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Original research article

Morphometric Analysis of Bicipital Groove of Humerus: A Cross-Sectional Study in Gujarat Region

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ABSTRACT

Introduction: The Bicipital Groove (BG) lies below the anatomical neck of humerus, separating the greater and lesser tubercles. It lodges the tendon of Long Head of Biceps Brachii (LHBB) and ascending branch of the anterior circumflex humeral artery. The shoulder pain is frequently caused by biceps tendon pathologies, which are associated with variations in morphometry of the BG. Therefore, this study was conducted to determine morphometric features of BG in Gujarat region of India to provide additional information.

Materials & Methods: The data was collected from 100 dry adult humeral bones of unknown sex (50 right and 50 left) available in anatomy department of Pramukhswami Medical College, Karamsad, Gujarat, India. The digital Vernier caliper was used to precisely measure the BG's length, breadth, depth, medial wall length, and lateral wall length. The opening angle (OA) and medial wall angles (MWA) was measured by screen protractor software after capturing and transferring images of bones to the computer. Statistical analysis was done on the collected data.

Result: The length, width and depth of BG were 73.21 ± 9.08 mm, 10.15 ± 1.01 mm and 4.24 ± 0.69 mm on right side and 71.94 ± 8.45 mm, 10.11 ± 0.89 mm, 4.31 ± 0.83 mm on left sides respectively. The average opening angle on the right side was 76.11±13.79º, while on the left side was 76.11 ± 13.79º. The medial wall angle was 55.74 ± 11.92º on right side and 54.03 ± 8.94º on left side.

Conclusion: This study provides additional information on the morphometry of the BG in the Gujarat region, which can be useful for anatomists, anthropologists, orthopaedic surgeons and radiologists. The results of this study may also be used to determine prosthetic design, size, and position in humeral head replacement.

Keywords: Humerus, Bicipital Groove, Morphometry, Biceps brachii muscle

Introduction

The bicipital groove (BG) divides the greater and lesser tuberosities, situated below the anatomical neck of humerus. It has lateral wall, medial wall and floor.[1] The fibrous transverse humeral ligament, which stretches between the greater and lesser humeral tubercles, converts the BG into a canal. The canal lodges tendon of Long Head of Biceps Brachii (LHBB) and an ascending branch of the anterior circumflex humeral artery.[2,3] The LHBB muscle is stabilized by the BG and transverse humeral ligament, which also prevents its displacement during the multidirectional biomechanical movements of the arms.[4]

According to Rockwood and Matsen, humans are the only primates that exhibit a significant variation in the shape of the bicipital groove. The depth and breadth of the bicipital groove play a crucial role in preventing subluxation and dislocation of tendon. A thick tendon is more prone to dislocate if groove is wide and shallow. On the other hand, a deep, narrow groove may produce impingement syndrome by constricting the tendon. [5,6]

Since the BG and LHBB tendon are intimately related, variation in morphology and morphometry of BG (deep and narrow grooves vs. wide and shallow grooves) may influence the function of the tendon and consequently play a vital role in a variety of causes of shoulder pain and disability. Apart from this, morphometry of BG may influence the function of surrounding structures, leading to various pathologic conditions (tenosynovitis and pulley lesions) and traumatic injuries (viz., proximal tears of the biceps brachii muscle and subluxation).[7,8,9,10]

The morphometric data of the BG is also highly useful in prosthetic sizing, positioning, and designing for shoulder replacement.[11] In India, data related to the morphometry of BG is scarce in western regions, such as Gujarat, compared to other regions. Therefore, the present study will be conducted to provide additional information regarding the morphometry of BG in Gujarat region of India

Materials & Methods:

This cross-sectional study was conducted in the Department of Anatomy, Pramukhswami medical college Karamsad, Gujarat. The study was conducted after approval of institutional ethics committee.

Inclusion and Exclusion Criteria:

The current study was done on 100 adult humeri of unknown sex (50 right and 50 left). Only dry specimens without any gross evidence of pathologies were selected for the study. All broken and pathologically deformed humeri were excluded from the study.

