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Original Article

Clinical outcomes following interpositional arthroplasty for advanced hallux rigidus: A retrospective case series

Fernando Gonzalez Correa[1], Ítalo Sousa de Moraes Castro[2], Gustavo Ambrósio Carillo[1], Tania Szejnfeld Mann[1], Eduardo Souza Maciel[1], Lucas Furtado da Fonseca[1], Nacime Salomão Barbachan Mansur[1], Leonardo Fernandez Maringolo[1]

1. Departamento de Ortopedia e Traumatologia, Centro de Traumatologia do Esporte, Universidade Federal de São Paulo, São Paulo, SP, Brazil.
2. Grupo de Cirurgia do Pé e Tornozelo, IFOR Rede D'Or, São Bernardo do Campo, SP, Brazil.

Abstract

Objective: To evaluate clinical and functional outcomes following interpositional arthroplasty in a Brazilian cohort.

Methods: This retrospective case series included 10 patients with grade III-IV hallux rigidus (HR) treated between January and September 2025. All procedures were performed by a single experienced foot and ankle surgeon. Inclusion criteria were failure of at least six months of conservative treatment. Exclusion criteria included diabetes mellitus, rheumatoid arthritis, and prior first metatarsophalangeal joint (MTPJ) surgery. Outcomes were assessed using the visual analog scale (VAS) and the American Orthopaedic Foot & Ankle Society (AOFAS) score preoperatively and at four months postoperatively. Statistical analysis included descriptive statistics, the Shapiro-Wilk test, and the Wilcoxon signed-rank test, with significance set at $p < 0.05$.

Results: The cohort was predominantly female (90.00%, 9/10), with a mean age of 58.700 ± 11.180 years. All patients achieved greater than 30° of first MTPJ range of motion at final follow-up. Radiographs demonstrated adequate bone resection and preservation of joint space. Pain improved progressively, with median VAS decreasing from 7.000 (IQR 6.500-8.000) preoperatively to 1.500 at four months (IQR 0.000-2.000). Functional outcomes improved significantly, with median AOFAS increasing from 52.000 (IQR 42.000-66.750) preoperatively to 84.000 (IQR: 84.000-99.000) at final follow-up.

Conclusion: Interpositional arthroplasty resulted in significant improvements in pain and function while preserving joint motion in patients with advanced hallux valgus. This technique represents a viable motion-preserving alternative for selected patients who wish to avoid arthrodesis.

Level of evidence IV; Retrospective Study.

Keywords: Metatarsophalangeal joint; Hallux rigidus; Arthroplasty; Treatment outcome.

Introduction

Hallux rigidus (HR) is among the most common arthritic conditions of the foot, affecting approximately 2.5% of individuals over 50 years of age [1,2], with a higher prevalence in females[3,4]. It is a progressive degenerative disorder of the first metatarsophalangeal joint (MTPJ), characterized by joint stiffness and a gradual loss of motion, particularly impairing the push-off phase of gait. As the disease progresses, it can result in significant pain, functional limitation, and reduced quality of life[5]. The MTPJ is subjected to substantial mechanical loads, with forces reaching approximately 119% of body weight during normal gait[1].

The HR etiology is multifactorial, involving mechanical factors, genetic predisposition, and, in some cases, prior trauma[6]. Patients with osteoarthritis in other joints, such as gonarthrosis, have an increased risk of developing HR. In addition, individuals with gout, hallux valgus, or inflammatory joint diseases, such as rheumatoid arthritis, represent relevant risk groups, although the degenerative form remains the most prevalent[2,6].

Study performed at the Departamento de Ortopedia e Traumatologia, Centro de Traumatologia do Esporte, Universidade Federal de São Paulo, São Paulo, SP, Brazil.

Correspondence: Fernando Gonzalez Correa. Rua Botucatu, 740, 1º Andar, Vila Clementino, São Paulo, SP, 04023-062, Brazil. **Email:** fer_correa89@hotmail.com. **Conflicts of interest:** none. **Source of funding:** none. **Date received:** July 10, 2026. **Date accepted:** July 29, 2026.

