DOI: https://doi.org/10.30795/jfootankle.2025.v19.1922

Original Article

Hallux valgus treatment with the Percutaneous Bianchi System: a five-year evaluation

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Abstract

Objective: The objective of this study was to evaluate the Percutaneous Bianchi System (PBS) technique in the treatment of hallux valgus (HV) and its durability in a five-year postoperative follow-up.

Method: Nineteen patients diagnosed with HV underwent surgical treatment using the PBS method, and 17 of them were evaluated radiographically before and after surgery, with a 60-month follow-up. The degree of deformity correction was recorded based on the hallux valgus angle (HVA) and intermetatarsal angle (IMA), to evaluate the durability of correction over time.

Results: The HVA and IMA were significantly reduced in the immediate postoperative evaluation and remained so until 60 months after surgery, with little variability in the temporal relationship.

Conclusion: The PBS technique proved to be a safe and durable procedure for correction of symptomatic HV, achieving improvement of the deformity, although further studies are needed for greater consistency in recommending the technique.

Level of Evidence IV; Therapeutic Studies; Case Series.

Keywords: Hallux valgus; Surgical procedures, operative; Osteotomy.

Introduction

Hallux valgus (HV) is the most common deformity of the first metatarsal (M1) bone, with a higher prevalence in women between 40 and 60 years of age, often occurring bilaterally. Surgery is indicated in case of persistent pain, functional limitation for wearing shoes, or significant impairment of quality of life, including aesthetic and functional aspects. Several surgical techniques based on M1 osteotomies are described, ranging from open approaches to minimally invasive methods whose goal is to reduce morbidity and accelerate functional rehabilitation[1-5].

Among such minimally invasive techniques, the Percutaneous Bianchi System (PBS) stands out for enabling a complete extra-articular metatarsal osteotomy without the need for internal fixation. The technique involves performing an exostectomy of the medial prominence, releasing the conjoint tendon. An M1 osteotomy angled at 45°–50° is performed in the sagittal plane, from distal to proximal, and at 15° in the frontal plane, from medial to lateral, with displacement of the distal M1 fragment laterally and plantarly. By preserving a step in the lateral cortex, similar to that of the Mitchell technique, after complete osteotomy and providing support for primary bone stability, PBS allows for potential application in cases ranging from mild to severe deformities[6].

Despite the advantages attributed to percutaneous techniques—such as less tissue trauma and faster recovery—there is still controversy regarding the accuracy and durability of the angular correction obtained. In this context, the present study aims to critically and longitudinally evaluate clinical and radiographic results of the PBS technique in the treatment of HV, with an emphasis on analyzing the durability of corrections over five years of postoperative follow-up.

Study performed at the Hospital COT – Ortopédico e Traumatológico, Salvador, BA, Brazil.

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Conflicts of interest: none. **Source of funding:** none. **Date received:** July 11, 2025. **Date accepted:** September 25, 2025.

How to cite this article: Moreno MVMG, Vieira TEM, Alves SMC, Silva TMV. Hallux valgus treatment with the Percutaneous Bianchi System: a five-year evaluation. J Foot Ankle. 2025;19(3):e1922.

Method

This is a retrospective longitudinal observational study approved by the Institutional Review Board. Information was extracted from electronic medical records, and weight-bearing radiographic examinations were performed in upright position, with anteroposterior and lateral views, between January 2019 and December 2024. The following angles were measured: the hallux valgus angle (HVA), between the axis of the proximal phalanx and the M1; and the intermetatarsal angle (IMA), between the axes of the M1 and second metatarsal, according to the guidelines of the American Orthopaedic Foot and Ankle Society (AOFAS)[4-7].

Patients over 18 years of age diagnosed with HV who underwent PBS surgery and had radiographic follow-up for up to 60 months were included. Patients with functional limitation of the metatarsophalangeal joint, inflammatory or rheumatological diseases, diabetes, joint instability, or a history of previous surgery on the same foot were excluded.

All surgeries were performed by the same team, following standardized operative and postoperative protocols. Images were evaluated preoperatively and at 12 and 60 months after surgery to verify the durability and stability of the technique.

