Right	Midtarsal arthrodesis + soft-tissue procedures	80
4	59	M	Carpenter	Left	Ankle arthrodesis	77
5	57	M	Retired	Right	Talectomy	66
6	49	M	Salesperson	Left	Arthrodesis + Ilizarov	66
7	51	M	Fare collector	Right	Panarthrodesis	76
8	61	F	Housekeeper	Left	Talectomy	56
9	55	F	Housekeeper	Right	Panarthrodesis	83
10	56	M	Construction worker	Left	Ankle arthrodesis	80

AOFAS: American Orthopaedic Foot and Ankle Society.

and standard deviation values were calculated. To explore the association between age and AOFAS score, Pearson and Spearman correlation coefficients were applied, according to the data distribution.

In addition, frequency analysis was performed for each AOFAS item, considering the pain, function, and alignment domains; the results are shown in Table 2.

Results

The results present a clinical and functional analysis of ten patients who underwent surgery to correct foot deformities resulting from poliomyelitis sequelae, based on medical records and the AOFAS scores recorded during postoperative follow-up. Demographic and clinical characteristics and the surgical procedures performed are detailed in Table 1.

Patient age ranged from 49 to 61 years, with a mean of 55.3 years (± 3.98). Eight patients were men and two were women. Regarding the affected side, six patients presented paralysis in the right limb and four in the left limb. Regarding surgical procedures, four patients underwent panarthrodesis (Figure 1), two underwent ankle arthrodesis, two underwent talectomies, one underwent midtarsal arthrodesis with associated soft-tissue procedures, and one underwent arthrodesis using the Ilizarov method.

Individual AOFAS scores, presented in Table 1, ranged from 56 to 83 points. The mean score was 72.5 points (SD = 7.95), and the median was 74.5.

To explore the association between age and AOFAS score, Pearson and Spearman correlation coefficients were applied. Both tests showed a weak correlation, with Pearson's coefficient of -0.38 and Spearman's coefficient of -0.33, indicating no strong association between age and functional performance. The results are shown in the scatter plot in Figure 2.

Table 2 presents the distribution of AOFAS scores across pain, function, and alignment domains, providing an overview of the sample's functional performance.

Table 3 presents the individual scores across AOFAS domains for each patient, distinguishing the pain, function, and foot and ankle alignment components.

The following description refers exclusively to score distributions across the AOFAS domains. In the pain domain, six patients had a maximum score (40 points), and four had a score corresponding to mild pain (30 points). Regarding functional items, most patients had restricted limitations in recreational activities, did not require gait support, and had no limitations in activities of daily living, whereas three patients achieved the maximum score for this item. In the gait subdomain, scores varied among no or slight abnormality, evident abnormality, and marked abnormality. All patients had the maximum score in the ankle and hindfoot stability domain. In contrast, all had zero scores in the sagittal and hindfoot mobility domains. For hindfoot alignment, eight patients had the maximum score, one had an intermediate score, and one had a zero score.

Regarding postoperative complications, three patients developed superficial skin necrosis that resolved satisfactorily. One patient had delayed union of the tibiotalar arthrodesis, which progressed without additional complications. No patient required reoperation.

Overall, these findings summarize the distribution of AOFAS scores in the analyzed sample and characterize the functional profile observed in patients with foot deformities resulting from poliomyelitis sequelae, a condition that is currently rare in Brazil. Presenting these results as a case series allows objective documentation of the functional variability associated with different deformities and the surgical approaches used during postoperative follow-up.

Discussion

The findings of the present study should be interpreted considering the current rarity of poliomyelitis in Brazil and the consequent scarcity of contemporary series that systematically address surgical strategies to correct residual

Table 2. AOFAS score frequency distribution

AOFAS (up to 100 points) Answer (Score)	Frequency	Frequency (%)
Pain (up to 40 points)		
None (40)	6	60%
Mild (30)	4	40%
Moderate (20)	-	-
Severe (0)	-	-
FUNCTIONAL (up to 50 points)		
Activity limitations, need for support		
No limitation, no support (10)	3	30%
No limitation in daily activities or recreational activities, no support (7)	7	70%
Limitation in daily activities (4)	-	-
Severe limitation in daily activities (0)	-	-
Maximum walking distance (blocks)		
More than 6 (5)	3	30%
From 4 to 6 (4)	7	70%
From 1 to 3 (2)	-	-
Less than 1 (0)	-	-
Walking surfaces		
No difficulty (5)	-	-
Some difficulty (3)	10	100%
Severe difficulty (0)	-	-
Gait abnormality		
None (8)	3	30%
Evident (4)	6	60%
Marked (0)	1	10%
Sagittal mobility (flexion + extension)		
Normal (≥ 30º) (8)	-	-
Moderate (15°-29°) (4)	-	-
Severe (< 15º) (0)	10	100%
Hindfoot mobility (inversion + eversion)		
Normal (75-100%) (6)	-	-
Moderate (25-74%) (3)	-	-
Severe (< 25%) (0)	10	100%
Ankle and hindfoot stability		
Stable (8)	10	100%
Unstable (0)	-	-
Alignment (up to 10 points)		
Good (10)	8	80%
Fair (5)	1	10%
Poor (0)	1	10%

AOFAS: American Orthopaedic Foot and Ankle Society.