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Initial management of early-stage HR includes activity modification, orthotics, analgesics, and corticosteroid injections[7,8]. When conservative treatment fails, numerous viable operative techniques exist to treat HR, such as cheilectomy, resection arthroplasty, interpositional arthroplasty, and arthrodesis[4,9,10]. In advanced stages of the disease (grades III and IV), MTPJ arthrodesis is considered the gold-standard treatment for HR, providing long-lasting pain relief, a high rate of bone consolidation, and high functional satisfaction, especially after failure of conservative treatment[11,12]. However, the loss of joint motion following arthrodesis has led to growing interest in motion-preserving alternatives[13,14].

Interpositional arthroplasty has emerged as an alternative for advanced HR, aiming to preserve joint motion by placing a biologic spacer, particularly in active patients who wish to avoid permanent loss of mobility[15]. This technique preserves both motion and bone stock and has evolved since its initial description by Hamilton et al. (1997)[16] with modifications incorporating capsular tissue, local tendons, or biologic matrices. Among these, the modified oblique Keller capsular interpositional arthroplasty (MOKCIA), described by Johnson and McCormick (2014)[14], has gained attention for its ability to maintain joint stability while preserving flexor tendon function.

Recent systematic reviews have demonstrated improvements in functional outcomes and range of motion following interpositional arthroplasty at mid-term follow-up[17]. Additionally, a systematic review including 20 studies and 539 feet reported that 90% of patients experienced significant clinical improvement at a mean follow-up of 4.5 years, with only 3.8% requiring revision surgery[17].

However, there remains a paucity of studies evaluating outcomes within a single surgical team and at a national level. Therefore, this study aims to assess the effects of interpositional arthroplasty on pain, function, and alignment, as measured by the visual analog scale (VAS) and the American Orthopaedic Foot & Ankle Society (AOFAS) score.

Methods

This is a retrospective case series study comprising 10 patients diagnosed with grade III or IV HR who underwent surgery between January and September 2025 at a public hospital. All patients completed a 4-month postoperative follow-up, which corresponded to the final study assessment. All procedures and follow-up evaluations were performed by a single foot and ankle specialist surgeon with more than five years of experience in foot and ankle surgery.

The study was approved by the Institutional Review Board. The guidelines established by Resolution No. 674/2022 of the National Health Council, which regulates research involving human beings in Brazil, were followed. All participants signed the Informed Consent Form (ICF).

All consecutive eligible patients with HR refractory to conservative treatment for at least six months who were treated during the study period were included. Exclusion criteria included diabetes mellitus, rheumatoid arthritis, and previous MTPJ surgery.

Indications for interpositional arthroplasty were based on the criteria described by Hamilton et al.[16] and included severe HR with less than 10° of range of motion (grades III and IV), as confirmed by clinical and radiographic evaluation. On physical examination, patients demonstrated marked limitation of motion (particularly dorsiflexion), pain, and enlargement of the MTPJ. Anteroposterior and lateral radiographs showed near-complete joint space obliteration and extensive periarticular osteophyte formation (Figure 1).

