

Acetabular Profile and its Correlation in South Indian Population.

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Abstract: Orthopaedic surgeons face great difficulty in placement of screws during uncemented total hip arthroplasty and fixation of acetabular fractures. The screws need to be placed with great care to avoid injury to the nearby neurovascular structures. Knowledge of the important structures and a preoperative determination of the length of the screw would help the orthopaedic surgeons to achieve adequate fixation and hence better results. Literature on the acetabular profile including the diameter and thickness of South Indian acetabuli are scarce. The objective of this study is to find the average acetabular diameter, thickness and to find the correlation between the two in South Indian population. 108 pelvic bones without any pathology were studied. The acetabulum was divided into four quadrants based on standard guidelines. The diameter of the acetabuli were measured along a single plane and the thickness was measured in all the four quadrants using a vernier caliper. The results were analyzed statistically. The mean diameter was found to be 48.74 ± 3.62 mm. The average thickness of the posterior quadrants was calculated to be about 70% of the acetabular diameter (about 33 mm). Thickness of three quadrants except the antero-inferior quadrant showed a linear correlation with the diameter. The posterior quadrants were found to be the most safe zone for placement of screws and the antero-inferior quadrant the least safe.

Key words : acetabular fractures, acetabular profile, screws, safe zone, correlation

INTRODUCTION

The acetabulum is an incomplete hemispherical socket with an inverted horseshoe shaped articular fossa¹. According to Judet and Letournel², the acetabulum is supported by two columns of bone-anterior and posterior. The iliac crest, the iliac spines, the anterior half of the acetabulum and the pubis forms the anterior column. The ischium, the ischial spine, the posterior half of the acetabulum forms the posterior column. The acetabular fractures are classified based on the involvement of fracture in these columns. The surgical approach for internal fixation of these fractures is also planned based on the column involved in fractures.

Acetabular fractures are usually due to high energy trauma. The nearby neurovascular structures including the iliac vessels, the lumbosacral trunk and obturator artery are at great risk for injury both at the time of initial trauma and also later during the surgical treatment¹. Iatrogenic injuries may occur due to the usage of drills, reduction forceps and over lengthed screws during surgery. Also screws with inadequate length fails to achieve adequate fixation. Therefore it is very important for the orthopaedic surgeons to know the average length of the screws that can be placed safely at various quadrants of the acetabulum as a part of the pre-operative assessment. This study is aimed at correlation of the diameter and thickness of South Indian acetabuli and its relevance to clinical application in terms of assessing the safe zone for placement of screws in acetabulum and also a guide for pre-operative determination of screw length.

MATERIALS AND METHODS

For this study, 108 dry hip bones without any pathology belonging to the bone banks of VMKV Medical College, Salem, Annapoorana Medical College, Salem and Vinayaka Mission's Homeopathy Medical College, Salem were utilized. Of these, 58 belonged to right side and 50 belonged to left side. Gender and age of the bones were not determined. Vernier caliper was used to measure the parameters. Four quadrants as described by Wasielewski et al (1990)³ were determined. Two lines A and B were drawn to divide the acetabulum

into four quadrants (R1, R2, R3 and R4). Line A was drawn from the anterior superior iliac spine through the center of the acetabulum. Line B was drawn perpendicular to the Line A at the mid-point of the acetabulum (Fig.1). R1 is the antero-superior quadrant. It includes the region of the anterior part of the acetabulum and the pubic bone. The postero-superior quadrant (R2) represented the part lying over the posterior part of the dome of the acetabulum and the postero-inferior quadrant (R3) is the posterior part of the acetabulum and the area over the tuberosity of the ischium. The antero-inferior quadrant (R4) is the inferior part of acetabulum including the part lying in front of the obturator foramen.



Fig. 1: Hip bone lateral view showing acetabular quadrant delineation

Line A: From anterior superior iliac spine through the center of acetabulum

Line B: Line drawn perpendicular to the line A at the mid-point of the acetabulum

The diameter was measured along the line A. Thickness of the acetabular wall was measured in all the quadrants near the rim using a vernier caliper. All the readings were repeated by two other observers by staging method.

The results were analyzed using SPSS 12.0 system.

RESULTS

The average acetabular diameter was found to be 48.74 ± 3.62 mm (range 42-56 mm). The mean diameter for 58 right sided bones was 48.39mm and for 50 left sided bones it was 49.09 mm.

The mean thickness of acetabulum was found to be 25.85 mm in R1,

36.33mm in R2, 33.32 mm in R3 and 5.63 mm in R4. The correlation between the acetabular diameter and thickness for R1 quadrant (25.85 mm), for example, was 0.504 & R square was 0.254. This was highly significant ($p < 0.01$). R2 and R3 also showed significant correlation ($p < 0.01$) but in case of R4 it was not significant ($p = 0.158$) (Table 1).