Figure 1. Postoperative radiography panarthrodesis.

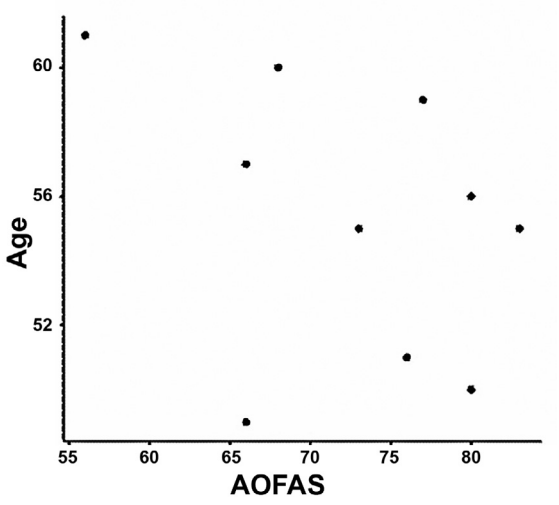

Figure 2. Scatter plot of age versus AOFAS score.

foot deformities in this population. Although eradicated from an epidemiologic perspective, poliomyelitis remains clinically relevant due to late neuromuscular sequelae, often associated with muscle imbalance, progressive joint stiffness, and complex foot and ankle deformities, requiring individualized therapeutic approaches based on the deforming pattern and degree of functional impairment[1-5]. Since the classic descriptions by Seddon et al.[6], it has been established that the primary objective of orthopedic treatment of poliomyelitis is to obtain a stable and functional plantigrade foot, even if this requires sacrificing joint mobility, a principle that remains valid in current clinical practice[6]. In this context, case series remain clinically and scientifically relevant, especially given the disease's low prevalence and the limitations of conducting large-sample studies in this population[2-5].

In the analyzed sample, the mean AOFAS score was 72.5 points, with wide individual variation (56 to 83 points), reflecting clinical heterogeneity among patients and the surgical strategies employed. Among the procedures performed, the highest individual AOFAS score was observed in a patient who underwent panarthrodesis (83 points). This finding should be interpreted descriptively, since the retrospective design, small sample size, and heterogeneity of deformities and techniques do not allow establishing superiority or a causal relationship between panarthrodesis and functional performance. The therapeutic rationale

Table 3. AOFAS score breakdown

ID	PAIN	FUNCTIONAL							ALIGNMENT
	Pain	Limitation	Distance	Surfaces	Gait	Sagittal mobility	Hindfoot mobility	Stabilities	Alignment
1	None (40)	Limitation in recreational activities (7)	More than 6 (5)	Some difficulty (3)	Marked (0)	Severe restriction (0)	Severe restriction (0)	Stable (8)	Fair (5)
2	Mild (30)	No limitation, no support (10)	4 to 6 (4)	Some difficulty (3)	None, mild (8)	Severe restriction (0)	Severe restriction (0)	Stable (8)	Good (10)
3	None (40)	No limitation, no support (10)	More than 6 (5)	Some difficulty (3)	Evident (4)	Severe restriction (0)	Severe restriction (0)	Stable (8)	Good (10)
4	None (40)	Limitation in recreational activities (7)	More than 6 (5)	Some difficulty (3)	Evident (4)	Severe restriction (0)	Severe restriction (0)	Stable (8)	Good (10)
5	Mild (30)	Limitation in recreational activities (7)	4 to 6 (4)	Some difficulty (3)	Evident (4)	Severe restriction (0)	Severe restriction (0)	Stable (8)	Good (10)
6	Mild (30)	Limitation in recreational activities (7)	4 to 6 (4)	Some difficulty (3)	Evident (4)	Severe restriction (0)	Severe restriction (0)	Stable (8)	Good (10)
7	None (40)	Limitation in recreational activities (7)	4 to 6 (4)	Some difficulty (3)	Evident (4)	Severe restriction (0)	Severe restriction (0)	Stable (8)	Good (10)
8	Mild (30)	Limitation in recreational activities (7)	4 to 6 (4)	Some difficulty (3)	Evident (4)	Severe restriction (0)	Severe restriction (0)	Stable (8)	Poor (0)
9	None (40)	No limitation, no support (10)	4 to 6 (4)	Some difficulty (3)	None, mild (8)	Severe restriction (0)	Severe restriction (0)	Stable (8)	Good (10)
10	None (40)	Limitation in recreational activities (7)	4 to 6 (4)	Some difficulty (3)	None, mild (8)	Severe restriction (0)	Severe restriction (0)	Stable (8)	Good (10)

AOFAS: American Orthopaedic Foot and Ankle Society.

aligns with the classical principles of treating paralytic sequelae described by Seddon et al.[6] and is supported by contemporary series that evaluate the surgical management of rigid echinocavovarus deformities associated with poliomyelitis[7-9].