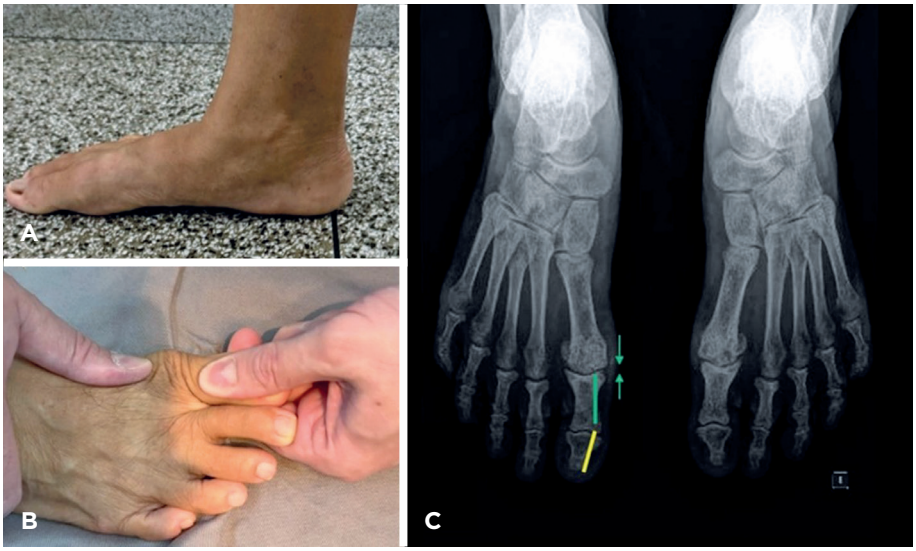

Figure 1. Clinical and radiographic evaluation of hallux rigidus. (A) Lateral view showing enlargement of the first metatarsophalangeal joint. (B) Physical examination demonstrating pain and marked limitation of motion, particularly dorsiflexion. (C) Anteroposterior and lateral radiographs showing near-complete joint space obliteration with extensive periarticular osteophyte formation.

Surgical technique

The procedure was performed in the operating room under spinal anesthesia. Potential sources of bias were minimized by including consecutive eligible patients, using standardized surgical and postoperative protocols, and performing all procedures under the supervision of a single experienced surgeon. However, given the retrospective design, residual measurement bias inherent to medical record data cannot be fully excluded. A dorsomedial incision was made over the MTPJ to expose the capsule. A U-shaped capsular flap with a distal base was created. Soft tissues were carefully released, including partial detachment of the dorsal capsule and selected fibers of the plantar plate and flexor hallucis brevis. A standard cheilectomy was performed, with resection of approximately 25%-30% of the dorsal aspect of the first metatarsal head using a sagittal saw. The base of the proximal phalanx was resected approximately 0.3 cm distal to the MTPJ. The extensor hallucis brevis tendon was transected to allow adequate mobilization, and the capsular flap together with the tendon was interposed beneath the base of the proximal phalanx and secured using nonabsorbable sutures. Postoperatively, patients were allowed immediate weight-bearing as tolerated with a rigid-soled postoperative shoe for six weeks, followed by a transition to regular footwear. Early mobilization was encouraged (Figures 2 and 3).

