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Böhler and Gissane angles: Approximation to normal values in the Colombian population

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Abstract

Introduction: Calcaneal fractures are a common tarsal injury, which remains a diagnostic and therapeutic challenge. Although tomography has optimized their evaluation, the measurement of Böhler and Gissane angles on conventional radiographs remains essential for initial diagnosis and follow-up. The normal values of these angles may vary according to the population, the present study is looking for reference values in the Colombian population.

Methodology: A descriptive cross-sectional study was performed in an imaging center in Barranquilla, Colombia. Lateral ankle radiographs of patients older than 18 years without bone alterations were analyzed. Böhler and Gissane angles were measured by two investigators independently on two different occasions. Measures of central tendency and dispersion were calculated. Student's t-tests were applied to evaluate differences by sex, laterality and age group.

Results: 240 radiographs of 189 patients were evaluated. The mean Böhler angle was 31.36° ± 6.03 and the mean Gissane angle was 117.23° ± 7.74. No statistically significant differences were observed according to sex, laterality or age group ($p > 0.05$).

Discussion: The values obtained are similar to those reported in Latin American studies, although slightly lower than the classic ranges described in North American and European populations. These findings reinforce the importance of having local reference values for radiographic evaluation of the calcaneus.

Conclusions: The Böhler and Gissane angles in the Colombian population present values comparable to those of other Latin American populations. It is suggested to use these values as a reference in local clinical practice for a more accurate diagnosis

Keywords: Calcaneal Fractures; Radiography; Orthopedics; Anthropometry; Anatomy

1. Introduction

Calcaneal fractures represent the most common tarsal injury, usually secondary to high-energy trauma [1]. Their complex anatomy, associated soft tissue complications and the multiple therapeutic strategies available make these fractures a challenge for orthopedists [2]. Since their initial description, Böhler and Gissane angles have been used for the diagnosis, preoperative planning and postoperative follow-up of calcaneal fractures, especially in settings where

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computed tomography (CT) is not immediately available (Figures 1a and 1b) [3,4]. Although the routine use of CT has allowed for more detailed analysis, radiography remains the initial method of evaluation. [5]

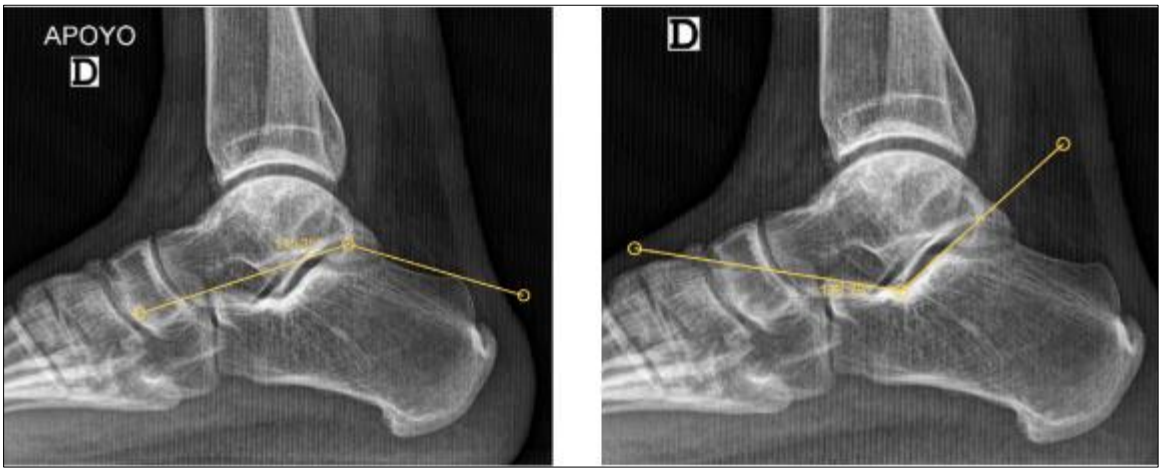

Figure 1 a Böhler angle measurement**, b.** Gissane angle measurement

Classically, normal values for the Böhler and Gissane angles have been stipulated to be between 20-40° and 120-140° respectively. Works such as those of Hauser and Kroeker in the United States, Loucks and Buckley in Canada and Shoukry in Egypt have attempted to characterize more precisely these values in their population [6-8]. As for the Latin American population there are few antecedents with the same objective, the closest was performed in the Brazilian population by Louro and collaborators where they find values for the Böhler angle at 32.6°±6.1 and Gissane at 110.6°±11.9 [9]. Determining the reference values in the Colombian population and comparing them with those already established in the literature allows for an objective diagnosis and a search for results close to normality corresponding to our context

2. Material and methods

A descriptive cross-sectional study was carried out in an imaging center in Barranquilla, Colombia. The study included lateral ankle radiographs of patients older than 18 years with adequate technique for the measurement of Böhler and Gissane angles. Radiographs with osteosynthesis devices, congenital or acquired deformities, sequelae of previous fractures or artifacts that prevented a correct measurement were excluded (Figure 2). Measurements were performed independently by two investigators, on two separate occasions, using calibrated digital measurement software. For statistical analyses, measurements with a value of 0 were excluded. The mean, median, mode and standard deviation of the Böhler and Gissane angles were calculated. For comparison between sex, laterality and age groups, Student's t-tests were applied. A value of $p < 0.05$ was considered statistically significant.

