Original Article

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Dimensions of Glenoid Fossa of Scapula: Implications in the Biomechanics of an Implant Design

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Abstract

Introduction: The entire upper extremity is connected to the axial skeleton through the scapula by various strong muscles and two joints, the sternoclavicular and acromioclavicular. The clavicle appears to play the role of a strut that defines the distance between the torso and the scapula. Nevertheless, the true biomechanical function of the clavicle is not clearly understood. Attempts have been made by several authors to understand the shoulder suspension complex and to explain the pathobiomechanics of certain shoulder injuries.

Aim: The aim of the present study was to observe the glenoid fossa of the human scapula.

Materials and Methods: The present study was conducted on eighty dry adult human intact scapulae obtained from the Department of Anatomy of four different medical colleges in the state of Bihar. Dimensions of the glenoid fossa of each in two axes were recorded and compared bilaterally.

Result: Vertical glenoid diameter is higher than horizontal glenoid diameter due to shape and diameters on the right side were larger than those of the left side.

Conclusion: Dimensions of the glenoid fossa are important both surgically and biomechanically, as orthopedicians require the utility of an implant for shoulder arthroplasty. Knowledge of variations of the glenoid cavity is essential for evaluating pathological conditions, osseous lesions and osteochondral defects related to the shoulder joint.

Key words: Arthroplasty, Glenoid fossa, Implant, Scapula

INTRODUCTION

The scapulae are a pair of triangular, large, flat bones that are situated dorsally in the ribcage in relation with the second to seventh ribs. The scapula has three borders, three processes, and three angles. The glenoid (Gk. *Gléne* "socket") fossa is oriented at the lateral angle of the bone. During development, the glenoid fossa shows slight concavity at 20 mm crown rump length. The process of scapular development and ossification are extremely variable. Individuals may experience different rates of ossification, and some may never obtain the complete fusion of the scapula with the acromial process (*os acromiale*). The shoulder joint is a synovial joint of ball and socket variety and by virtue of evolution; it has gained mobility at the cost of stability. It is a complex assembly of muscles, tendons, ligaments, cartilages and bones. For the functional integrity of the joint, all these structures should be healthy and must work in accordance with each other. If any one of these structures is diseased or injured, it can have a negative ripple effect on the functioning of the others. The two articulating surfaces of the shoulder joint are the hemispherical head of the humerus and the glenoid fossa of the scapula. The stability of the humeral head on the glenoid fossa is provided by the musculotendinous cuff. The scapula is surrounded by muscles and is further protected from injury by its vicinity to the thoracic wall. In polytrauma

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patients, fracture of the scapula is an indicator of severe thoracic trauma including occasional rupture of the thoracic aorta. Isolated fractures are rare and are usually due to an isolated blow from the back directly targeting the scapula. Associated ipsilateral fracture of the clavicle may occur in a quarter of the cases and can result in a floating shoulder. Shoulder arthroplasty is a common orthopedic intervention in the clinical management of shoulder arthritis. Compared to fractures of the clavicle and scapula, fracture of the glenoid rim is a completely different entity as it is usually a result of dislocation of the glenohumeral joint. Knowledge of the shape and morphological parameters of both the articulating surfaces is essential for a successful shoulder arthroplasty as otherwise there would be loosening of the joint necessitating revision surgery.[1] The fibrocartilaginous glenoidal labrum can be detached leading to a Bankart's lesion.[2] Surgical treatment in glenohumeral arthritis requires a thorough knowledge of both morphology and morphometry of glenoid fossa especially when a prosthesis has to be used. As no such previous citable research was available in Bihar, this study was taken up with the aim of providing morphometric data for anatomists, anthropologists, forensic experts, and orthopedicians.

MATERIALS AND METHODS

Eighty dry adult human intact scapulae were obtained from four medical colleges in Bihar. Specimens that were malformed or showed signs of previous pathology in any part of the bone were excluded from this study. Sex of the bone was not considered. Bones were bilaterally equal in number. Morphometry of the glenoid fossa was performed using sliding Vernier callipers. Measurements of the glenoid fossa were taken along two different axes; vertical and horizontal. Vertical glenoid diameter (VGD) was taken along the maximum vertical length of the glenoid fossa between its superior and inferior borders. Horizontal glenoid diameter (HGD) was taken along the maximum horizontal breadth of the glenoid fossa around its midpoint between the anterior and posterior borders (Figures 1 and 2) .