Morphometric parameters such as length, width, depth, length of medial and lateral wall of BG was measured with the help of a digital vernier caliper in millimeters (Figure 1). The opening angle (OA) and medial wall angle (MWA) were measured by screen protractor software after capturing and transferring images of bones to the computer (Figure 2). The parameters of BG's on the proximal humerus were measured using the methods described by Kumar P et al., (2016). [12]

Measurements of the Bicipital Groove:

A) **Length**: From the point between the tubercles to the end where it finishing with the shaft
B) **Width**: Maximum distance between the midpoint of the medial and lateral lips

C) **Depth**: Distance between the floor and the margins of the bicipital groove at the midpoint of the tubercles
D) **Opening Angle**: Between the planes of lateral and medial walls of the BG
E) **Medial Wall Angle**: Angle between the plane of the floor and medial wall of the BG
F) **The length of the medial and lateral walls**: from the tubercles to the ends of the respective lips of the BG.

STATISTICAL analysis:
Data were entered and analyzed with IBM SPSS Statistics 29.0 (SPSS Inc., Chicago, Illinois, USA). Length, width, and depth were analyzed by descriptive statistics that included the mean, standard deviation, and range. An independent t-test was used to compare the differences in parameters on both sides.

Result:
Total 100 dry humerii (50 right and 50 left) were examined in this study. Irrespective of sides, the mean values of different morphometric parameters were length 72.58±8.75 mm, width 10.13±0.95 mm, depth 4.27±0.76 mm, medial wall length 66.45±9.44, lateral wall length 76.66±8.37 mm, opening angle 78.19±13.17° and medial wall angle 54.89±10.52°. As shown in Table-1, the mean values of length, width, depth, medial wall length, and lateral wall length of BG were 73.21 ± 9.08 mm, 10.15 ± 1.01 mm, 4.24 ± 0.69 mm, 67.39 ± 8.92 mm and 76.82 ± 8.42 mm, respectively, on the right side, and on the left side, they were 71.94 ± 8.45 mm, 10.11 ± 0.89 mm, 4.31 ± 0.83 mm, 65.59 ± 9.93 mm and 76.50 ± 8.40 respectively. The average opening angle on the right side was 76.11±13.79º, while on the left side was 76.11 ± 13.79º. The medial wall angle was 55.74 ± 11.92º on right side and 54.03 ± 8.94º on left side. There was no statistically significant difference found between the right and left sides with regard to all parameters of BG.