This is a "before and after" study design. Relative frequencies were described for gender and operated side, as well as mean and standard deviation for age, stratified according to the Brazilian Institute of Geography and Statistics (IBGE) criteria (elderly: ≥ 60 years). Paired t-test was used to compare pre- and postoperative HVA and IMA means. To assess the effect of age and side of operated foot, t-test for independent samples was applied. Normality was tested using the Kolmogorov-Smirnov test. Analysis of changes in angle classifications was performed using the McNemar test. The level of significance adopted was 5%, and confidence intervals were 95%. Analyses were performed using the Stata 14.0 software.

Results

The study recruited 19 patients, two of whom were excluded because, in addition to PBS, they had undergone another complementary technique for correction of interphalangeal deformity. Of the 17 participants included, all were women, with a mean age of 51.1 ± 13.5 years (ranging from 22 to 66 years). Seven of them (41.2%) were 60 years of age or older. Regarding the side of the operated foot, nine interventions were performed on the right foot and eight, on the left foot, with no reports of bilateral cases (Table 1).

Table 2 shows the HVA evolution after correction using the PBS technique. Preoperative mean was 23.6° ± 4.3°, reduced to 8.4° ± 3.1° in the first year (Δ = -15.1°; 95% CI: 13.8–16.5; p < 0.001). At five years, it remained stable, at 8.3° ± 3.1° (Δ = -15.0° vs. baseline; 95% CI: 13.5–16.5; p < 0.001). Comparison between results at 12 and 60 months showed no significant difference (Δ = -0.15°; 95% CI: -1.65 to 1.36; p = 0.845). Analysis of variance (ANOVA) confirmed overall significance (p < 0.001), demonstrating the efficacy and stability of the technique.

Figure 1 shows the HVA evolution after the PBS technique correction, with averages of 23.6° preoperatively, 8.4° at 1 year, and 8.3° at 5 years. The scale (0°–30°) shows the magnitude of the correction obtained. Notes indicate a statistically significant difference between the preoperative period and the two postoperative periods assessed (p < 0.001), and no significant variation between 1 and 5 years (p = 0.845), which indicates a result stability over time.

Table 3 shows the longitudinal IMA trajectory in patients undergoing the PBS technique correction. Mean preoperative value was 12.9° ± 2.1°, reduced to 5.5° ± 1.7° at 1 year (mean reduction: 7.4°; 95% CI: 6.4–8.5; p < 0.001) and remaining at 5.3° ± 1.8° at 5 years (mean reduction vs. preoperative: 7.2°; 95% CI: 6.1–8.4; p < 0.001). Comparison among postoperative periods revealed no significant difference (Δ: -0.21°; 95% CI: -1.34 to 0.93; p = 0.709), corroborating the lasting stability of the correction (one-way ANOVA: p < 0.001).

Table 1. Characterization of patients with hallux valgus undergoing the Percutaneous Bianchi System technique

Patient characteristics	Statistics
Sex: Female	17 (100%)
Age	
Mean ± Standard Deviation	51.1 ± 13.5 years
Minimum – Maximum	22 – 66 years
Age group	
< 60 years	10 (58.8%)
≥ 60 years	7 (41.2%)
Intervention foot side	
Right	9 (52.9%)
Left	8 (47.1%)
Bilateral	0 (0%)

Table 2. Evolution of hallux valgus angle in patients undergoing the Percutaneous Bianchi System technique

Time point	Hallux valgus angle (degrees) over time Mean ± SD	Mean postoperative reduction (95% CI)
Preoperative	23.6 ± 4.3	-
1-year post-op	8.4 ± 3.1	-
5-year post-op	8.3 ± 3.1	-
Statistical comparisons (Intragroup)[b]	< 0.001[a]	
p-value: Pre-op vs. 1-year post-op	< 0.001	15.1 (13.8 to 16.5)
p-value: Pre-op vs. 5-year post-op	< 0.001	15.0 (13.5 to 16.5)
p-value: 1-year vs. 5-year post-op	0.845	-0.15 (-1.65 to 1.36)

[a] One-Way ANOVA for repeated measures: effect between assessments; [b] Post-Hoc ANOVA: intragroup effect.