Table-1: Correlation analysis of acetabulum ($n = 108$)

Quadrant	Mean Thickness (mm)	R	R ²	Significance
R1	25.85	0.504	0.254	<0.01(S)
R2	36.33	0.472	0.222	<0.01(S)
R3	33.32	0.480	0.231	<0.01(S)
R4	5.63	0.158	0.025	0.158(NS)

S-Significant NS- Not significant

The histogram of the dependent variable (thickness of acetabulum) showed a normally distributed curve (Fig. 2). The scatter plot of the dependent variable to the diameter was found to be within the linear best-fit line (Fig.3).

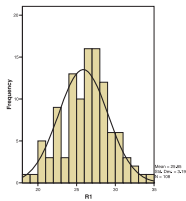


Figure 2 The histogram of the thickness of acetabulum showing normally distributed "Bell" shaped curve (R1 – Antero superior quadrant thickness of acetabulum in mm)

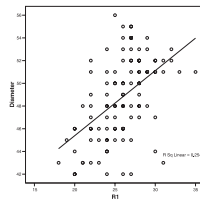


Figure 3 The scatterplot of the dependent variable to the diameter of acetabulum (R1 – Anterosuperior quadrant thickness of acetabulum in mm)

Mean thickness at R1 was found to be about 50% of acetabular diameter. The average thickness at R2, R3 & R4 was found to be about 75% , 68% and 11.7% of acetabular diameter respectively. The average posterior quadrant thickness (posterosuperior and posteroinferior) was the maximum (33mm) and it was found to be about 70% of the acetabular diameter . The antero-inferior quadrant was found to have the minimum thickness (about 11 % of acetabular diameter).

Interobserver analysis showed more than 90% agreement ($k=90\%$). It was found to be a better agreement.

DISCUSSION

The average acetabular diameter in our study is found to be 48.74 ± 3.62 mm ($n=108$). Our findings are similar to that as observed by Eric Vandebussche et al(2008)⁴(48.5 ± 4.4 mm) but differs with that of the average observed by Namchai Varodompon et al(2002)⁵ (51.82 mm)in their study on Thai population. Chauhan R. et al (2002)⁶ in their study on North Indian hip joints in cadavers, have

reported the average acetabular diameter in males on the right side as 47.10 ± 2.09 mm and on the left side as 47.48 ± 3.05 mm. In females they found it as 44.38 ± 3.01 mm on the right side and 46.0 ± 2.28 mm on the left side

Namchai et al(2002)⁵ noted the thickness of the postero-superior and postero-inferior quadrants to be 85% and 72% of the average acetabular diameter. In our study the thickness of R1 quadrant was found to be about 50% of acetabular diameter and at R2, R3 & R4 it was found to be about 75% , 68% and 11.7% of acetabular diameter respectively.

The present study revealed that the posterior quadrants (R2 & R3 together) are the thickest quadrants with maximum bone stock and can accommodate screws ranging from 33 mm to 36 mm safely. Stranne SK et al (1991)⁷ have reported that the screw fixation over the superior part of ilium, posterior column and over the ischium was the strongest since these areas possess the maximum bone stock for adequate and safe fixation of screws. The antero-inferior quadrant is the quadrant with least thickness and least available bone stock. Transacetabular placement of screws in this quadrant therefore needs special care since improper placement may cause damage to the external iliac vessels, obturator vessels and nerve. Our study showed a statistically significant linear correlation between the acetabular diameter and thickness in South Indian population. Therefore we strongly feel that the diameter of the acetabulum can be used as a guideline in the pre-operative assessment of the thickness of the different acetabular quadrants and length of screws that can best fit that particular quadrant and hence achieve adequate fixation. Gender and Age of the bones were not taken into account in the present study. These factors can be included in future studies.

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REFERENCE

- James L. Guyton. Campbell's Operative Orthopaedics. In: Fractures of Hip, Acetabulum and Pelvis 9th edn. Mosby, Chicago 1992: 2234 – 2236.
- Judet R, Judet J, Letournel E. Fractures of the acetabulum: classification and surgical approaches for open reduction: preliminary report. J Bone and Joint Surg. 1964; 46 A: 1615.
- Wasielewski RC, Cooperstein LA, Kruger MP and Rubash HE. Acetabular anatomy and the transacetabular fixation of screws in total hip arthroplasty. JBJS 1990; 72(4): 501-508.
- Eric Vandebussche, Mohammed Saffarini MEng, Fabienne Taillieu, Celine Mutschler. The Asymmetric Profile of the Acetabulum. Clinical Orthopaedic Related Research 2008; 466: 417 – 423.
- Namchai Varodompon, Tshewang Thinley, Boonyarak Visuipol, Bunyat Ketmalasiri and Narongchai Pattarabunjard. Correlation between the acetabular diameter and thickness in Thais. Journal of Orthopaedic Surgery. 2002; 10(1): 41-44.
- Chauhan, R., Paul, S., Dhon, B.K. Anatomical Parameters of North Indian Hip Joints – Cadaveric study. Journal of the Anatomical Society of India. Jan 2002; 51 (1) : 202 – 6
- Stranne SK, Callaghan JJ, Elder SH, Gillsson RR, Seaber AV. Screw-augmented fixation of acetabular components. J Arthroplasty. 1991; 6: 301-5.

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