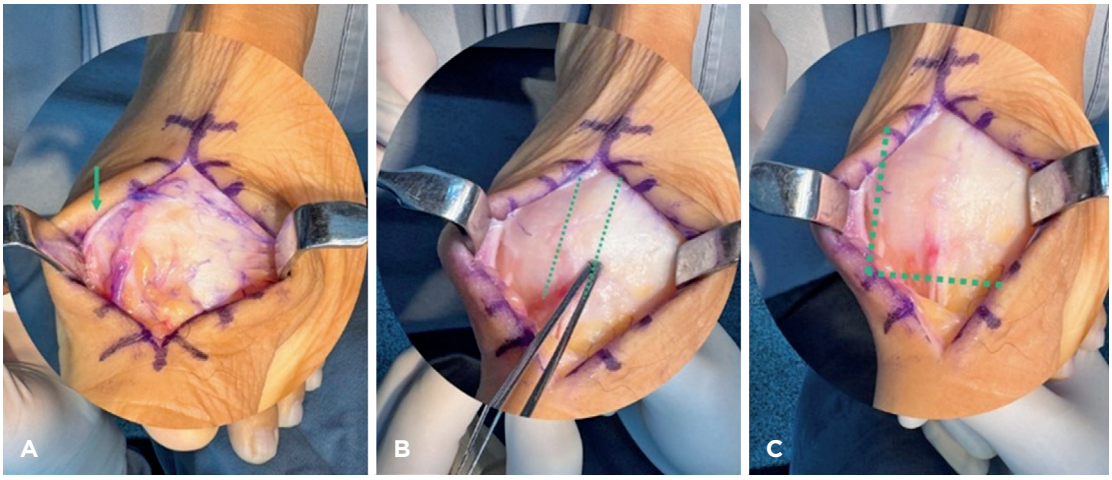

Figure 2. Intraoperative steps of interpositional arthroplasty for hallux rigidus. (A) Identification of the dorsomedial cutaneous nerve (green arrow) on the medial aspect of the foot. (B) Identification and dissection of the extensor hallucis longus tendon (green dotted line) from the joint capsule. (C) Surgical exposure of the first metatarsophalangeal joint through capsular dissection, with separation of the capsule from the extensor hallucis brevis tendon, facilitating preparation for interpositional arthroplasty.

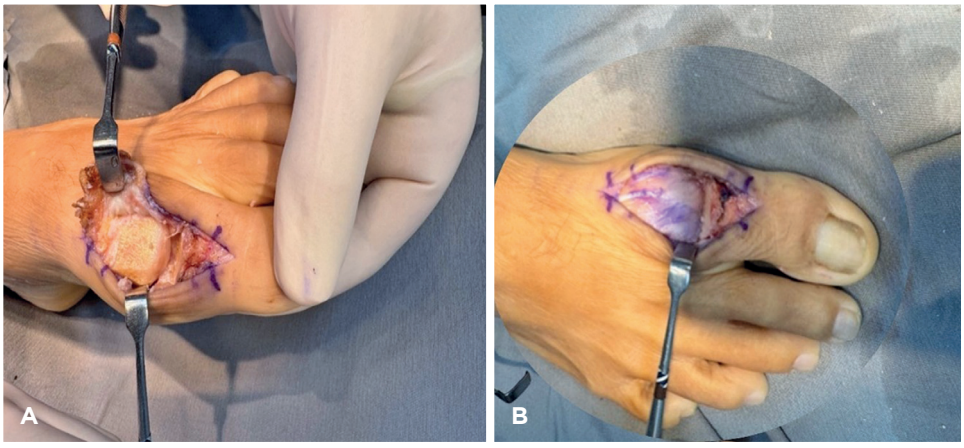

Figure 3. Interpositional Arthroplasty for hallux rigidus. (A) Cheilectomy with resection of approximately 25%-30% of the dorsal aspect of the first metatarsal head, followed by resection of the base of the proximal phalanx approximately 0.3 cm distal to the first metatarsophalangeal joint. (B) Clinical image demonstrating capsular interposition.

Patient-reported outcomes

Physical function was evaluated using the AOFAS. Preoperative AOFAS scores were collected from patients' medical histories. The AOFAS consists of three subscales: pain, function and alignment, and includes a total of nine items. The minimum score is 0 points (indicating severe pain and impairment), the maximum score is 100 points (no impairment). Pain was evaluated using the VAS from 0 to 10 (0: no pain, 10: worst possible pain). The pain VAS was obtained preoperatively and at five postoperative follow-up time points.

Data collection and statistical analysis

Data were extracted from complete medical records with no missing variables for the outcomes of interest. The study included all consecutive eligible patients treated during the study period; therefore, no formal sample size calculation was performed. The database was constructed using Excel. Descriptive analysis was performed using absolute (n) and relative (%) frequencies for categorical variables. Continuous variables are presented as mean ± standard deviation or median (interquartile range, IQR), depending on the data distribution. Data distribution was assessed using the Shapiro-Wilk test. The Wilcoxon signed-rank test was used for comparisons between related samples, and exact p-values were reported for non-parametric comparisons. Because this was a descriptive retrospective case series without a comparison group, no adjustment for potential confounding variables was performed. GraphPad Prism version 11.0.0 (GraphPad Software, Boston, MA, USA) was used for statistical analyses, with a significance level of $p < 0.05$.

