



BOHLER'S ANGLE—WHAT IS NORMAL IN THE UNINJURED MAKURDI POPULATION?

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ABSTRACT

Background: Calcaneal fracture is the commonest fracture of the tarsal bones and it is associated with displacement of the posterior facet of the calcaneus with resultant alteration in the normal range of the Bohler's angle. **Aim:** To measure and establish the normal range of Bohler's angle in the Makurdi population and to compare their values to the published data. **Materials and Methods:** Normal lateral plain radiographs of feet and ankles of patients aged above 15 years were analyzed retrospectively at Benue State University Teaching Hospital and Federal Medical Hospital, Makurdi. Bohler's angle was measured and the mean and standard deviation were calculated. The relationship between the angle with age, gender, and side of body was tested and compared to international figures. **Results:** One hundred and thirty radiographs were measured; of which 60 (46.2%) were of males and 70 (53.8%) females. From this study it was observed that the Bohler's angle ranges from 20-42°. The normal international reference values of Bohler's angle is 28° to 40°. **Conclusion:** The lower limit of Bohler's angle in our study group, was found to be less than the reference values which is used to diagnose Calcaneal fractures. The study shows variation in the range of Bohler's angle and reinforces the need to establish the normal ranges in a given population.

KEYWORDS: Bohler's angle, calcaneal fractures, reference values, Makurdi, Population.

INTRODUCTION

The Calcaneus is the largest, strongest^[1] and ironically the most commonly fractured of the tarsal bones of the foot.^[2] It accounts for 1- 2 % of all fractures.^[3] The majority of calcaneus fractures are caused by a fall from height or a motor vehicle accident and typically result in depression of the posterior facet and loss of calcaneal inclination.^[4] The fracture if subtle may not be obvious on radiographs, however will cause depression of the calcaneal posterior facet.

Certain parameters could be used to assess the integrity of the Calcaneus, of which is the Bohler's^[5] (BA) or the "Tuber Angle" is the most common. It is measured using a true lateral radiograph of the foot. The angle is formed by the intersection of a line from the highest point of the posterior articular facet to the highest point of the posterior tuberosity, and a line from the posterior articular facet to the highest point on the anterior articular facet.^[6] The BA is therefore an important parameter in the assessment and diagnosis of the Calcaneal fracture which is shown to be reduced in such cases.^[7] It determines the amount of posterior facet displacement and loss of calcaneal inclination. It has also

been shown to have prognostic value in determining morbidity and outcomes following calcaneus fractures,^[8] this is because Calcaneal fracture with a markedly diminished BA carry a poorer prognosis.

It is widely accepted that in the uninjured adult population, a normal BA is between 28 and 40 degrees,^[9,10] however, current literature has demonstrated variation among populations.^[11] Individuals or a population with a wide range of BA after some fractures, the angle may remain in the established normal limits. In such cases, the degree of displacement may be misjudged and an inappropriate treatment plan instituted. The aim of this study, therefore, was to measure and establish the normal range of BA in the Makurdi population and to compare their values to the published data.

MATERIALS AND METHOD

Retrospective data was obtained over a 2 year period from January 2014 – December 2016. Lateral foot plain radiographs of subjects 15 years and above were collected from the archives of the Benue State University Teaching Hospital Makurdi and Federal Medical Center Makurdi. Radiographs of injured feet, congenital or

acquired deformities and those with arthritic changes were excluded from the study.

Radiographs were reviewed by two consultant radiologist with 3-5years post fellowship experience. Bohler's angle was measured independently to prevent inter-observer variation. A protector graduated in degrees was used in the measurement. BA was obtained as the complement of the angle formed by 2 lines: the first line (A) was drawn between the superior aspect of the anterior process and the superior aspect of the posterior articular surface. A second line (B) was drawn between the same point on the posterior articular surface and the most superior point of the calcaneal tuberosity (fig 1). The variables studied were age, sex and laterality. Data was analyzed for various variables using statistical package for social sciences version 21 and Microsoft excel.

RESULTS

One hundred and thirty (130) plain foot radiographs were reviewed. Sixty (46.2 %) were males while seventy (53.8%) were females all aged from 15years (table 1.).

The mean Calcaneal Bohler's angle for the total population in the study was $27.42 \pm 4.57^\circ$, and ranges from $20 - 42^\circ$ with a modal distribution of 30° (Fig 2).

The males had a mean value of 27.25 ± 4.82 while that of the Female was 28.21 ± 5.02 (fig 3). The difference was not statistically significant ($P=0.167$).

The mean values of the Bohler's angle for the various age groups in this study is shown in table 2. The highest mean 30.0° occurs in the age group less than 20years old, while the lowest mean 24.00° was found in the older age group between 60 and 69 years old however this is not statistically significant. ($p=0.311$).

The mean values of the Bohler's angle of the right side of the examined feet was 28.00 ± 3.84 while that of the left side was 26.97 ± 5.05 (fig 4) but this was not statistically significant ($p=0.205$).

Table: 1 showing sex distribution in the study

Sex	Frequency	%
Male	60.0	46.2
Female	70.0	53.8
Total	130.0	100.0



Fig: 1. Measuring of Bohler's angle.

