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Research Article

MORPHOMETRIC & MORPHOLOGICAL STUDY OF BICIPITAL GROOVE IN NORTH INDIAN POPULATION

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ABSTRACT
The bicipital groove is an important landmark for humeral head placement in fractures of the proximal humerus. It contains the long head of the biceps brachii muscle, its synovial sheath and an ascending branch of the anterior circumflex humeral artery. The BG & LBT are intimately related. The shape of the BG has a great impact on the tendency for the LBT to be dislocated or subluxated. A shallow & wide BG promote subluxation/ dislocation of the LBT while a deep, narrow BG can cause LBT irritation and tenosynovitis. Osseous spurs in the BG can cause LBT fraying, and the presence of the supratubercular ridge of Meyer is suspected to promote dislocation. Despite it being a subject of clinical interest, there is paucity of data available on this landmark which led us to conduct this study on it.

Keywords: *Humerus, Bicipital Groove, Tendon, Biceps Brachii, Supratubercular Ridge*

INTRODUCTION
An understanding of normal humeral morphology is important, since recreation of normal anatomy is the goal in prosthetic replacement of the upper end of the humerus. This knowledge can affect prosthetic sizing, positioning and design (Robertson *et al.*, 2000) Many authors have studied the normal gleno-humeral relationship to identify reference points for the correct placement of the humeral head prosthesis in shoulder arthroplasty. The bicipital groove (BG) is used as a landmark for humeral head placement in fractures of the proximal humerus (Itamura *et al.*, 2002). The intertubercular sulcus (ITS) is between the greater and lesser tubercles and it continues distally for about 5 cm on the shaft of the humerus, which altogether is called the BG (Joseph, 1976). It contains the long head of the biceps brachii muscle, its synovial sheath and an ascending branch of the anterior circumflex humeral artery. Its lateral lip is marked by the bilaminar tendon of the pectoralis major, its floor by the tendon of the latissimus dorsi and its medial lip by the tendon of the teres major. The transverse humeral ligament passes between its tubercles and converts it into a canal and acts as a retinaculum for the long tendon of the biceps (Standring, 2006). Anatomical knowledge of the BG is important as abnormalities of the bicipital tendon and its synovial sheath have been implicated in a variety of causes of shoulder pain and disability (Booth & Marvel, 1975; Slatis & Aalto, 1979). A radiological study recommended that the entire length of the BG be examined to determine the osseous anatomy of the groove (Farin & Jaroma, 1996). Although the BG is a subject of clinical interest, only few studies are available in the literature on this landmark which gave us an impetus to conduct a study with the aim to provide a baseline data on this landmark in North Indian population.

MATERIALS AND METHODS
The present study was conducted over a period of 3 years from June 2008 to June 2011 after getting approval from the institutional ethical committee. The material for the study comprised of 100 dried adult humeri of known sex (M:50; F: 50), obtained from the Department of Anatomy, Government Medical College, Amritsar. These humeri were free of any gross abnormality & labelled from 1-100 with suffix M(Male) or F(Female). Following parameters were measured on the BG at the proximal end of the humerus.

1. LENGTH OF BG: It was measured with the Vernier caliper as maximum distance between the most proximal and distal most point of the intertubercular sulcus (CD in Figure 1).

2. WIDTH OF BG: Width of the intertubercular sulcus was measured at two locations on the bicipital groove.

i. Top width was measured with the Vernier caliper as the maximum distance between the medial and lateral lips of the intertubercular sulcus along the plane of the intertubercular line as illustrated in figure (MN in Figure 1).

ii. Middle width was measured by Vernier caliper as distance between the medial and lateral walls of the sulcus at a point equal to one and a half of the depth of the sulcus.

3. DEPTH OF BG: The maximum depth of the BG was obtained indirectly as the difference between the diameters of the upper end of the humerus at the levels of:

i. Margins of medial and lateral walls of the BG.

ii. Floor of the BG.

These diameters were measured with the fixed jaw of the calipers placed to rest:

a. On the margins of the medial and lateral walls of the BG [(Figure 2(b)]

b. On the floor of the BG, while the sliding jaws of the calipers was at the same diametrically opposite point each time [Figure 2(a)].

