

Original Article

Radiographic evaluation of Calcaneal angles in patients presenting to tertiary care center of Nepal

Rokaya PK, Pokharel RK, Lamichhane AP

Department of Orthopedics and Trauma Surgery, Tribhuvan University Teaching Hospital, Kathmandu, Nepal

Corresponding Author: Dr. Poojan Kumar Rokaya

E mail: pkr2039@gmail.com

Abstract

Introduction: Fractures of the calcaneus are the most common tarsal fracture and they account for approximately 2% of all fractures. Recognizing the normal limits of the calcaneal angles is important in determining the degree of deformity and quality of reduction, and can thus help to predict the morbidity after calcaneal fractures. No study about the normal ranges of the calcaneal angles in the Nepalese populations is to our knowledge till date.

Methods: Lateral plain radiographs of foot and ankle of 140 patients without a calcaneal fracture were analyzed at Department of Orthopedics TUTH, Maharajgunj, Kathmandu between February 2012 to September 2013. Böhler angle and Gissane angle were measured. The distribution characteristics of these angles with respect to age, gender, and side of the body were analyzed and compared with those of previous studies.

Results: The mean BA was $31.3 \pm 5.28^\circ$ (range of $18^\circ - 47^\circ$) and the mean GA was $108.4 \pm 10.59^\circ$ (range of $85^\circ - 135^\circ$). There were no significant differences for calcaneal angles with respect to side (for BA, $p=0.728$; for GA, $p=0.091$) and for sex (for BA, $p=0.555$; for GA, $p=0.212$). There were no significant differences between the age groups for calcaneal angles (for BA, $p=0.659$; for GA, $p=0.912$).

Conclusion: Calcaneal parameters specific to the Nepalese population have to be taken into consideration by the orthopedic surgeons to improve the standard of calcaneal fracture treatment in Nepal. The range herein reported of ($18^\circ - 47^\circ$ for BA, $85^\circ - 135^\circ$ for GA) may be used as reference values for the Nepalese population.

Key words: Böhler angle, Calcaneus, Gissane angle, Radiograph.

Introduction

Calcaneal fractures account for 2% of all fractures and approximately 60% to 70% of tarsal fractures.^{1,2} Male patients predominated (75%) and several authors have reported that patients may be totally incapacitated for up to 3 years and partially impaired for up to 5 years post calcaneal injury³. Cotton and Henderson⁴ stated, “ordinarily speaking, the man who breaks his heel bone is done so far as his industrial future is concerned.”

Böhler angle (BA) was introduced by Dr. Lorenz Böhler in 1931 as the “tuber angle” and a decrease in this angle indicates that the weight-bearing posterior facet of the calcaneus has collapsed.⁵ In his original

article Böhler reported the normal range of the BA between $30^\circ - 35^\circ$. Since then various ranges such as $25^\circ - 40^\circ$, $14^\circ - 50^\circ$, $28^\circ - 38^\circ$, $20^\circ - 50^\circ$, $16^\circ - 47^\circ$ and $20^\circ - 40^\circ$ are mentioned in several studies.⁶

Gissane angle (GA) has been described to help in the assessment of calcaneal fractures and reflects the relationship of the anterior, middle and posterior facets. Various ranges, such as $96^\circ - 152^\circ$, $100^\circ - 130^\circ$, $120^\circ - 145^\circ$ and $95^\circ - 105^\circ$ are reported in different studies.⁷ On a lateral radiograph of ankle, an increase in GA suggests fracture of the posterior subtalar joint surface. Traumatic alteration of these angles can be used as a measure of fracture severity, with one goal of

surgical management being restoration of these angles to normal values.⁸

The previous studies performed in the American, African, Saudi, Turkish, Egyptian, Indian, populations revealed a wide variability of the calcaneal angles among these different populations.^{6, 7, 11, 12, 13} Recognizing the normal limits of the calcaneal angles is important in determining the degree of deformity and quality of reduction, and can thus help to predict the morbidity after calcaneal fractures.¹⁴ In Nepal, the reference value for BA and GA are as per the western textbooks, and no study about the normal ranges of the calcaneal angles in the Nepalese populations is to our knowledge till date.

Thus, the aim of this study is to identify the normal values of the Calcaneal angles in Nepalese population and to compare the results with the ranges from other studies.

Methods

This was a descriptive observational study conducted at Department of Orthopedics and Trauma Surgery, TUTH Maharajgunj Kathmandu, Nepal between February 2012 to September 2013 after approval from the Institutional Review Board.

One hundred and forty patients above 15 years of age who had an indication to perform plain lateral radiograph of foot and ankle were enrolled in this study after taking an informed written consent. No extra financial burden was placed on the patients.

X-rays with superposition of the malleoli were included in the study. All X-rays showing congenital, traumatic, infective or neoplastic bony abnormalities of calcaneus or not displaying a full lateral view of the calcaneus were excluded from the study.

Participants were in the age range of 15 to 68 years (mean 33.65 years). Out of total 140 radiographs, 80 (57.1%) were females and 60 (42.9%) were male; 76 were of the right side and 64 were of the left side.

Böhler and Gissane angle were measured using goniometer and pencil on the lateral plain radiograph of foot and ankle. Each angle was measured twice to ensure accuracy.

Böhler angle was measured as an angle formed by the intersection of two lines on a lateral radiograph. The first line was drawn from the tip of anterior process of the calcaneus to the uppermost point of the posterior facet, and the second line which was drawn from the upper most point of posterior facet to the uppermost point of calcaneal tuberosity. (figure1) Gissane angle was measured as an angle between the lines drawn on

the lateral border opacity of the posterior facet and the line drawn on the linear opacity of the anterior facet. (figure2)

Dataanalysis was done using Statistical Package for Social Sciences (SPSS) 17.0 version. Descriptive statistics including mean, standard deviation and range for BA and GA were calculated. The association between each of two angles and age were tested using one way ANOVA test. The association of Calcaneal angles with gender and side was assessed using Independent sample t test. A p value of < 0.05 was considered to be significant.