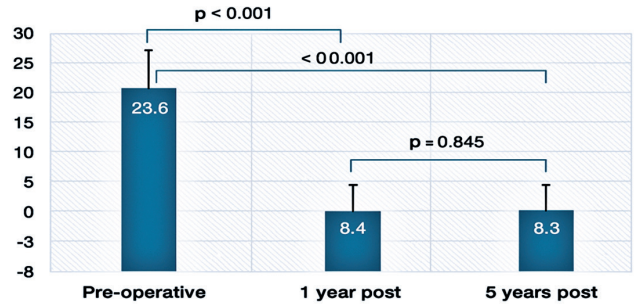

Figure 1. Average hallux valgus angle of patients with hallux valgus undergoing Percutaneous Bianchi System technique before and after intervention.

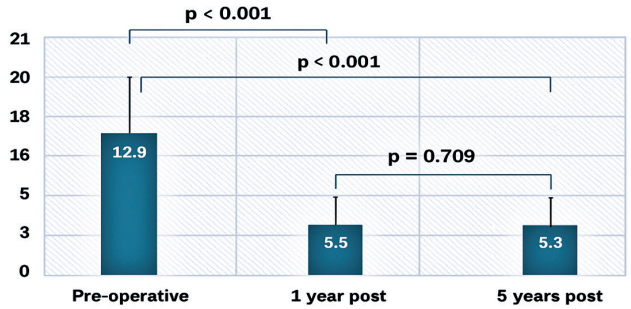

Figure 2. Mean angle between the first and second metatarsals of patients with hallux valgus undergoing the Percutaneous Bianchi System technique before and after intervention.

Table 3. Evolution of intermetatarsal angle after Percutaneous Bianchi System technique

Time point	Intermetatarsal angle (1st-2nd, degrees) over time Mean ± SD	Mean postoperative reduction (95% CI)
Preoperative	12.9 ± 2.1	-
1-year post-op	5.5 ± 1.7	-
5-year post-op	5.3 ± 1.8	-
Statistical comparisons (Intragroup)[b]	< 0.001[a]	
p-value: Pre-op vs. 1-year post-op	< 0.001	7.4 (6.4 to 8.5)
p-value: Pre-op vs. 5-year post-op	< 0.001	7.2 (6.1 to 8.4)
p-value: 1-year vs. 5-year post-op	0.709	-0.21 (-1.34 to 0.93)

[a] One-Way ANOVA for repeated measures: effect between assessments; [b] Post-Hoc ANOVA: intragroup effect.

Table 4. Evolution of hallux valgus classification after Percutaneous Bianchi System technique

Measures	Preoperative	1-Year Postoperative	5-Year Postoperative	p-value
Hallux valgus angle				
Mild (<20°)	4 (21.0%)	19 (100%)	15 (100%)	< 0.001
Moderate (20–40°)	15 (79.0%)	0 (0%)	0 (0%)	
Severe (>40°)	0 (0%)	0 (0%)	0 (0%)	
Angle between 1st and 2nd metatarsals				
Mild (<11°)	2 (10.5%)	19 (100%)	15 (100%)	< 0.001
Moderate (11–16°)	15 (79.0%)	0 (0%)	0 (0%)	
Severe (>16°)	2 (10.5%)	0 (0%)	0 (0%)	

[a] McNemar test.

Figure 2 shows the sustained reduction in IMA after the PBS technique intervention: 12.9° preoperatively, 5.5° at 1 year, and 5.3° at 5 years. Differences from baseline were statistically significant ($p < 0.001$). Similarity between values at 1 year and 5 years ($p = 0.709$) indicates a long-term clinical stability.

After PBS, there was a significant reclassification in the severity of HVA and IMA deformity. Preoperatively, 79% of cases were moderate in both angles, with 10.5% of them being classified as severe in IMA. In the first and fifth postoperative years, all patients were classified as mild ($p < 0.001$; McNemar test). The absence of moderate or severe cases in the late follow-up reinforces the sustained efficacy of the technique (Table 4).