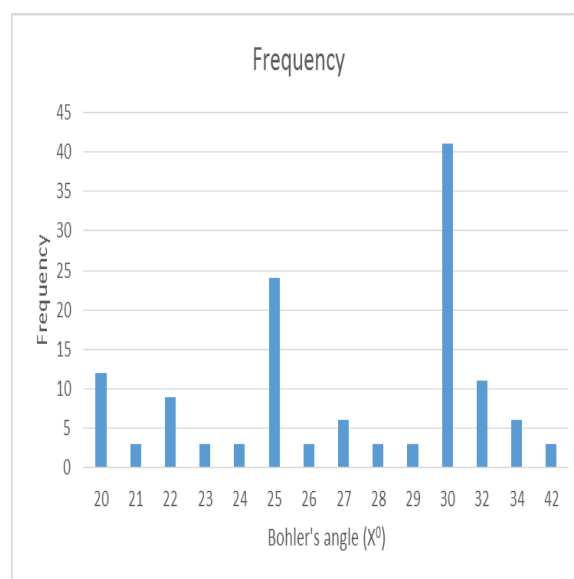


Fig 2 Bar chart showing the mean Bohler's angle value with range and modal distribution for the total population.

Fig: 3 Bar chart showing the mean values of BA for the sex groups.

Table 2: Mean BA values for the various sex groups.

Age range of patients (years)	Bohler's angle (BA) (mean value)	SD ($\pm$)
<20	30.00	0.00
20-29	28.30	4.35
30-39	25.00	3.68
40-49	28.38	3.47
50-59	29.50	8.79
60-69	24.00	3.12
70+	25.00	0.00
Total	27.42	4.57

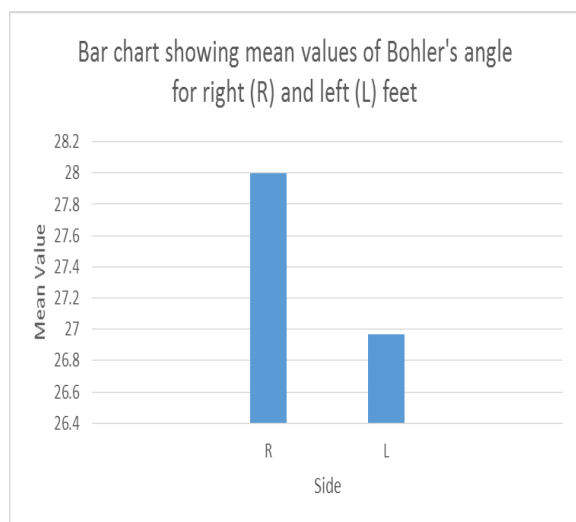


Fig: 3 Bar chart showing mean values of Bohler's angles for right and left feet.

DISCUSSION

As calcaneal angles generally decrease during calcaneal fractures, the lower limit of BA should be of greater interest.^[2] In our study, the mean total population value was of 20°-42°. Similar studies in the north-east Nigeria by Ahidjo et al^[12] and south-south by and Udoaka et al^[7] gave ranges of 23-45° and 28-38° respectively. Fahmy Anwar et al^[2] with Egyptian population gave a mean BA value of 30.14 ± 4.182 ranged from 22° to 40° while Khalid et al^[13] with Saudi population reported a wide range of 16° to 47° and Chen et al with Caucasians gave a wider range of 14-50°.^[14] Didia and Igbigbi, who assessed the calcaneal angles in black Africans showed an ethnic and geographic variability for these angles.^[15]

The mean BA in women in our study was slightly higher than in men but was not statistically significant (p=0.167) This collaborated with the findings of Igbigbi et al,^[16] Fahmy et al,^[1] and Aksel seyahi et al,^[17] who also demonstrated slightly higher BA in the female groups with no statistically significant relation between the measured angles and sex.

The relation of the calcaneal angles with age should ideally be assessed on X-rays of the same individual taken at different ages. In our study on different individuals, it was observed that the age group of <20 years possessed the highest mean for BA while the age group 60-69 years had the lowest BA. It was also observed that there was no statistical related with BA and age groups (p=0.311). This findings collaborates with the work of Khalid et al^[13] with Saudi population which also demonstrated the highest mean value for BA in the youngest and the lowest value in the older age group. However, age and BA were not statistically related. Other works by Ventrivel⁵ et al, and Seyahi et al^[17] also showed that there is no significant statistic relation with age and BA.

In comparing the mean of all of the right sided and left sided X-rays in the study group, there was no statistically significant difference in BA with side (p=0.205). This findings were similar to studies done on the Indians, Turkish, and Egyptians populations earlier mentioned.

This study confirms the documented findings that there is no significantly correlation between the calcaneal angles with sex, age and side of the body occupation, residence, and body mass index in the previously documented works.^[1]

CONCLUSION

There is variation in the range of BA with different population and even within the same population like Nigeria, there could be regional or ethnic variation. The widely published value of 28°-40° may not be applicable in this region; BA of 20°-42° should therefore be adopted for diagnosis and management of calcaneal fracture in Makurdi North central Nigeria. It is pertinent therefore to establish a normal range in a given population especially the lower limit of the angle so as not to have a high percentage of false positive abnormal cases of Calcaneal fracture. Comparative radiograph of the contralateral side in unilateral calcaneal injury may be advised to assess if the presence of fracture is ambiguous.

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