

Correlation between the acetabular diameter and thickness in Thais

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ABSTRACT

We conducted a study on dried cadaveric pelvic bones to determine the relation between acetabular diameter and thickness of the acetabular wall.

The acetabulum was divided into four quadrants: antero-superior, postero-superior, postero-inferior, and antero-inferior. The diameters of the acetabulum were measured for 152 pelvic bones. The thickness of the center of the acetabulum was measured with the use of a caliper at four quadrants of the acetabulum. The average acetabular diameter was found to be 51.8224 mm for all the acetabuli. The average thickness in the posterior quadrant has been calculated to be about 50% of the acetabular diameter, which is about 26 mm. The acetabular diameter and the thickness of the acetabulum correlated very well though there was very little significance statistically (0.099) due to the lack of full data for all the individual bones.

Linear correlation between the thickness and the diameter is definitely collinear but the correlation is not statistically significant. Some additional factors such as bone density, body mass, etc, are required to correlate the thickness and the diameter. Further study is required in this field.

Key words: acetabulum, acetabular diameter, acetabular thickness, screw length

INTRODUCTION

During surgery of the acetabular fractures or during the placement of acetabular cups in arthroplasty, placement of the screws in the acetabulum is very critical because of the neurovascular structures that surround it. It is very important to know the anatomical landmarks as well as the average length of the screws that can be placed safely at various quadrants of the acetabulum.

OBJECTIVE

The objective of the study was to find the correlation between the acetabular diameter and the thickness of the acetabulum at various quadrants in Thais.

MATERIALS AND METHODS

152 dry pelvic bones were used to measure the diameter and the thickness of the acetabulum: 18 female acetabuli (age 17 to 70 years), 118 male acetabuli (age 20 to 86 years). The ages of 16 were not recorded, and 80 were right-sided and 72 left-sided. A caliper with pointed ends measuring to 0.01 mm determination was used to measure the thickness of the acetabulum. The diameters of all 152 acetabulums were measured.

The acetabuli were divided into four quadrants as described by Wasielewski et al.⁴ by bisecting them by a line from the anterior superior iliac spine and another line passing through the center of the acetabulum perpendicular to the first line. This division divided the acetabulum into the thickest part, which was at the posterior-superior part, followed by the posterior-inferior part, then the anterior-superior part and the thinnest part, anterior-inferior.

Each quadrant of the acetabuli was divided into three parts, rim (R), middle (M) and the centre (C). The anterior superior quadrants were represented by R1, M1 and C1. This part represented the region of the anterior part of the acetabulum and the pubic bone. The posterior-superior parts were represented by R2, M2 and C2. This area was the thickest part of the acetabulum that lies over the posterior part of the dome of the acetabulum. The posterior-inferior parts were represented by R3, M3 and C3. This area was the second thickest part of the acetabulum that lies just over the ischial tuberosity. The anterior inferior parts were the parts of the acetabulum which lie in front of the obturator foramen. Then the thickness of the acetabular walls at the rim, middle and the centre were measured for all the quadrants, and the rim, middle and the center were measured for all the quadrants

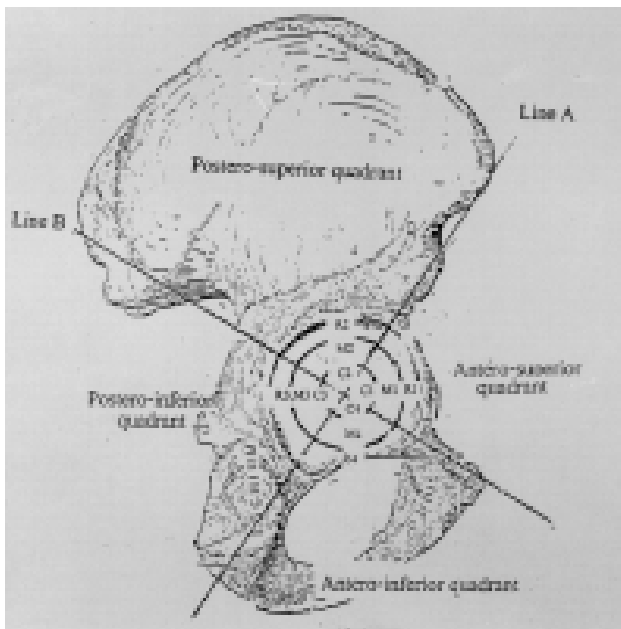


Figure 1 The acetabulum was divided into 4 quadrants by line A and line B. Each quadrant was divided into rim (R), middle(M) and center (C).

and for all the divisions (Fig. 1). Using the SPSS system of statistical analysis, the correlation between these variables was calculated.

RESULTS

The average acetabular diameter was found to be 51.8224 mm for all acetabuli. The mean diameter for 118 male bones was 52.3894 mm and for 18 female bones was 49.5455 mm.

Using the Regression Linear Equation:

$$y = a + bx \quad (x = \text{independent variable})$$

$$b = \frac{\sum xy - \sum x \sum y}{n}$$

$$\frac{\sum x^2 - (\sum x)^2}{n} \quad \begin{matrix} a = \text{constant} \\ b = \text{coefficient} \end{matrix}$$

$$a = y - bx$$

Summaries Equation

	Mean thickness (mm)	R	R Square	Significance
C1	8.027	0.314	0.099	0.000
C2	12.973	0.169	0.029	0.036
C3	8.757	0.233	0.054	0.006
C4	2.336	0.179	0.032	0.029
M1	15.159	0.518	0.269	0.000
M2	29.124	0.307	0.094	0.000
M3	26.631	0.458	0.210	0.000
M4	3.494	0.154	0.025	0.047
R1	28.195	0.557	0.310	0.000
R2	44.035	0.469	0.220	0.000
R3	37.394	0.561	0.315	0.000
R4	5.111	0.110	0.012	0.123

The correlation between the acetabular diameter for R1 (28.195 mm), for example, was 0.557 to 1.00 (standard deviation) = 0.00, R square = 0.310, with very little statistical significance. (p = 0.05 being the statistical significance).

