A Comparison of Acetabular Diameter using Direct and Indirect Measurement

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ABSTRACT

Background: In total hip arthroplasty, it is necessary to evaluate the diameter of the acetabulum as a part of the preoperative planning. However, usually the measurement of the acetabular diameter in the anteroposterior view of the pelvic radiograph gives an inaccurate value.

Objective: To determine the accuracy of acetabular diameter measurement from various pelvic radiographs when compared to direct measurement.

Methods: The study was performed in 10 cadavers; 5 males and 5 females with a mean age of 69.7 years. 20 hips were studied by taking radiographs at 3 positions: anteroposterior, 45° iliac oblique and 45° obturator oblique views. The acetabular diameters were directly measured from the cadaver and in all views of pelvic radiographs. Intraobserver and interobserver reliability of all the methods were evaluated by measuring 3 times by 3 doctors.

Results: The mean diameter of the acetabulum measured directly from the cadaver was 46.13 ± 3.05 mm., while when measured from the pelvic radiographs in anteroposterior, iliac oblique and obturator oblique view was 54.29 ± 3.67, 47.63 ± 2.85, and 57.29 ± 4.34 mm. respectively. The iliac oblique view gave the most accurate value with a magnification of 3.36%, while the magnification in the anteroposterior and the obturator oblique view was 17.81% and 24.30%, respectively. The diameter measured from the iliac oblique view was not statistically different from the direct measurement, while the diameter measured from the anteroposterior and obturator oblique view was statistically different ($p < 0.001$). The intraobserver and interobserver reliability of the 3 observers showed excellent correlations ($p < 0.0001$).

Conclusion: The iliac oblique view of the pelvic radiograph provided the most accurate value compared with the direct measurement. The iliac oblique view is the best view of the pelvic radiograph used to measure the acetabular diameter for operative planning for hip arthroplasty as a guide to choosing the proper prosthetic size.

Keywords: Acetabulum, acetabular radiography, template acetabular, acetabular measurement

Siriraj Med J 2009;61:68-70

E-journal: http://www.sirirajmedj.com

In the surgical procedure of the acetabulum especially in total hip arthroplasty, it is necessary to evaluate the diameter of the acetabulum as part of the preoperative planning[1,2], in order to estimate the size of the acetabular cup. The measurement of the acetabular diameter was usually performed in the anteroposterior view of the pelvic radiograph[6,8]. However, the direct measurement from the anteroposterior radiographs gives an inaccurate value[1,2] because there is the magnification effect from the radiographs[3,4,5,7]. Therefore, the commercial template is routinely used to solve the magnification problem and to estimate the size of the acetabulum and the prosthesis[1,2]. This study is designed to determine what is the most accurate radiographic view for measuring acetabular diameter when compared to a direct measurement from cadaver and to determine whether this view can be used to estimate the diameter of the acetabulum as an alternative method to the commercial template or not.

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Objective

The purpose of this study is to determine the accuracy of acetabular diameter measurement from various pelvic radiographs when compared to direct measurement.

MATERIALS AND METHODS

The study was performed in 10 cadavers; 5 males and 5 females with the mean age of 69.7 years (range 42–86 years). Twenty hips were studied by taking radiographs at 3 positions. The views selected were the anteroposterior, 45° iliac oblique and 45° obturator oblique views (Fig 1). The cadaver pelvis was placed on 5 cm.- thick foam while taking the radiographs to replace the soft tissue thickness (Fig 1), and the claribration of the anterior pelvic plane was adjusted by gravity goniometer.

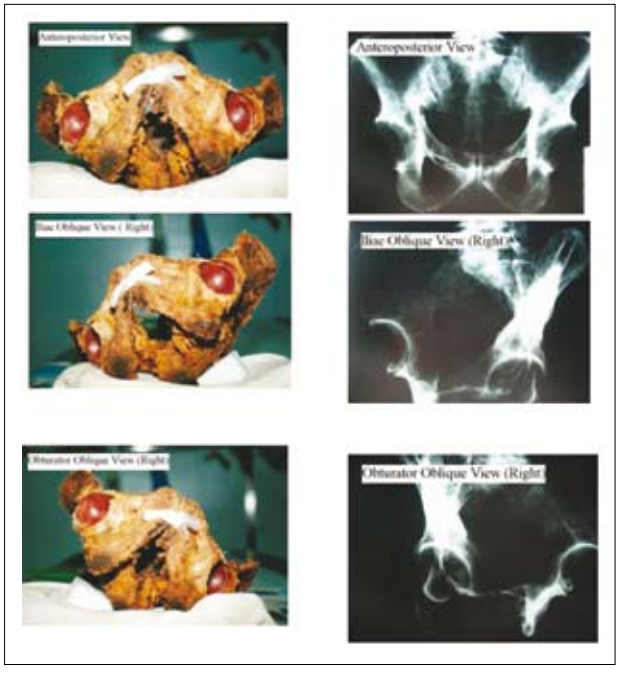


Fig 1. The cadaver pelvis radiographs were taken in 3 views: anteroposterior, iliac oblique and obturator oblique views.

The measurements of the acetabulur diameter directly in the cadaver and in all views of pelvic radiographs were accomplished by using the Vernier caliper (Fig 2). The standard measurement is in the imaginary direction from the anterior superior iliac spine to the ischial tuberosity (Fig 2).

Intraobserver and interobserver reliability of all the methods were evaluated by measuring 3 times by 3 different doctors. The 3 observers were blinded to the radiographs and the identifications of the cadaver pelvis specimen. Each observer independently measured the diameter of the acetabulum from the radiographs and cadaver specimen. The data was recorded. All markings from the measurements were removed from the radiographs and then each set wascirculated to different observers for the next reading. Each observer measured each radiographs 3 times with an interval of 2 weeks between each reading. None of the radiographs contained any cadaver indentification. The observers did not know how the radiographs were accessed by the other observers. The same caliper was used in all measurements.