Analysis by age group showed no statistically significant effect of age on angle reduction after the PBS intervention. For the HVA, patients under 60 years of age had a mean reduction of 16.0° at 1 year and 15.7° at 5 years, while those aged 60 years or older had reductions of 14.2° and 14.3°, respectively ($p = 0.398$). Regarding the IMA, mean reduction was 6.8° (1 year) and 6.5° (5 years) in the < 60 years group, and 8.1° and 8.0°, respectively, in the ≥ 60 years group ($p = 0.327$). Differences between age groups were not significant, indicating that the technique's efficacy was similar regardless of age (Table 5).

Analysis by laterality demonstrated that the operated side did not significantly influence the angular reduction after the PBS intervention ($p > 0.05$). In both the right and left feet, there was a marked reduction in the HVA (Δ14.7° and Δ15.4°, respectively; $p < 0.001$), as well as in the IMA (Δ6.7° and Δ7.7°; $p < 0.001$). There was no significant difference between the 1- and 5-year time points ($p > 0.7$), or between the operated sides ($p = 0.552$ for HVA; $p = 0.607$ for IMA), confirming the bilateral and lasting effectiveness of the technique (Table 6).

Figures 3 and 4 illustrate, respectively, clinical and radiographic aspects of the deformity in HV before and after

Table 5. Influence of age on the correction of hallux valgus and intermetatarsal angle after Percutaneous Bianchi System technique

Measures	< 60 years (n = 10)	Mean reduction	≥ 60 years (n = 9)	Mean reduction	p-value
HVA					0.398 [a]
Pre-operative	23.0 ± 4.3		24.2± 5.5		0.099 [b]
1-year post-op	7.0 ± 2,3		10.0 ± 3.3		0.005 [b]
5-year post-op	7.0 ± 2,5		9.7 ± 3.3		0.021 [b]
p-value: pre-op x 1 year[c]	< 0.001	16.0	< 0.001	14.2	
p-value: pre-op x 5 years[c]	< 0.001	15.7	< 0.001	14.3	
p-value: mid x final[c]	0.760	-0.3	0.977	-0.03	
IMA					0.327 [a]
Pre-operative	12.7 ± 2,2		13.1 ± 2,0		0.099 [b]
1-year post-op	5.9 ± 1,7		5.0 ± 1,6		0.005 [b]
5-year post-op	5.7 ± 1.9		4.9 ± 1.6		0.021 [b]
p-value: pre-op x 1 year[c]	<0.001	6.8	<0.001	8.1	
p-value: pre-op x 5 years[c]	<0.001	6.5	<0.001	8.0	
p-value: mid x final[c]	0.721	-0.2	0.877	-0.1	

[b] Two-way ANOVA for repeated measures: effect between groups; [b] Post-hoc ANOVA: effect between groups. [c] Post-hoc ANOVA: effect within groups.

Table 6. Influence of operated side on angular correction

Measure	Right (n = 10)	Mean reduction	Left (n = 9)	Mean reduction	p-value
HVA					0.552 [a]
Pre-operative	22.9 ± 4.6		24.3± 4.0		0.562 [b]
1-year post-op	8.3 ± 3.4		8.6 ± 2.9		0.159 [b]
5-year post-op	7.6 ± 3.2		9.0 ± 3.2		0.363 [b]
p-value: pre-op x 1 year[c]	< 0.001	14.6	< 0.001	15.8	
p-value: pre-op x 5 years[c]	< 0.001	14.7	< 0.001	15.4	
p-value: mid x final[c]	0.943	0.7	0.727	-0.4	
IMA					0.607 [a]
Pre-operative	12.9 ± 2.1		12.9 ± 2.1		0.516 [b]
1-year post-op	5.9 ± 1.4		5.0 ± 1.9		0.842 [b]
5-year post-op	6.0 ± 1.4		4.6 ± 1.9		0.811 [b]
p-value: pre-op x 1 year[c]	< 0.001	7.0	< 0.001	7.9	
p-value: pre-op x 5 years[c]	< 0.001	6.7	< 0.001	7.7	
p-value: mid x final[c]	0.750	-0.3	0.849	-0.2	