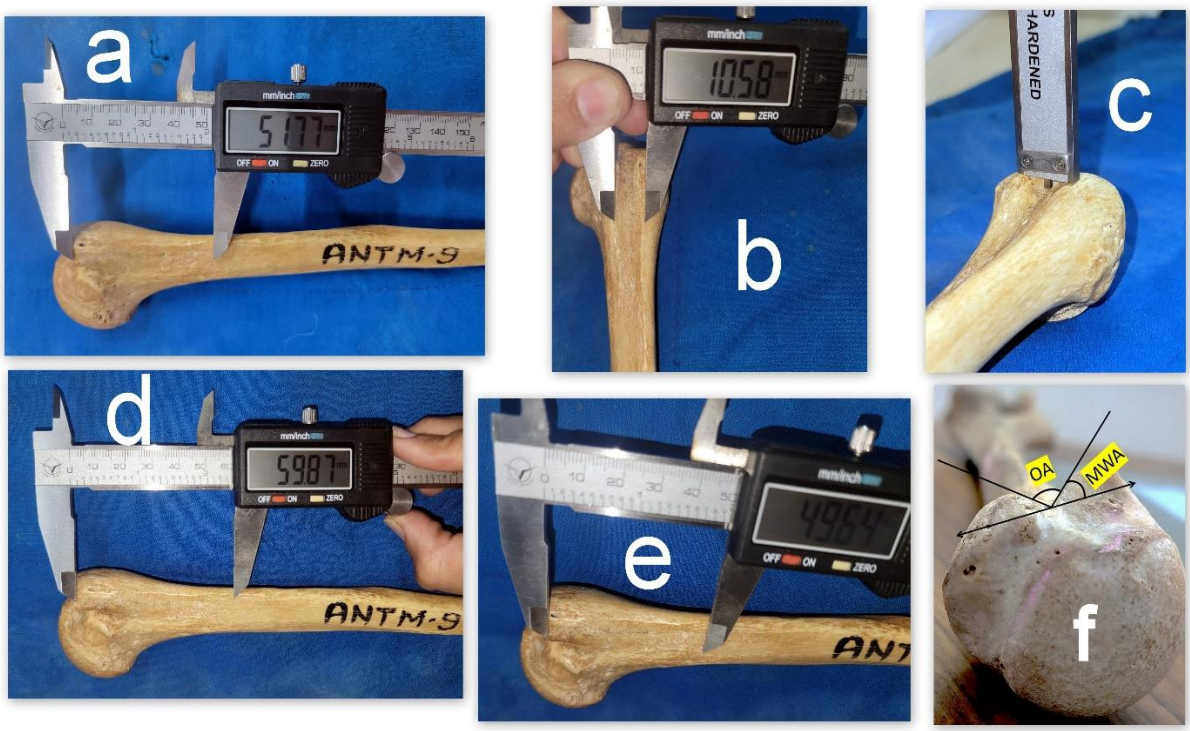

Figure 1: Measurements of BG: a – Length**, b –** Width**, c –** Depth**, d –** Lateral Wall Length**, e –** Medial Wall Length**, f –** Opening angle(OA) and Medial Wall Angle(MWA)

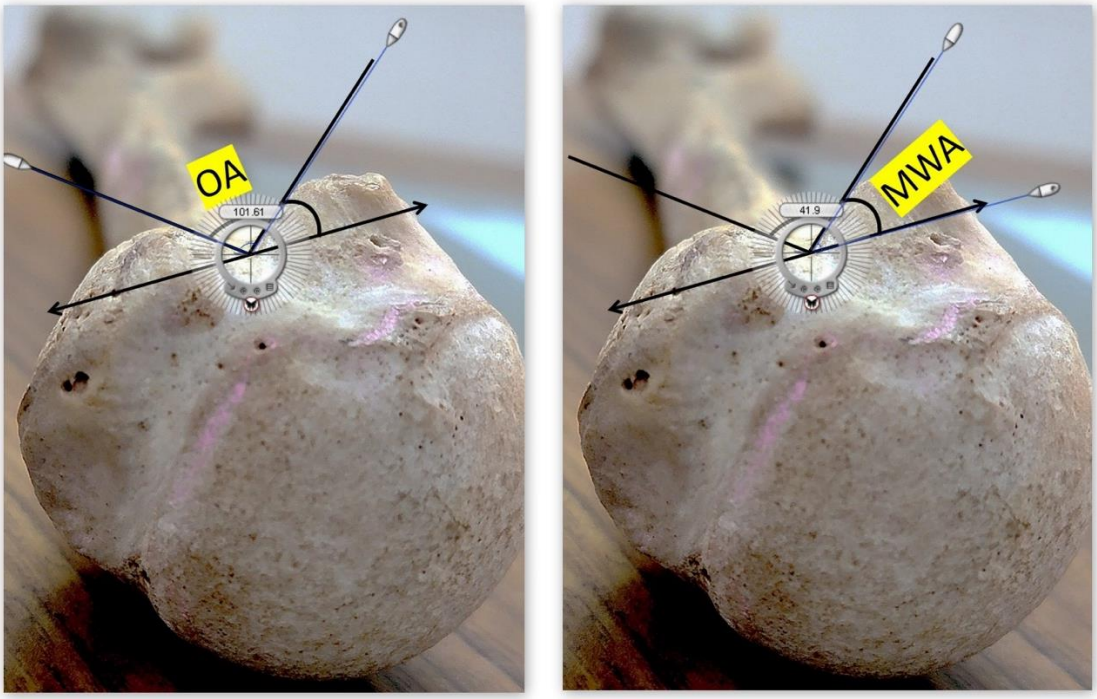

Figure 2: Measurements of Angles with Screen Protractor: OA – Opening Angle and **MWA –** Medial Wall Angle