Results

Ten patients were included in the final analysis. The sample was predominantly female (90.00%; 9 females and 1 male). Age, weight, and height (mean ± SD) were 58.700 ± 11.180 years, 73.900 ± 8.103 kg, and 1.710 ± 0.049 m, respectively. Regarding the affected side, five participants underwent right-sided surgery and five underwent left-sided surgery (Table 1). Radiographs were reviewed before surgery, immediately after surgery, and at the last follow-up appointment (Figure 4). The range of MTPJ in all patients was greater than 30°.

Table 1. Demographic factors of 10 patients undergoing interpositional arthroplasty for the treatment of hallux rigidus**.**

Variables	Mean	SD	95% CI of the mean
Age (years)	58.700	11.180	50.71 to 66.69
Weight (kg)	73.900	8.103	68.10 to 79.70
Height (m)	1.710	0.049	1.675 to 1.745
BMI (kg/m^2)	25.260	2.248	23.480 to 27.030
Gender, n (%)			
Female	9 (90%)	-	-
Male	1 (10%)	-	-
Operated side, n (%)			
Right	5 (50%)	-	-
Left	5 (50%)	-	-

BMI: Body mass index; CI: Confidence interval; SD: Standard deviation.

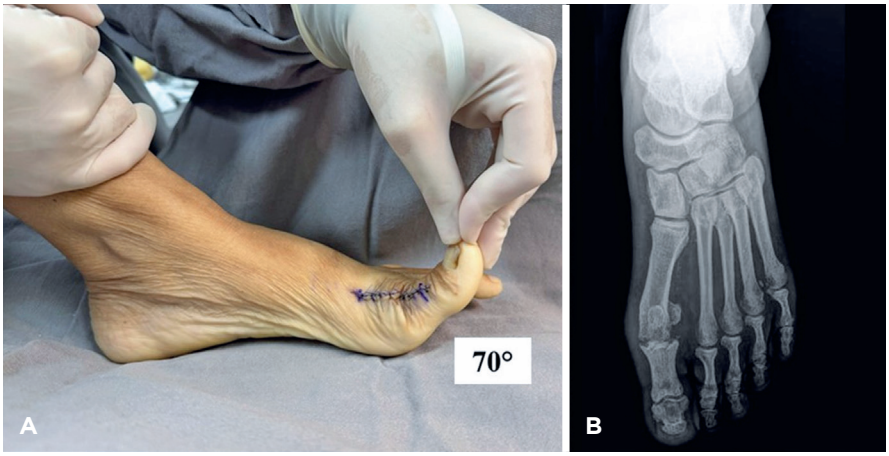

Figure 4. Assessment of range of motion and radiography after surgery at the time of the last follow-up. (A) Clinical assessment of the range of motion of the first joint. (B) Anteroposterior radiograph demonstrating bone resection level and preserved joint space. Observe the relatively equal lengths of the first and second metatarsals.

Pain and functional outcomes improved progressively after surgery. Preoperatively, the median VAS score was 7.000 (IQR 6.500-8.000). At one week postoperatively, it decreased to 5.000 (IQR 3.500–5.500), a statistically significant reduction compared with baseline (p = 0.035). At three weeks, the median was 4.500 (IQR 2.750-6.250), remaining lower than preoperative values (p = 0.014). Further reductions were observed at six weeks (median 3.000, IQR 1.500-4.000), two months (median 2.500, IQR 0.000-3.000), and four months (median 1.500, IQR 0.000-2.000), demonstrating continuous improvement in pain outcomes over time (Table 2).

Preoperatively, the median AOFAS score was 52.000 (IQR 42.000-66.750). Improvement was observed as early as one week (median 68.000, IQR 64.750-79.250; p = 0.0322). At three weeks, the median score increased to 70.000 (IQR 66.000-84.000), representing a significant improvement compared with baseline values. At six weeks, two months, and four months, median scores reached 84.000, indicating continuous functional recovery, with statistically significant differences compared with preoperative values at nearly all time points (Table 3).

One patient (10%) required revision surgery during the follow-up period due to persistent symptoms. No other postoperative complications were observed.