13. MEDIAL WALL ANGLE OF BG: Medial wall angle was the angle formed between the planes of the floor and the medial wall of the intertubercular sulcus. A scale was kept tangent to the superior margins of the greater and lesser tuberosities of the humerus. A second scale was kept tangent to the medial wall of the intertubercular sulcus of the bicipital groove. The angle of intersection of these 2 scales was measured with a protractor (Angle BAC in Figure 3).

14. BICIPITAL GROOVE SPURS: Presence or absence of bony spurs and their number was noted. Such spurs were divided into 2 groups.

a) Bony excrescences formed on the medial lip of the intertubercular sulcus were recorded as medial wall spurs.

b) Bony excrescences formed within the inferior half of the intertubercular sulcus were recorded as groove spurs.

4. SUPRATUBERCULAR RIDGE: The presence or absence was noted. This was seen as a ridge of bone projecting immediately proximal to the medial wall of the bicipital groove and continuous with it.

5.

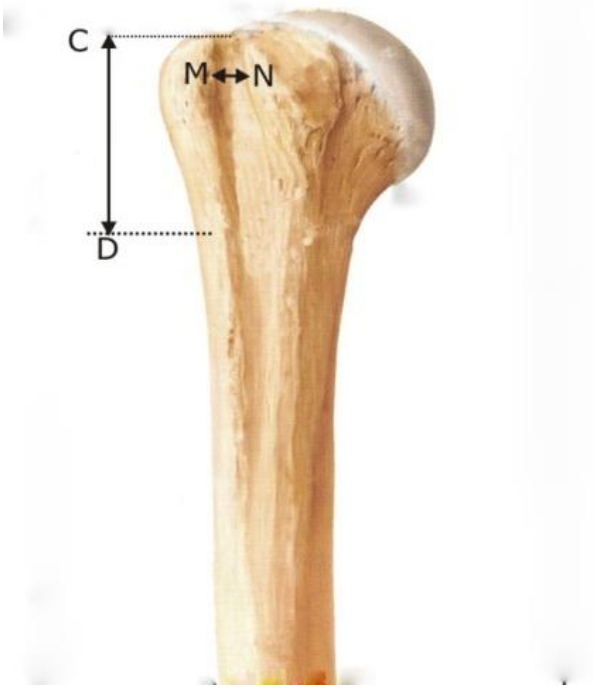

Figure 1: CD: Length of ITS; MN: Top width of ITS

Figure 2(a) **Figure 2(b)**
Measurement of depth of intertubercular sulcus

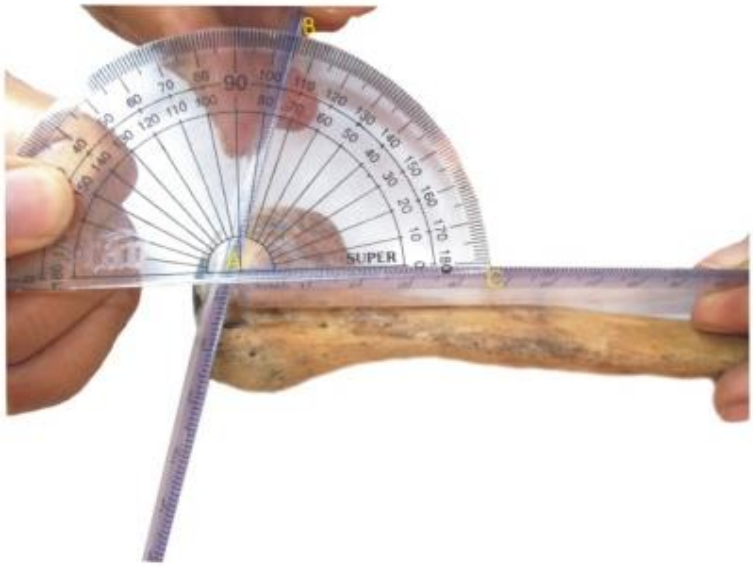

Figure 3: Measurement of angle of medial wall of intertubercular sulcus

RESULTS AND DISCUSSION

Results

Table 1 shows the length, width, depth & medial wall angle of the right (RBG) & left BG (LBG) in both sexes. The mean values of the length of RBG & LBG in males were 32.68±2.58mm and 31.32±2.53mm respectively. While in females, the corresponding values were 28.61±3.80mm and 27.96±3.21mm. Thus BG was found to be longer in males as compared with females and the difference was statistically significant (p<.001). Also, it was found to be longer on right side than left but the difference was statistically insignificant. The mean values of top width of RBG & LBG were 8.83±1.43mm and 7.95±1.86mm respectively in males while in females, these were found to be 8.15±1.47mm and 7.79±1.48mm. The mean values of mid width of RBG & LBG in males were 5.88±1.13 & 5.49±1.47 mm whereas in females, these values were 5.73±1.15 & 5.19±1.27mm respectively. Width at both these points