Figure1: Plain lateral radiograph of ankle showing Böhler's angle



Figure 2: Plain lateral radiograph of ankle showing Gissane angle.

Results

In this study the mean BA was $31.3 \pm 5.2^\circ$ (range of $18-47^\circ$) and GA was $108.4 \pm 10.5^\circ$ (range of $85-135^\circ$). Table 1 shows the distribution of Calcaneal angles according to sex. Using Independent sample t test there

was no statistically significant difference between the mean of BA ($p=0.5$) and GA ($p=0.2$) and sex. Table 2 shows the comparison of Calcaneal angles according to side. There was no significant difference between the means of right and left side of BA ($p=0.7$) and GA ($p=0.09$). The Measured angles were divided in to 5 groups according to the age of the patients. Using one way ANOVA test, there was no statistically significant difference between BA ($p=0.6$) and GA ($p=0.9$) and the different age groups (Table 3).

Table1: Distribution of Calcaneal angles according to sex

	N	Böhler	Gissane
		Mean $\pm$ SD	Mean $\pm$ SD
Male	60	31.70 $\pm$ 5.59	107.12 $\pm$ 9.93
Female	80	31.15 $\pm$ 5.07	109.35 $\pm$ 11.03
<i>p value</i>		0.555	0.212
T		0.592	-1.254

Table2: Comparison of calcaneal angles according to side.

Calcaneal Angle	Side	Mean	SD	t	p value
Böhler	Right	31.533	5.63	0.349	0.728
	Left	31.21	4.88		
Gissane	Right	109.78	10.84	1.70	0.091
	left	106.75	10.12		

Table 3: Böhler and Gissane angles in different age groups.

Age group (years)	N	%	Böhler		Gissane	
			Mean	SD	Mean	SD
< 20	19	13.6	32.76	6.60	107.65	9.31
21-30	49	35	31.66	5.06	109.32	9.47
31-40	33	23.6	31.16	4.28	108.43	12.19
41-50	25	17.9	30.68	5.19	106.88	10.57
>51	14	10	30.35	6.60	108.78	12.95
p value			0.659		0.912	

F	0.607	0.245
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Table 4: Comparison of Calcaneal angles reported in previous studies.

Study	Year	Range (Degree)
Loucks and Buckley ¹⁵	1999	BA: 25-40
Didia and Dimkpa ¹⁰ (Nigerian)	1999	BA: 28-38
Igbigbi and Msamati ¹¹ (Malawian)	2002	BA: 14-45
Igbigbi and Mutesasira ⁹ (Ugandan)	2003	BA: 20-50
Khoshhal et al. ⁷ (Saudi Arabian)	2004	BA: 16-47
		GA: 96-152
Seyahi et al. ⁶ (Turkish)	2008	BA: 20-46
		GA: 100-133
FA Shoukry ¹² (Egypt)	2010	BA: 22-40
		GA: 108-138
VC Sengodan ¹³ (India)	2012	BA: 18-43
		GA: 100-145
Our Study (Nepal)	2013	BA:18-47
		GA:85-135

Discussion

This study revealed a wide range of calcaneal angles. BA was between 18-47° and GA was between 85-135°. The range of BA obtained in this study is higher as compared to the studies conducted in Nigerian, Egyptian, Indian and Turkish population (Table 4). Because of the wide ranges of Calcaneal angles assessment of the other side can be helpful for unilateral fractures.

The lowest BA is 18° in this study which is same as the value obtained by Sengodan et al.¹³ in the study conducted in Indian population. The lower limit is of importance for the diagnosis especially, when both calcanei are fractured, because comparison to a normal side will not be possible. In such cases the degree of displacement may be misjudged and an inappropriate correction may be planned. As BA decreases in intraarticular fractures of the calcaneus the lower limit of the angle should be of greater interest.

The relation of the calcaneal angles with age should ideally be assessed on the X-rays of the same individual

taken at different ages. There was insignificant difference between Calcaneal angles and age in our study and previous studies conducted in Egypt¹² and Saudi Arabia⁷. This insignificant difference between calcaneal angles and age may help in treating a patient with bilateral calcaneal fracture if a previous x-ray with intact calcaneus is available.

Our study did not reveal significant difference between Calcaneal angles and sex which is similar to studies conducted in Turkish population⁶, Saudi population⁷ and Indian population¹³.

Comparison according to the side should be done on the same subject. This study did not show statistically significant difference between calcaneal angles and side which is in correlation with the study done in Turkey⁶, Saudi Arabia⁷, Egypt¹² and India¹³. This insignificant difference of calcaneal angles and side suggests that in unilateral calcaneal fractures the calcaneal angles of the intact side may be taken as an individual reference value.

Calcaneal angles were measured manually with a goniometer so these values may differ with the true measurement as an error of calculation though we have tried to minimize it. Study was conducted over patients presenting to tertiary care center of Nepal which do not represent all Nepalese population. A larger multicenter study should be conducted in other regions of Nepal to prepare more specific radiological calcaneal parameters.

Conclusion

Calcaneal angles have a wide range of normal limits and distribution in different populations. Therefore their normal limits and distribution should be defined for a given population. The range of 18-47° for the BA and 85-135° for the GA may be taken as the normal ranges for the Nepalese population. This study will help the orthopedic surgeons to improve the standard of calcaneal fracture treatment and serve as a base for further studies in future regarding different aspects of the calcaneal fracture.

Conflict of interest: None declared

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