Taking R2 (rim), the posterior superior quadrant variables were plotted, for example, number of dependant variables = 152, maximum diameter = 56.9644 mm, minimum diameter = 51.82224 mm,

which was taken as 0.00 (mean), 1.00 as the standard deviation. The graphs were plotted for Regression Standard Residual against the frequency variables.

R square was found to have very little significance because of the lack of full data on the individual bones. They correlated very well and normal P-P plot for Regression Standardized Residual was collinear and the Histogram of Dependant variable to Diameter had a normally distributed curve, a classic bell-shaped curve (Fig. 2).

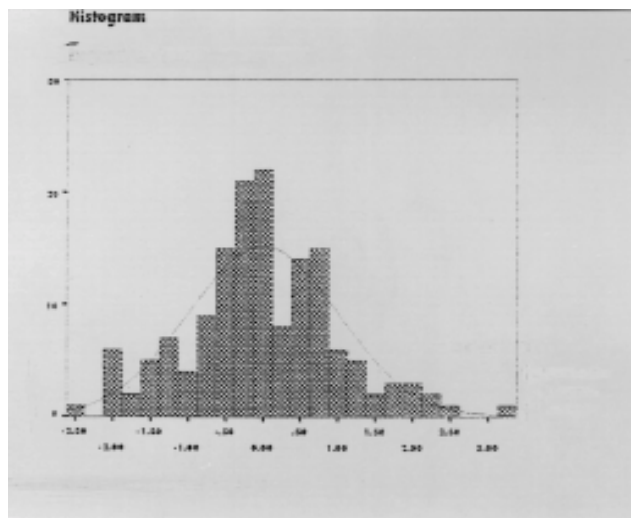


Figure 2 The histogram of the dependent variable to the diameter.

The scatter graph of the data was also within the linear regression best-fit line (Fig. 3).

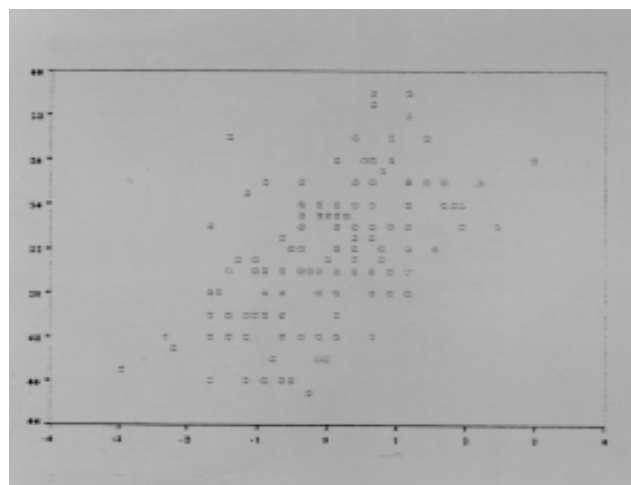


Figure 3 The scatterplot of the dependent variable to the diameter.

1. Anterior superior quadrant
 R1 = 28.195 mm (thick) = 54% of acetabular diameter
 M1 = 15.159 mm = 29%
 C1 = 8.027 mm = 15%
2. Posterior superior quadrant
 R2 = 44.035 mm = 85%
 M2 = 29.124 mm = 56%
 C2 = 12.973 mm = 25%
3. Posterior inferior quadrant
 R3 = 37.394 mm = 72%
 M3 = 26.631 mm = 51%
 C3 = 8.757 mm = 17%
4. Anterior inferior quadrant
 R4 = 5.111 mm = 10%
 M4 = 3.494 mm = 7%
 C4 = 2.336 mm = 4%
 Overall average = 18.43 mm = 35% only

If we take only the posterior quadrant (two quadrants), the average thickness of the acetabular wall was 51%, about 26.48 mm. The posterior half of the acetabulum was the thickest with an average thickness of about 50% (26 mm) of the acetabular diameter. The antero-inferior quadrant was found to be the shallowest with only 7% of the acetabular diameter.

DISCUSSION

From our study we found the thicknesses of the postero-superior and the postero-inferior rim were 85% and 72% of the acetabular diameters . They can accommodate more than 37 mm and less than 44 mm of screw length .

Our findings are almost the same as that of PC Noble^{1,2} , who found that the thickness of the acetabulum was more than 50% of the acetabular diameter at the posterior rim , 40% to 50% around it and 30% to 40% over the dome of the acetabulum and less than 30% in the centre. SK Stranne et al.,³ in their mechanical model study about the screw-augmented fixation of acetabular components, reported that the bicortical screw fixation over the superior ilium, posterior column and the ischium was strongest, indicating that these areas are the thickest parts.

Reviewing the articles, there is no mention of the acetabular diameter in males and females. We found the acetabular diameter in males was larger than in females.

The most important thing in acetabular surgery is the operative technique, and using these safe quadrants may be important to avoid injuring the

neurovascular structures. Even drilling and using the depth gauge can injure them. By just knowing the acetabular diameter, the screw lengths can be approximated at various quadrants of the acetabulum and inserted safely without damaging the neurovascular structures.

We have found that the linear correlation between the thickness and the diameter of the acetabulum is collinear though it is not statistically significant. More data, such as bone density, body mass etc. is required.

CONCLUSION

There is definite correlation between the diameter and the thickness of the acetabulum although it is statistically not significant. Additional information with regard to bone density, bone mass, etc. is needed. Further study is required in this field.

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