showed similar trend i.e. wider on the right side as compared to left, difference being statistically insignificant. However the values were almost similar in both the sexes. The mean values of depth were 3.94±0.72mm and 4.13±0.73mm respectively in males and 3.72±1.12mm and 3.71±0.98mm respectively in females. The BG was deeper in males than females and the difference was statistically significant (p<.001). However, no significant difference was seen on comparing two sides in both the sexes which was in accordance with Vettivel *et al.,* The mean values for the medial wall angle were found to be 48.04±4.13 degree (RBG) and 59.72±5.35 (LBG) degree in males and 50.12±5.61 degree (RBG) and 60.40±3.99 degree (LBG) in females. The angle was higher in females as compared to males i.e. more acute in males. Further it was more acute for RBG as compared to LBG and the difference was statistically highly significant (p<.001). The medial wall spurs was noticed in 30% of the total bones & groove spurs in 8% of the total bones. The supratubercular ridge was found in 41% of the total bones (Males 44%, Females 38%). However, it was found to be more in right humeri (46%) as compared with left (36%).

Table 1: Showing The Length, Width, Depth & Medial Wall Angle Of BG In Present Study

Sex and side	Length (mm)		Width (mm)				Depth (mm)		Medial wall angle (Degree)	
			Top		Mid					
	Mean± S.D	Range	Mean ±S.D	Range	Mean ±S.D	Range	Mean ±S.D	Range	Mean± S.D	Range
MR	32.68±2 .58	26.32-38.11	8.83± 1.43	6.50-11.97	5.88± 1.13	3.04-7.30	3.94± 0.72	2.25-5.58	48.04±4 .13	36 -56
ML	31.32±2 .53	27.82-38.38	7.95± 1.86	5.20-12.50	5.49± 1.47	3.42-8.20	4.13± 0.73	3.10-5.61	59.72±5 .35	50-68.
FR	28.61±3 .80	19.72-35.23	8.15± 1.47	5.12-10.91	5.73± 1.15	3.10-7.47	3.72± 1.12	1.12-7.12	50.12±5 .61	40-62
FL	27.96±3 .21	20.63-35.00	7.79± 1.48	4.43-11.00	5.19± 1.27	1.70-7.80	3.71± 0.98	1.76-5.83	60.40±3 .99	52-68

MR: Male right; ML: male left; FR: female right; FL: female left.

Discussion

The results in present study have been compared with the results of studies available in accessible literature (see table 2).

Table 2: Showing the comparison of width, depth, medial wall angle & supatubercular ridge with other authors

Author & year	Width Top	Mid	Depth	Medial wall angle	Supratubercular ridge
Meyer (1928)					17.5
Hitchcock & Bechtol (1948)					59(moderately marked) & 8(well marked)
Cone *et al.,* (1983)	8.8	5.4	4.3	56	48
Vettivel *et al.,* (1995)	R-10.23±0.14		3.70	44.47±0.71	88
	L-9.8±0.16		3.72	60.20±1.04	57
Ueberham & Prigent (1998)	6.33±0.84		2.44±0.49	-	45
Present Study	R-8.49	R-5.85	3.83	49.08	46
	L-7.87	L-5.34	3.92	65.07	36