Table 1: Morphometric parameters of BG with descriptive analysis

Parameters of Bicipital Groove	Side of Bone	Minimum (mm)	Maximum (mm)	Mean ± SD	p-value
Length	Right	51.29	93.17	73.21 ± 9.08 mm	0.235
	Left	49.73	87.33	71.94 ± 8.45 mm	
Width	Right	8.10	12.74	10.15 ± 1.01 mm	0.426
	Left	8.21	12.72	10.11 ± 0.89 mm	
Depth	Right	3.00	6.13	4.24 ± 0.69 mm	0.314
	Left	2.96	6.08	4.31 ± 0.83 mm	
Medial Wall Length	Right	43.09	87.93	67.39 ± 8.92 mm	0.171
	Left	36.39	84.53	65.59 ± 9.93 mm	
Lateral wall length	Right	55.46	94.34	76.82 ± 8.42 mm	0.425
	Left	56.77	92.36	76.50 ± 8.40 mm	
Opening Angle	Right	54.11	107.96	80.27 ± 12.31º	0.057
	Left	44.45	113.60	76.11 ± 13.79º	
Medial Wall Angle	Right	39.76	94.75	55.74 ± 11.92º	0.209
	Left	37.17	83.52	54.03 ± 8.94º	

Table 2: Comparisons of morphometric parameters of BG in different population

Sr. No	Authors - Year	Place of Study	Length (mm)	Width (mm)	Depth (mm)	Medial wall length (mm)	Lateral wall length (mm)
1	Wafae N et al., -2010. [17]	Brazil	8.1	10.1	4	-	-
2	Muralimanju BV et al., - 2012 [18]	Mangalore, India	84.6±10.9	8.5±2.3	4.4±1.8	-	-
3	Singh R and Singh M - 2013 [20]	Uttar Pradesh, India	Right-85	9	5	22±4	31.6±6
			Left-83	8.9	6	23±5	31±5
4	Arun Kumar KR et al., - 2016 [21]	Kolkata, India	83	8.4	5	Right-23±3	30±2
						Left-24±3	32±6
5	Rajan YS and Sampath SK - 2016 [23]	Chennai, India	84	6.8	4.2	Right-24.22±1.02	32.5±2.21
						Left-23.31±2.2	31.1±0.24
6	Ashwini ZA et al., - 2017 [19]	Karnataka, India	Right-89.94	8.53±1.6	6.48±1.3	81.72±6.4	89.61±6.03
			Left-88.8	7.96±1.9	6.14±1.4	79.56±4	89.15±8.27
7	Kumar P et al., - 2021 [12]	Gurugram, India	Right-71.81±6.98	8.42±1.84	5.85±1.15	53.33±10.12	59.19±9.05
			Left-74.53±8.04	10.03±2.27	5.61±1.15	59.19±56.80	62.98±5.81
8	Present study - 2023	Gujarat, India	Right – 73.21 ± 9.08	10.15 ± 1.01	4.24 ± 0.69	67.39 ± 8.92	76.82 ± 8.42
			Left – 71.94 ± 8.45	10.11 ± 0.89	4.31 ± 0.83	65.59 ± 9.93	76.50 ± 8.40

Discussion:

The BG along with strong fibrous transverse humeral ligament forms a tunnel which lodges LHBB tendon.[2] Additionally, it also prevents the dislocation of the LHBB tendon during movement of the arm. The alignment of head of humerus with glenoid cavity is maintained significantly by the tendon of LHBB.[13]

A large portion of mankind, particularly the elderly, suffers from several shoulder disabilities that might result from any variation in position of LHBB tendon. One of the most common causative factors for shoulder pain is the pathology of LHBB such as tenosynovitis, impingement, and instability of tendon at the entry into the BG. And these pathological condition of LHBB is also affected by variation in morphometry (i.e., length, width, and depth) of the BG. [14,15,16]