Observation

The results are well explained in Tabular form. Table 1 gives information about Statistical analysis of bilateral VGD and HG. Along with that Table 2 depicts the Comparison of VGD with other workers and Table 3 provides information about the Comparison of HGD with other workers

DISCUSSION

Anterior dislocation of the shoulder joint is perhaps the commonest of dislocations in the human body and is more

Figure 1: Scapula and sliding Vernier Calliper with 1 mm accuracy

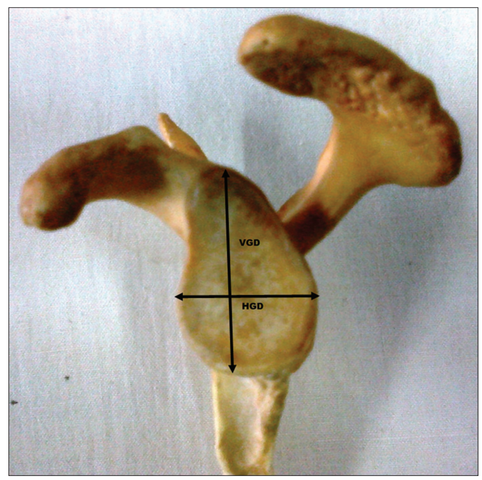

Figure 2: Measurements of the glenoid fossa in two axes. VGD: Vertical glenoid diameter, HGD: Horizontal glenoid diameter

common in adults than in children. It results due to a direct force pushing the head of the humerus out of the glenoid cavity and thereby injuring the latter consequently. Scapular fractures may be related to any of the following: Body, neck, processes, articular fractures, and fractures involving the associated clavicle. Fractures involving the glenoid rim may be treated operatively to restore the joint surface and to avoid long-term instability of the glenohumeral articulation. Shoulder arthritis presents a unique challenge to the orthopedic surgeon as there may be stripping of the glenoidal labrum from the glenoid fossa. Due to the complex anatomy of the concerned region it is relevant to understand the dimensions of the screw and implants to be utilized as they must have access to the posterior cortex in the neck region of the scapula. Total shoulder replacement has often yielded poor results due to eccentric loading of the glenoid leading to loosening and early failure. Multiple procedures have been recommended to solve this problem including total arthroplasty, hemiarthroplasty and

Table 1: Statistical analysis of bilateral VGD and HGD

S. no.	VGD				HGD			
1	R	Mean=3.62 cm	L	Mean=3.32 cm	R	Mean=2.42 cm	L	Mean=2.25 cm
2	R	Range=3.5-3.9	L	Range=3.1-3.6	R	Range=2.3-2.6	L	Range=2.1-2.5
3	R	SD=0.17	L	SD=0.18	R	SD=0.13	L	SD=0.14

R: Right, L: Left, SD: Standard deviation, VGD: Vertical glenoid diameter, HGD: Horizontal glenoid diameter

Table 2: Comparison of VGD with other workers

Authors	Race	Mean (cm)	SD
Coskum	Turkish	3.36	0.4
Piyawinijwong	Thai	3.36	0.31
Von Schroeder	Canadian	3.6	0.4

SD: Standard deviation, VGD: Vertical glenoid diameter

Table 3: Comparison of HGD with other workers

Authors	Race	Mean (cm)	SD
Coskum	Turkish	2.4	0.25
Piyawinijwong	Thai	2.7	0.31
Von Schroeder	Canadian	2.9	0.3

SD: Standard deviation, HGD: Horizontal glenoid diameter

shoulder arthrodesis. For treating the displaced fractures of the glenoid fossa, most authors have recommended open reduction and internal fixation to restore joint congruity and to prevent post-operative arthrosis. The current standard of treatment in shoulder arthritis offers limited goal for functional improvement and only a modest improvement in pain. Glenoid reconstructions using implants may be considered. Morphometric parameters of the glenoid fossa in our study were recorded and statistically analyzed. On the right side, mean VGD and mean HGD were 3.62 and 3.42, respectively. On the left side, mean VGD and mean HGD were 3.32 and 2.25, respectively. Our data obtained is in accordance with the research of previous workers.[3-10] As there are variations in scapular morphology, individualized adjustments may be required for reverse shoulder prostheses.

CONCLUSION

Anatomical knowledge of variations in the glenoid fossa is a pre-requisite for successful management of shoulder surgery. Dimensions of glenoid fossa exhibit racial variations hence are important parameters for selecting appropriate shoulder implants. Scapular measurements can be used for comparative anatomy and manufacturing of prosthetic products. Further, this study may also be helpful for orthopedic surgeons during surgical interventions on the shoulder and for biomechanical engineers during designing of implants for reverse total shoulder replacement surgery.

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