Discussion

This study demonstrated that interpositional arthroplasty for HR resulted in significant early and sustained improvements in pain and function in a Brazilian cohort, with all procedures performed by a single experienced foot and ankle surgeon, ensuring technical consistency across cases. Both VAS and AOFAS scores improved progressively from the immediate postoperative period through the final follow-up (4 months), supporting this technique as an effective motion-preserving option for selected patients.

Pain reduction was clinically relevant and early, with median VAS decreasing from 7.000 (IQR 6.500-8.000) preoperatively to 5.000 (IQR 3.500-5.500) at one week (p = 0.035), 4.500 (IQR 2.750-6.250) at three weeks (p = 0.014), and reaching 1.500 (IQR 0.000-2.000) at four months.

This represents an overall reduction of approximately 79% in pain scores. The early and sustained improvement is consistent with a recent systematic review showing that interpositional procedures provide reliable short-term pain relief in HR[18] and with a retrospective study[19]. Furthermore, Vulcano et al.[20] reported results similar to ours, with a mean VAS score decreasing from 7.9 preoperatively to 1.8 postoperatively at a mean follow-up of 11.3 years, suggesting that these outcomes may be sustained over time.

Functional outcomes followed a similar trajectory. Preoperatively, the median AOFAS score was 52.000 (IQR 42.000-66.750). Improvement was observed as early as one week (median 68.000, IQR 64.750-79.250; p = 0.0322). At three weeks, the median score increased to 70.000 (IQR 66.000-84.000), representing a significant improvement compared with baseline values. Scores remained stable thereafter, with a median score of 84.000 at final follow-up. This represents an overall gain of approximately +32 points, which is consistent with the benefits of interpositional arthroplasty shown in systematic review studies[9,18,21]. The early functional recovery observed in this cohort is particularly relevant, as most

Table 2. Evaluation of the visual analog scale after interpositional arthroplasty for hallux rigidus.

Time	Mean ± SD	Median	IQR (Q1-Q3)	p1	p2	p3	p4	p5
Pre-operative	7.000 ± 1.491	7.000	(6.500-8.000)	—				
1 Week	4.500 ± 2.270	5.000	(3.500-5.500)	**0.035**	—			
3 Weeks	4.200 ± 2.250	4.500	(2.750-6.250)	**0.014**	**0.523**	—		
6 Weeks	2.600 ± 1.570	3.000	(1.500-4.000)	**0.009**	**0.020**	**0.035**	—	
2 Months	1.800 ± 1.390	2.500	(0.000-3.000)	**0.005**	**0.008**	**0.013**	0.065	—
4 Months	1.300 ± 1.050	1.500	(0.000-2.000)	**0.004**	**0.008**	**0.008**	**0.021**	0.089

SD: Standard deviation. Values are presented as mean ± standard deviation and median (interquartile range, IQR). P-values were obtained using the Wilcoxon signed-rank test for paired comparisons. p1 compares each follow-up time point with preoperative values; p2 with 1 week; p3 with 3 weeks; p4 with 6 weeks; and p5 with 2 months. Bold values indicate statistical significance (p < 0.05).

Table 3. Evaluation of American Orthopaedic Foot & Ankle Society scores after interpositional arthroplasty for hallux rigidus.

Time	Mean ± SD	Median	IQR (Q1-Q3)	p1	p2	p3	p4	p5
Pre-operative	56.100 ± 14.890	52.000	(42.000-66.750)	—				
1 Week	69.700 ± 14.890	68.000	(64.750-79.250)	**0.032**	—			
3 Weeks	73.700 ± 8.840	70.000	(66.000-84.000)	**0.024**	**0.035**	—		
6 Weeks	83.300 ± 11.450	84.000	(73.750-96.000)	**0.005**	**0.005**	**0.014**	—	
2 Months	87.200 ± 11.650	84.000	(79.750-99.000)	**0.005**	**0.005**	**0.008**	0.062	—
4 Months	90.000 ± 7.970	84.000	(84.000-99.000)	**0.005**	**0.005**	**0.005**	**0.031**	0.345

SD: Standard deviation. Values are presented as mean ± standard deviation and median (interquartile range, IQR). P-values were obtained using the Wilcoxon signed-rank test for paired comparisons. p1 compares each follow-up time point with preoperative values; p2 with 1 week; p3 with 3 weeks; p4 with 6 weeks; and p5 with 2 months. Bold values indicate statistical significance (p < 0.05).

patients were physically active and motivated to preserve joint motion, a key factor in surgical decision-making for HR. In this context, motion-preserving procedures may offer a distinct advantage over arthrodesis, especially in individuals with higher functional demands in daily and recreational activities[18,19,21].