Table -2 shows a comparison of the parameters of BG in different populations reported by different authors. In this study, irrespective to the sides the length of BG was 72.58±8.75 mm

which is comparable with the study done by Kumar P et al., and Wafae N et al..[12,17] In study done by Muralimanju BV et al., and Ashwini ZA et al. the length was around 84.6±10.9mm and 89.37mm respectively, which was slightly higher than our observation [18,19]. The mean width of BG was 9.12 mm in this study, which was as consistent with studies performed by Kumar P et al., Wafae N et al., Muralimanju BV et al., Ashwini ZA et al., Singh R and Singh M and Arun Kumar KR et al.. [12, 17,18,19,20,21]. But the average width reported by Vettivel S et al., and, Rajan YS was very less.[22,23] The mean depth in current study was 4.27±0.76 mm; comparable with Kumar P et al., Arun Kumar KR et al., Singh R and Singh M.[12, 20,21] But very small depth (3 mm on right side) reported by Vettivel S et al. among South Indian population, and the depth was found very high (9.4 mm) in a study by Prajakta K et al., [22,24].

Very few researchers have measured the length of the medial and lateral walls. In comparison to our study, Kumar P et al. had similar results; higher lengths were reported by Ashwini ZA et al. [19], and a lower value was found in studies done by Singh R and Singh M, Arun Kumar KR et al., and Rajan YS et al..[20,21,23]

In this research, the opening angle was 78.19±13.17 °, which was comparable to the opening angles reported by Kumar P et al., Singh R and Singh M, and Arun Kumar KR et al.[12,20,21] But Wafae N et al. found an extremely broad opening angle that was about 106^{o} among the Brazilian population.[17] Vettivel S et al. and Rajapriya V et al., on the other hand, found BG with narrow opening angles of 60^{o} and 62^{o}, respectively.[22,25] Last but not least, the medial wall angle was measured in the current study turned out to be around 54.89±10.52°, which is somewhat lower than findings reported by Kumar P et al., and Ashwini ZA et al..[12,19] The same angle, with a range of 15° to 90°, was reported by both Hitchcock HH and Bechtol CO.[4] The age and gender of the humerii used for the current investigation were unknown. The factors like the patients' height and body type (which may affect morphometry of BG) were also not included in this study. If this information was available, a more thorough analysis might have been conducted. Additional details about the participants' occupations and preferred method of using their upper limbs would also have been very helpful. Then, the morphometric data that was collected may have been correlated functionally. And of course, the accuracy and reliability of the method used in the current study cannot be compared to processes using sophisticated imaging technology and equipment.[26,27]

Conclusion:

Shoulder pain and disabilities are associated with disorders of the LHBB tendon and its synovial sheath, which are also affected by variations in BG. Therefore, morphometric analysis of the BG can give orthopaedic surgeons important information to help them in planning an effective operating strategy to restore the normal functioning of the shoulder joint. Even though only small differences have been found between the previous studies and the current study, this study will provide additional information on the morphometry of the BG in the Gujarat region, which can be useful for anatomists, anthropologists, orthopaedic surgeons, and radiologists.

Reference:

1. Snell RS. THE UPPER LIMB. In: Clinical Anatomy by Regions. 9th ed., Wolters Kluwer, Lippincott Williams & Wilkins. 2012. p. 343.
2. Standring Susan. Gray’s anatomy, the anatomical basis of clinical practice 40th edi. Churchill Livingstone, Elsevier.2008;.796-798.