[b] Two-way ANOVA for repeated measures: effect between groups; [b] Post-hoc ANOVA: effect between groups. [c] Post-hoc ANOVA: effect within groups.

surgical correction using the PBS technique. In Figure 3, on the left, the evident deformity of the HV is observed in the preoperative period, with a marked angular deviation of the hallux in the lateral direction, affecting the aesthetics and functionality of the foot. On the right, the image obtained 60 months after surgery demonstrates the correction maintenance, with satisfactory alignment and absence of clinical recurrence of deformity, evidencing the stable, long-term result of the intervention.

Figure 4 shows complementary anteroposterior radiographs of the same case. On the left, there is a medial deviation of the M1 and an increase in the IMA, characterizing the structural deformity of HV. On the right, the image obtained five years after reveals the maintained angular correction, with restored alignment between M1 and the second metatarsal and no signs of instability or bone resorption.

The radiological record reinforces the durability of the PBS technique over time, corroborating the quantitative findings presented in the statistical analyses.

Discussion

Growing evidence attests to the efficacy and stability of percutaneous surgery for HV, although long-term comparative

Figure 3. Frontal image showing hallux valgus deformity prior to surgery (left) and correction maintained 60 months after surgery (right).

Figure 4. Anteroposterior radiographs showing the deformity and surgical correction. Prior to surgery (left) and 60 months after surgery (right).

studies are still scarce[8]. The PBS technique, focus of this study, stands out for dispensing K-wires and screws[4,6], using extra-articular osteotomy of the M1 and prioritizing immobilization as an essential factor for maintaining correction.

Retrospective analysis with 60 months of follow-up demonstrated significant and sustained reductions in HVA and IMA ($p < 0.001$), with stability between 1 year and 5 years ($p > 0.7$), which is in line with previous data on the technique. The absence of recurrences and serious complications and its minimal angular loss reinforce its safe profile, in contrast to recurrence rates greater than 15° found in other approaches and recurrence rates of 3.6%–11.3% in shorter follow-ups, close to those of open techniques in 5 years (5%–12%)[9-12].

The durability of results, however, depends on technical, operative, and postoperative factors. The steep learning curve requires training to avoid complications such as recurrent deformity or pseudarthrosis[13,14]; and metatarsal shortening, limited to 2 mm in PBS, must be monitored, since pressure changes only occur above 5 mm[4,6]. Case selection and adherence to the immobilization protocol are therefore essential. Such immobilization with a special dressing to maintain surgical reduction should be maintained for six weeks, with only one change, in the third week, concomitant with the removal of sutures.

Despite the limited number of patients (n = 19), reflecting the recent introduction of the technique in the country[6], results were positive. The absence of implants avoids complications with foreign bodies, reducing costs and favoring the application of PBS in public and private systems. The technique demonstrated good reproducibility, maintenance of correction, and a low incidence of complications – only three mild cases of skin irritation, resolved conservatively –, contrasting with complications described in other series, which consolidates PBS as a safe and effective alternative.

Conclusion

We conclude that the PBS technique for the treatment of HV is a safe, reproducible, and effective procedure for the correction of mild to severe deformities. Results remained consistent in the medium term in this five-year postoperative follow-up analysis. Advantages of this technique are its minimally invasive approach, low incidence of complications, no use of synthetic materials, and early walking.

Authors' contributions: Each author contributed individually and significantly to the development of this article: MVMGM *(https://orcid.org/0000-0002-7320-9628) Conceived and planned the activities that gave rise to the study, wrote the article, and participated in the review process; TEMV *(https://orcid.org/0000-0002-9162-5908), SMCA *(https://orcid.org/0009-0004-0429-1551), and TMVS *(https://orcid.org/0000-0001-8764-8560) Participated in the review process and wrote the article. All authors read and approved the final manuscript. *ORCID (Open Researcher and Contributor ID).

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