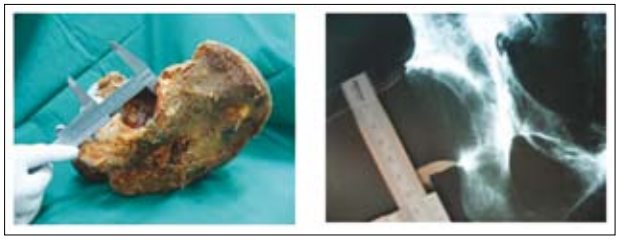


Fig 2. The Vernier caliper was used to measure the diameter of acetabulum in the cadavers and all views of radiographs.

Statistical analysis

The software package SPSS for Windows version 11 was used to perform the statistical analysis. The magnification of the acetabular diameter measured from the pelvic radiogrphs in all views was calculated in percentages. The Scheffe test was used to analyze the acetabular diameter measured from the pelvic radiographs in anteroposterior, iliac oblique and obturator oblique views and in comparison to the direct measurement from the cadaver. The intraobserver and interobserver reliability was analyzed with one way ANOVA and intraclass correlation coefficients.

RESULTS

The mean diameter of the acetabulum measured directly from the cadaver was 46.13 mm. ± 3.1 mm., while when measured from the pelvic radiographs in anteroposterior, iliac oblique and obturator oblique view the mean diameters were 54.29 ± 3.7, 47.63 ± 2.9, and 57.29 ± 4.3 mm., respectively (Table 1).

The iliac oblique view gave the most accurate value with a magnification of 3.36%, while the magnifications in anteroposterior and the obturator oblique views were 17.81% and 24.30%, respectively. The diameter measured from the iliac oblique view was not statistically different from the direct measurement, while the diameters measured from the anteroposterior and obturator oblique views were statistically different (p-value < 0.001) (Table 1). The intraobserver reliability of the 3 observers showed excellent correlations (p-value < 0.0001) (Table 2). The interobserver reliability among the 3 observers also showed excellent correlations (p-value < 0.0001) (Table 3).

DISCUSSION

It is necessary to evaluate the diameter of the acetabulum as part of the preoperative planning in order to estimate the size of the acetabular cup in the surgical procedure of the acetabulum,[1,2] especially in total hip arthroplasty. As we know that one of the problems of the radiographs is the magnification effect,[3-5,7] so the indirect measurement of the acetabular diameter from the radiographs also gives an overestimated value. Usually the measurement of the acetabular diameter was performed in the anteroposterior view of the pelvic ra-

TABLE 1. Acetabular diameter measured from pelvis radiographs and directly measured in cadaver.

Observer	Direct Measurement (mm.)		Pelvis Radiograph Measurement (mm.)					
			Anteroposterior		Iliac oblique		Obturator oblique	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
First	46.01	3.11	54.20*	3.76	47.66	2.84	57.15*	4.31
Second	46.19	3.00	54.41*	3.66	47.69	2.85	57.42*	4.34
Third	46.11	3.03	54.41*	3.60	47.54	2.86	57.30*	4.39
Mean	46.13	3.06	54.27*	3.67	47.63	2.85	57.29*	4.34

*p<0.001

TABLE 2. The intraobserver reliability analysed with one way Anova and intraclass correlation coefficients.

Measurement	First observer		Second observer		Third observer	
	ICC	P-value	ICC	P-value	ICC	P-value
Cadaver	0.9695	<0.0001	0.9673	<0.0001	0.9750	<0.0001
Anteroposterior	0.9632	<0.0001	0.9685	<0.0001	0.9637	<0.0001
Iliac oblique	0.9308	<0.0001	0.9468	<0.0001	0.9431	<0.0001
Obturator oblique	0.9617	<0.0001	0.9696	<0.0001	0.9606	<0.0001

ICC= Intraclass correlation coefficient

diograph, and the commercial template is routinely used to solve the magnification problem and to estimate the size of the acetabulum[1,2] and the prosthesis.

Our study indicated that among the anteroposterior, iliac oblique and obturator oblique views of the cadaver pelvic radiographs, the iliac oblique view gave the most accurate value when compared to the direct measurement from the cadaver pelvis. In addition, the diameter measured from the iliac oblique view was not statistically different from the direct measurement from the cadavers. This may be explained by the less magnification of the iliac oblique view when compared with the others. The closer the distance is to the film cassette, the better the picture (less magnification) that will be obtained. From this study, both the intraobserver and interobserver reliability also showed excellent correlations.

This application may not apply to a deformed acetabulum because in this case a plane of the longest diameter is not predictable. However, the iliac oblique view may still be the most accurate view to template or to use for planning because of the benefit of its magnification. Another limitation may be soft tissue compensation which may be different in the significantly obese patient.

TABLE 3. The interobserver reliability analysed with one way Anova and intraclass correlation coefficients.

Measurement Method	ICC	p-value
Cadaver	0.9943	<0.0001
Anteroposterior	0.9907	<0.0001
Iliac oblique	0.9923	<0.0001
Obturator oblique	0.9927	<0.0001

ICC= Intraclass correlation coefficient

In conclusion, our study supports the view that the diameter of the acetabulum measured from the iliac oblique view can be used as a guide to choose the proper prosthetic size alternatively to the anterior posterior pelvic radiography or commercial template.

Clinical relevance

The clinical application from our study is that the iliac oblique view is the best view of the pelvic radiograph to estimate and measure the acetabular diameter as a guide to choose the proper prosthetic size as the alternative method to using the commercial template with anterior posterior pelvic radiography.

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