The length was compared with that of Uberham and Prigent LF who measured it on the humeri of French population & it was found to be higher in Indian population which is due to the racial variation. The mean values of top and mid width of BG in present study were seen to be almost similar to that of Cone *et al.,* but found to be higher than Uberham and Prigent LF, and lower than that of Vettivel *et al.,* In our study, RBG was wider as compared to LBG but the depth did not show any difference on both sides which was

in consonance with Vettivel *et al.,* However, the depth was less in North Indians as compared with Americans and more than French population. The median wall angle in present study was found to be slightly higher as compared to that measured by Vettivel *et al.,* in South Indian population & lower than that found by Cone et al. These differences in the parameters of BG of various populations may be attributed to regional & racial variations. The incidence of medial wall (30%) and groove spurs (8%) in the present study was less as compared to that of Cone et al who found it to be 33% & 20% respectively. However, the incidence of supratubercular ridge corresponded to that of Cone *et al.,* and Ueberham and Prigent LF while it was demarcately less than that of Vettivel *et al.,* and Hithcock and Bechtol. However the present work depicted higher incidence than that found by Meyer. In our study, the length & width were more on the right side ie the RBG was longer, wider as compared to LBG in North Indian Population. This could be due to the fact that 90-95% of people are right handed (Adams & Victor, 1989). In manual workers, the pressure of the biceps long head tendon (LBT) on the humerus of right side is higher than on left side which consequently may alter the morphometry of RBG (Vettivel *et al.,* 1992). The biceps is a muscle for heavy work & is hypertrophied in manual labourers (Rasch & Burke, 1974), with a resultant increase in size of its long tendon (Vettivel *et al.,* 1992). So the right tendon is larger than the left in the right handed people & vice versa. It was also reported that more pressure on the BG & accommodation of a larger, flat tendon could increase its length, width & depth. The depth and width of ITS are important factors in the retention of the long Biceps tendon. Cone et al reported that wide grooves (i.e.>17mm) are often shallow, a combination which may predispose to tendon sublaxation or dislocation. On patient radiographs, they found that the mean depth of the ITS was 4.6mm. They also reported that 90% of their patients had a sulcus with a depth > 3mm & 86% had a depth in the range of 4-6mm. Finally they felt that a groove 3mmdeep or less should be viewed with suspicion in managing pathological conditions of the shoulder. De Palma AF further opined that a shallow BG leads to chronic trauma of impingement by the overlying acromion, rotator cuff and coracoacromial arch during shoulder rotation but a deep narrow groove is likely to constrict the tendon. In a study by Pfahler *et al.,* the width & depth of BG showed sex related differences. In present study, the length & depth showed significant sex related differences whereas width & medial wall angle did not show any sex related differences. The concept of medial wall angle was first given by Hitchcock and Bechtol**.** According to him, the anatomy of the human skeleton dictates that when the Biceps tendon is under tension, it is pulled against the lesser tuberosity. The angle of medial wall is therefore very important in retaining the tendon in the ITS, a steeply sloping medial wall offers better retention. This can be explained by the fact that majority of the individuals are right handed which leads to higher stress on the tendon on right side. More is the medial wall pressed by the tendon, lesser will be its angle thus leading to markedly smaller angle on right side than left as shown in present study. O'Donoghue opined that medial wall angle of 90º may restrict the movement of the long Biceps tendon and increase the incidence of tenosynovitis. In our present study, no bone with medial wall angle of 90˚ was found. Various authors have explained the cause of medial wall spurs. According to Cone et al, the most likely etiology is traction by the transverse humeral ligament when it is placed under tension by the BG, especially in internal rotation of the Humerus with arm stressed. Bony excrescences on the floor of the groove can be related to chronic bicipital tenosynovitis. However Meyer opined that medial wall spurs could be the result of friction of tendon against this wall during medial rotation of arm. De Palma AF, Meyer, Nevaiser suggested that medial wall spurs are due to chronic inflammation of the bicipital tendon sheath. Supratubercular ridge was originally described by Meyer in 1928 and later by Hitchcock and Bechtol in 1948. On the contrary, Neviaser explained the harmful effects of supratubercular ridge i.e. it displaces the tendon of long head of Biceps forward thus favouring forward displacement. Supratubercular ridge could thus be the cause of all primary lesions of long head of Biceps Brachii.