Figure 2 Example of radiograph excluded from the study due to obvious deformity

3. Results

A total of 240 radiographs corresponding to 189 patients were evaluated: 110 women (58.2%) and 79 men (41.8%). Of the studies, 138 were unilateral and 51 bilateral. The right foot was evaluated in 130 cases and the left foot in 110 cases. The age of the patients ranged from 18 to 85 years, with a mean of 46 ± 16.2 years (Table 1). The Böhler angle had a mean of 31.36° ± 6.03, with a range between 16.1° and 44°, while the Gissane angle presented a mean of 117.23° ± 7.74. When comparing the angles between sexes, no statistically significant differences were found ($p > 0.05$). Nor were significant differences found when comparing between right and left feet ($p > 0.05$) or between the different age groups ($p > 0.05$). The aforementioned results are summarized in Table 2 and 3.

Table 1 Characteristics of the radiographs of the patients evaluated. n= 189

	Total (n)	**Total (%)**
Age (years)		
18 - 29	30	15.9%
30 - 39	45	23.8%
40 – 49	34	17.9%
50 – 59	37	19.5%
60 – 69	26	13.7%
70 – 79	13	6.8%
80 – 89	4	2.1%
	189	**100%**
Sex		
Female	110	58.2%
Male	79	41.8%
	189	**100%**
Laterality		
Right	130	54.1%
Left	110	45.9%
	240	**100%**

Table 2 Mean result of the Böhler and Gissane angles measured

	Right (°)	**Left (°)**	**Total Mean (°)**	**Standard Deviation**
Mean Böhler	30.81	31.91	31.36	6.03
Mean Gissane	117.83	116.64	117.23	7.74

Table 3 Comparison of the Böhler and Gissane angles measured according to age

	Female (°)	**Male (°)**	**T Student**	**P Value**
Mean Böhler	30.96	32.01	-1.187	0.8816
Mean Gissane	117.6	116.6	1.13	0.8701

4. Discussion

The evaluation of calcaneal fractures continues to rely heavily on conventional radiographic studies, despite the advent of computed tomography as a diagnostic tool. The Böhler and Gissane angles, initially described in a context prior to the widespread use of CT, continue to have clinical relevance for the diagnosis, surgical planning and follow-up of calcaneal fractures [1,3,4].

In the present study, the average values of the Böhler angle (31.36° ± 6.03) and Gissane angle (117.23° ± 7.74) were consistent with those reported in Latin American studies, such as that of Louro et al. in Brazil, who found an average Böhler angle of 32.6° ± 6.1 and Gissane angle of 110.6° ± 11.9 [9]. In contrast, our results showed slightly lower values with respect to those reported in North American and European populations, where the Gissane angle tends to be closer to 120°-130° [6,7]. These differences reinforce the hypothesis that anatomical parameters vary between populations, possibly influenced by genetic, environmental, ethnic and physical developmental factors.

A strength of our work is the methodology employed with dual analysis by two independent observers and repeated measurements, a strategy that improves the reproducibility of the results and minimizes measurement bias. In addition, the inclusion of a relatively large sample, in comparison with previous studies in Latin America and worldwide, increases the statistical power of the study and the reliability of the confidence intervals obtained.

Another favorable feature is the rigorous application of inclusion and exclusion criteria, eliminating radiographs with anatomical alterations, artifacts or previous post-traumatic conditions, ensuring that the measurements reflect unaltered normal anatomical values.

However, this study also has relevant limitations. The single-center design limits the extrapolation of the findings to the entire Colombian population, especially considering the existing ethnic diversity in the country. Secondly, additional factors that could have an impact on anginal measurements, such as height, weight, body mass index, occupation or habitual physical activity of the patients, were not evaluated. Previous studies have suggested that these factors may influence bone morphology and radiographic measurements [10,11].

Additionally, a formal intra- and interobserver agreement analysis (e.g., using intraclass correlation coefficients) was not performed, which would have further strengthened the validation of the measurements made. Also, the technical quality of some radiographs, inherent in the retrospective material, may have affected the accuracy of some measurements.

Finally, although our study focused on establishing anatomical reference values, neither clinical nor functional correlation with these values was included. Future studies could investigate whether small differences in Böhler and Gissane angles in healthy individuals correlate with clinical symptoms, fracture predisposition, or surgical outcomes in trauma cases.

In conclusion, our results support the need for local reference parameters to improve diagnostic accuracy and surgical planning of calcaneal fractures in the Colombian population. This work establishes a solid basis for future multicenter investigations, with larger samples and clinical correlations, which will further strengthen the anatomical knowledge applied to the treatment of this complex pathology

5. Conclusion

The average values of Böhler's angle (31.36°) and Gissane's angle (117.23°) in the Colombian population are similar to those reported in Latin American populations. There were no significant differences according to sex, laterality or age. The use of these reference values in local clinical practice is suggested.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflicts of interest to disclose.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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