3. MacDonald K, Bridger J, Cash C, Parkin I. Transverse humeral ligament: does it exist?. Clinical Anatomy: The Official Journal of the American Association of Clinical Anatomists and the British Association of Clinical Anatomists. 2007 Aug;20(6):663-7.
4. Hitchcock HH, Bechtol CO. Painful shoulder: observations on the role of the tendon of the long head of the biceps brachii in its causation. JBJS. 1948 Apr 1;30(2):263-73.
5. Christopher MJ, Wesley PP and Djuro P. Gross anatomy of the shoulder: Bones and joints. In: Rockwood and Matsen's The Shoulder E-Book. 6thedn., Netherlands: Elsevier Health Sciences, 2021. 3, e1-e58.
6. Neer CS. Impingement lesions. Clinical Orthopaedics and Related Research (1976-2007). 1983 Mar 1;173:70-77.
7. Levinsohn EM, Santelli ED. Bicipital groove dysplasia and medial dislocation of the biceps brachii tendon. Skeletal radiology. 1991 Aug;20(6):419-23.
8. Murthi AM, Vosburgh CL, Neviaser TJ. The incidence of pathologic changes of the long head of the biceps tendon. Journal of Shoulder and Elbow Surgery 2000;9(5):382–85.
9. Karistinos A, Paulos LE. Anatomy and function of the tendon of the long head of the biceps muscle. Operative Techniques in Sports Medicine. 2007 Jan 1;15(1):2-6.
10. Boileau P, Ahrens PM, Hatzidakis AM. Entrapment of the long head of the biceps tendon: the hourglass biceps—a cause of pain and locking of the shoulder. Journal of shoulder and elbow surgery. 2004 May 1;13(3):249-57.
11. Robertson DD, Yuan J, Bigliani LU, Flatow EL, Yamaguchi K. Three-dimensional analysis of the proximal part of the humerus: Relevance to arthroplasty. J Bone Joint Surg 2000;82(11):1594–602.
12. Kumar P, Saha S, Arora G, Aneja PS. Detailed Morphometry and Morphology of Bicipital Groove of Humerus among North Indian Population. Journal of Clinical & Diagnostic Research. 2021 Dec 1;15(12).
13. Kaur M, Gupta R. Morphometric and morphological study of bicipital groove in north Indian population. Int J Basic Appl Med Sci. 2015;5(3):48–53 2277-2103.
14. Boileau P, Ahrens PM, and Hatzidakis AM. Entrapment of the long head of the biceps tendon: the hourglass biceps—a cause of pain and locking of the shoulder. Journal of Shoulder and Elbow Surgery. 2004;13(3):249–257.
15. Guckel C and Nidecker A. MR arthrographic findings in tenosynovitis of the long bicipital tendon of the shoulder. Skeletal Radiology. 1998;27(1):7–12.
16. CO B. Painful shoulder; observations on the role of the tendon of the long head of the biceps brachii in its causation. The Journal of Bone and Joint surgery. American Volume. 1948 Apr 1;30(2):263-73.
17. Wafae N, Santamaría LE, Vitor L, Pereira LA, Ruiz CR, Wafae GC. Morphometry of the human bicipital groove (sulcus intertubercularis). Journal of shoulder and elbow surgery. 2010 Jan 1;19(1):65-8.
18. Muralimanju BV, Prabhu LV, Pai MM, Shreya M, Prashant KU, Chettiiar GK, et al. Anthropometric study of the bicipital grove in Indians and its clinical implications. Chang Gung Med J. 2012;(35):155-59.
19. Ashiwini ZA, Solanki S, Mehta CD. The morphometric measurement of segments of humerus. J Res Med Den Sci. 2016;4(1):38-40.
20. Singh R, Singh M. Review of bicipital groove morphology and its analysis in north Indian population. ISRN Anatomy: 2013;01-07.
21. Arun kumar KR, Manoranjjitham R, Delhi Raj U, Shalini R. Morphometric study of bicipital groove in south Indian population and its clinical implications. Int J Anat Res. 2016;4(2):2187-91.

22. Vettival S, Indrasingh I, Chandi G, Chandi SM. Variations in the intertubercular sulcus of the humerus related to handenes. J Anat. 1992;(180):321-26.
23. Rajan YS, Sampath SK. Morphometric study on bicipital groove among South Indian. J Clinical Diagnostic Research. 2016;10(7):AC01-03.
24. Prajakta K, Joshi M, Wabale R. Morphometry of intertubercular sulcus of humerus & its variations. International J of Scientific Research. 2012;3(6):318-19.
25. Rajapriya V, Jeyyanthi C, Gnanadeepam, Anjana TS, Srividhya E, Radhakrishnan M, et al. Moprhometry and morphology of the human bicipital groove with its clinical significance. Indian Journal of Basic and Applied Medical Research. 2017;(6):99-107.
26. Robertson DD, Yuan J, Bigliani LU, Flatow EL, Yamaguchi K. Three-dimensional analysis of the proximal part of the humerus: Relevance to arthroplasty. J Bone Joint Surg 2000; 82(11):1594–602.
27. Motagi M, Shankar N, Ravindranath R. Estimation of the angle of humeral torsion from digital images of dry humeri of South Indian origin. Anatomy 2012-2013;6-7:34-41.