Clinical Anatomy

The BG prevents the LBT from dislocating during movement of the arm. Bicipital root and proximal tendon disorders are becoming increasingly recognized as an important symptom generator in the shoulder. The spectrum of abnormalities includes tenosynovitis, pulley lesions, biceps dislocations, and

proximal tears. The BG and the LBT are intimately related; the shape of the BG can have a great impact on the tendency for the LBT to be dislocated, subluxated, frayed, or torn. It is understood that a shallow, wide BG can promote subluxation and/or dislocation of the LBT while a deep, narrow BG can cause LBT irritation and tenosynovitis. Osseous spurs in the BG can cause LBT fraying, and the presence of the supratubercular ridge of Meyer is suspected to promote dislocation (Meyer, 1928; Hitchcock & Bechtol, 1948; Bateman, 1978; Ueberham & Prigent, 1998).

REFERENCES

Adams RD and Victor M (1989). *Principles of Neurology,* 4th edition (Singapore: McGraw Hill) 377-95.
Bateman JE (1978). *The Shoulder and Neck* (USA: W. B. Saunders Company).
Booth RE and Marvel JP (1975). Differential diagnosis of shoulder pain. *Orthopedic Clinics of North America* **6** 353-79.
Cone RO, Danzig L, Resnick D and Goldman AB (1983). The Bicipital groove: Radiolographic, Anatomic and Pathologic study. *American Journal of Radiology* **141** 781-8.
DePalma AF (1963). Surgical anatomy of the rotator cuff and the natural history of degenerative periarthritis. *Surgical Clinics of North America* **43** 1507-20.
Farin PU and Jaroma H (1996). The bicipital groove of the humerus: sonographic and radiographic correlation. *Skeletal Radiology* **25** 215-9.
Hitchcock HH and Bechtol CO (1948). Painful shoulder. *Journal of Bone & Joint Surgery* **30-A**(2) 262-73.
Itamura J, Dietrick T, Roidis N, Shean C, Chen F and Tibone J (2002). Analysis of the bicipital groove as a landmark for humeral head replacement. *Journal of Shoulder and Elbow Surgery* **11** 322-6.
Joseph J (1976). Locomotor system. In: *Textbook of Human Anatomy,* edited by Hamilton WJ (London: Macmillan) 19-200.
Meyer AW (1928). Spontaneous dislocation and destruction of tendon of long head of Biceps Brachii. 59 Instances. *Archives of Surgery* **17** 493-506.
Nevaiser RJ (1980). Lesions of the Biceps and tendinitis of the Shoulder. *Orthopedic Clinics of North America* **11** 343-8.
O'Donoghue DH (1973). Subluxing Biceps tendon in the athlete. *American Journal of Sports Medicine* **1**(3) 20-9.
Pfahler M, Branner S and Refior HJ (1999). The role of the bicipital groove in tendinopathy of the long biceps tendon. *Journal of Shoulder and Elbow Surgery* **8** 419-24.
Rasch PJ and Burke RK (1974). *Kinesiology and Applied Anatomy,* 5th edition (Philadelphia: Lea & Febiger) 22-40.
Robertson DD, Yuan J, Bigliani LU, Flatow EL and Yamaguchi K (2000). Three-dimensional analysis of the proximal part of the humerus. *Journal of Bone and Joint Surgery: American Volume* **82** 1594-602.
Slatis P and Aalto K (1979). Medial dislocation of the tendon of the head of the biceps brachii. *Acta Orthopaedica Scandinavica* **50** 73-7.
Standring S (2006). Gray's Anatomy. In: *The Anatomical Basis of Clinical Practice,* 39th edition (Spain: Churchill Livingstone) 823-32.
Ueberham K and Prigent LF (1998). Intertubercular sulcus of the humerus : Biometry & morphology of 100 dry Bones. *Surgical and Radiologic Anatomy* **20** 351-4.
Vettivel S, Indrasingh I, Chandi G and Chandi SM (1992). Variations in the intertubercular sulcus of the humerus related to handedness. *Journal of Anatomy* **180** 321-6.
Vettivel S, Selvaraj KG, Chandi SM, Indrasingh I and Chandi G (1995). Intertubercular sulcus of the Humerus as an indicator of Handedness and Humeral Length. *Clinical Anatomy* **8** 44-50.