Preservation of motion is one of the main advantages of interpositional arthroplasty. In this series, all patients achieved greater than 30° of MTPJ at final follow-up, which has been associated with improved gait mechanics[9,19]. Maintenance of mobility has been consistently reported in recent literature and is particularly relevant in active populations, in whom loss of mobility may result in compensatory overload of adjacent joints[9,16,18,20].

Complication rates were low, with only one patient requiring revision surgery (10%). This is consistent with recent systematic reviews reporting acceptable complication profiles, with metatarsalgia as the most frequent adverse event[17,19].

Arthrodesis remains the gold standard for advanced HR due to its predictable pain relief and durability[22]. However, it eliminates motion and may limit footwear options and higher-demand activities. In contrast, interpositional arthroplasty offers a motion-preserving alternative, which may be particularly advantageous for younger or more active patients, or those who prioritize joint mobility. Comparative studies suggest that while arthrodesis may provide more consistent long-term pain control, interpositional techniques can achieve satisfactory outcomes while preserving function and motion[18,19,21,23].

Long-term comparative data also support interpositional techniques as a motion-preserving alternative. A recent study demonstrated similar pain, satisfaction, and functional outcomes between interpositional arthroplasty and arthrodesis at over 10 years of follow-up, with maintained joint motion and no significant differences in plantar pressure. These findings suggest that interpositional arthroplasty may achieve outcomes comparable to those of arthrodesis in selected patients while preserving mobility[14].

The demographic profile of this cohort (90% female, mean age 58.700 ± 11.180 years) is consistent with the known epidemiology of HR[16,19,23,24]. The homogeneous sample and single-surgeon design improve internal validity, but may limit external generalizability.

This study has several limitations. Its retrospective design, small sample size, and short follow-up period (4 months) limit conclusions regarding the long-term durability of the procedure, late complications, symptom recurrence, and revision rates. In addition, individual range of motion measurements were not consistently recorded throughout the postoperative follow-up, limiting the assessment of longitudinal changes in joint mobility. Although the single-surgeon approach improves technical consistency, it may reduce external applicability. The absence of a control group, particularly arthrodesis cases, also limits comparative interpretation.

Despite these limitations, the present study supports interpositional arthroplasty as a viable surgical option for HR, providing significant early improvements in pain (VAS: 7.000 to 1.500) and function (AOFAS: 52.000 to 84.000), while preserving joint motion in a population with higher functional demands than those typically reported in the literature. To our knowledge, this study is among the first Brazilian case series to evaluate interpositional arthroplasty for advanced HR using standardized patient-reported outcome measures and a single-surgeon protocol. The fact that this study was conducted in a Brazilian population and the single-surgeon design enhances the internal consistency of the findings, as there is a scarcity of published data on interpositional arthroplasty in South American cohorts. In addition, no previous Brazilian case series that specifically evaluates interpositional arthroplasty for HR using standardized patient-reported outcome measures has been published in the indexed literature, highlighting the regional contribution of the present study. However, future prospective, randomized, multicenter, and comparative studies with longer follow-up are required to better define its role relative to established surgical treatments.

Conclusion

Dorsal capsular interpositional arthroplasty may represent a valuable surgical option for advanced HR, providing early improvements in pain and function while preserving joint motion throughout the 4-month follow-up period. These findings are consistent with the broader literature on interpositional techniques. However, higher-quality studies with longer follow-up are needed to better define its indications and long-term outcomes.

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