The functional scores are within the range reported in the literature for rigid neuromuscular deformities undergoing reconstructive surgical treatment. However, interpreting the AOFAS total score in isolation is limited; a segmented analysis of its domains is more informative. This approach identifies a characteristic pattern after multiple hindfoot and midfoot arthrodeses: pain relief and increased structural stability at the expense of significantly reduced joint mobility. From a biomechanical perspective, joint fusion reduces the degrees of freedom of the ankle and hindfoot, with a direct impact on gait kinematics, particularly on the ability to adapt to irregular surfaces and on the efficiency of the gait cycle, as demonstrated in classic and functional gait analysis studies[8,9]. These results reinforce that the stability achieved is sufficient for weight bearing and functional gait, the central objective of treating poliomyelitis sequelae, in line with principles widely adopted in rehabilitation programs for this population[5].

In contrast, all patients showed marked restriction of sagittal and hindfoot mobility, reflected by zero scores in these domains of the AOFAS scale. This finding is expected after procedures involving multiple arthrodeses and aligns with contemporary studies evaluating reconstructive strategies in neurological deformities, where loss of range of motion is recognized as an inherent consequence of joint fusion[10]. From a functional perspective, this limitation can affect gait adaptation to irregular surfaces and fine adjustments during the gait cycle, phenomena classically described in the literature on human gait analysis[8] and corroborated by studies in patients with post-poliomyelitis syndrome undergoing functional walking tests[9].

The worst functional outcomes were observed in the patient undergoing talectomy, who had the lowest AOFAS total score and zero score in the alignment domain. The literature describes talectomy as an exceptional procedure, reserved for extremely rigid and complex deformities, often associated with residual biomechanical ankle and hindfoot impairment and more limited functional outcomes[11]. These findings are reinforced by case reports demonstrating difficulties maintaining alignment and functional recovery after this type of intervention[12].

The patient who underwent arthrodesis using the Ilizarov method achieved an intermediate functional result, consistent with the literature describing the method as an effective alternative for gradual correction of rigid and complex

deformities related to poliomyelitis. The biomechanical rationale for gradual controlled tension correction was originally described by Ilizarov, remaining as the conceptual basis of the method and supporting its clinical application in complex foot and ankle deformities. Modern clinical series confirm the effectiveness of this approach, although they highlight longer treatment times and the need for strict follow-up[10,13].

The exploratory analysis of the correlation between age and AOFAS score showed only a weak association, suggesting that in this sample, chronological age alone was not a determinant of postoperative functional performance. This finding reinforces the notion that factors such as deformity pattern, the degree of joint stiffness, neuromuscular involvement, and the surgical strategy adopted have a more relevant influence on functional outcomes than chronological age alone.

Finally, the results should be interpreted with caution, considering the small sample size, the heterogeneity of deformities and surgical techniques employed, as well as the retrospective and descriptive design of this case series. The absence of preoperative AOFAS scores prevents the evaluation of functional change between the preoperative and postoperative periods. Nevertheless, the study contributes to the literature by integrating epidemiologic background, classical principles as described by Seddon et al.[6], and contemporary clinical evidence, providing an updated view of the surgical management of orthopedic poliomyelitis sequelae.

Conclusion

The clinical and functional analysis, based on the AOFAS scores, suggests overall satisfactory postoperative functional status after surgical interventions performed to correct foot deformities resulting from poliomyelitis sequelae in this case series. The highest individual AOFAS score was observed in a patient who underwent panarthrodesis (83 points), whereas the lowest scores were observed in patients who underwent talectomy; these findings should be interpreted descriptively and do not allow conclusions regarding superiority or causal relationships among techniques. Despite the loss of mobility inherent in arthrodesis, functional performance was maintained, possibly due to increased stability and adequate pain control. Overall, this series suggests that well-indicated surgical interventions may improve stability and function, a finding that requires confirmation in studies with larger sample sizes and comparative designs.

Authors' contributions: Each author contributed individually and significantly to the development of this article: SDSP *(https://orcid.org/0000-0001-5957-527X) Conceived and planned the activities that led to the study, participated in the review process, performed the surgeries, data collection, approved the final version; JMM *(https://orcid.org/0000-0001-6039-4599) Interpreted the results of the study and participated in the review process; MAGR *(https://orcid.org/0000-0002-7424-9074) Performed the surgeries and data collection; IAR *(https://orcid.org/0009-0005-1228-3057) Interpreted the results of the study, participated in the review process, bibliographic review, and formatting of the article; MEBS *(https://orcid.org/0009-0006-1560-7923) Interpreted the results of the study, participated in the review process, bibliographic review, and formatting of the article. All authors read and approved the final manuscript. *ORCID (Open Researcher and Contributor ID).

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