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The Radiographic Measurement of the Acetabular Diameter of Cadavers in Comparison to the Direct Measurement

Somboon Wutthipiriyaangkool, MD
Aasis Unnanuntana, MD
Bavornrit Chuckpaiwong, MD
Thossart Harnroongroj, MD
Department of Orthopedics Surgery, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok, Thailand

Abstract

Background: **In the surgical procedure of the acetabulum, especially in the total hip arthroplasty, it is necessary to evaluate the diameter of the acetabulum as a step in the preoperative planning. According to previous studies in the radiographic measurement of the acetabulum, the iliac oblique view gave the most accurate value comparing to the direct measurement of the cadaver pelvis.**

Objective: **To find a new view of radiograph that gives a more accurate measurement than the iliac oblique view**

Materials and Methods: **This 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 their radiographs in 10 positions: 90 degrees (AP view), 80 degree, 70 degree, 60 degree, 50 degree, 40 degree, 30 degree, 20 degree, 10 degree and 0 degree. The cadaver pelvis was placed on the x-ray machine in antero-posterior view and was rotated in 10 degree steps. The direct measurement of the acetabular diameter in the cadaver and the measurements in all views of pelvic radiographs were accomplished by using a Vernier caliper. The landmark to be measured was in the direction from the anterior superior iliac spine to the ischial tuberosity. Intraobserver and interobserver reliability of all methods were evaluated by having 3 physicians each performed 3 measurements. Each observer measured each radiograph 3 times with an interval of 2 weeks between each reading.**

Results: **The mean diameter of the acetabulum measured directly from the cadaver was 44.18 mm. ± 4.44 mm., while those measured from the pelvic radiographs in 90 degree, 80 degree, 70 degree, 60 degree, 50 degree, 40 degree, 30 degree, 20 degree, 10 degree and 0 degree were 56.16 ± 3.97 , 55.14 ± 4.81, 54.13 ± 4.48, 52.67 ± 4.88, 51.59 ± 4.96, 50.74 ± 4.65, 49.13 ± 4.68, 47.63 ± 4.59, 45.47 ± 4.43, and 44.44 ± 4.68 mm. respectively. The 0 degree view gave the most accurate value. The diameters measured from the 0-40 degree views were not statistically different from that obtained from the direct measurement, while the diameters measured from the 50-90 degree views were statistically different (p-value <0.001). The intraobserver and interobserver reliability of the 3 observers showed excellent correlations (p-value <0.001).**

Conclusions: **From our study, the 0-degree view of the pelvic radiograph provided the most accurate value comparing with the direct measurement. The 0-degree view is the best view of the pelvic radiograph for measuring the acetabular diameter as a step in the preoperative planning for hip arthroplasty and as a guide to choose the proper prosthetic size.**

Correspondence address : *Somboon Wutthipiriyaangkool, MD, Department of Orthopedics Surgery, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.*

In the surgical procedure of the acetabulum especially in the total hip arthroplasty, it is necessary to evaluate the diameter of the acetabulum as a step in 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 antero-posterior view of the pelvic radiograph[3,4], but the direct measurement from the radiographs gives an inaccurate value[1,2] because there is a magnification effect from the radiographs[5-8]. Thus, a 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 was designed to determine which measurement of the acetatabular diameter from the cadever pelvic radiographs from 0 to 90 degree give the most accurate result in comparison to the direct measurement from the cadaver, and to determine whether it can be used to estimate the diameter of the acetabulum as an alternative method to the use of commercial template.

Objective

This study was designed to determine which view of the cadaveric pelvic radiographs, from 0- to 90-degree views from which the measurement of the acetatabular diameter was made, gave the most accurate result in comparison to the direct measurement from the cadaver.

Study Design

Experimental study

Materials and Methods

This study was performed with 10 cadavers, 5 males and 5 females, with mean age of 69.7 years (ranged from 42 to 86 years). Twenty hips were studied by taking radiographs in 10 positions. The views selected were 0- to 90-degree views. The cadaveric pelvis was placed on the x-ray machine in antero-posterior view and rotated in 10-degree steps (Figure 1). The direct measurement of the acetabulur diameter in the cadaver and the measurement in all views of pelvic radiographs were accomplished by using a Vernier caliper. The landmark to be measured was in the direction from the anterior superior iliac spine to the ischial tuberosity (Figure 2). Intraobserver and interobserver reliability of all methods were evaluated by having 3 physicians each performed 3 measurements. The 3 observers were not given information about the radiographs nor the identification of the cadaveric pelvic specimen. Each observer independently measured the diameter of the acetabulum from the radiographs and the cadaveric specimen. Data were recorded. All markings from the measurements were removed from the radiographs and then each set of radiographs was circulated to different observers for reading. Each observer measured each radiograph 3 times with an interval of 2 weeks between each reading. None of the radiographs contained any informative landmark. The observers did not know how the radiographs were accessed by the other observers. The same caliper was used in all measurements.

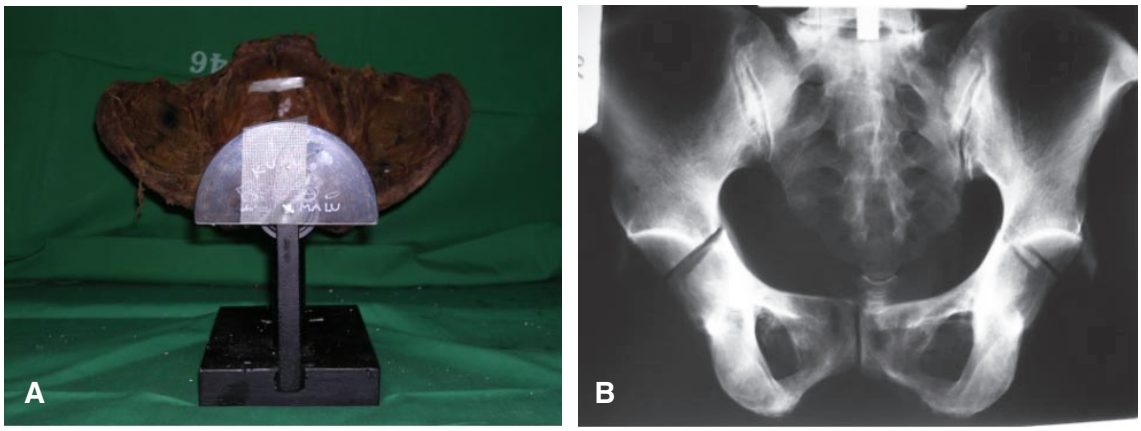

Figure 1 The cadaver pelvis radiographs were taken in 10 views from 0- to 90-degree, this picture shows 90-degree view

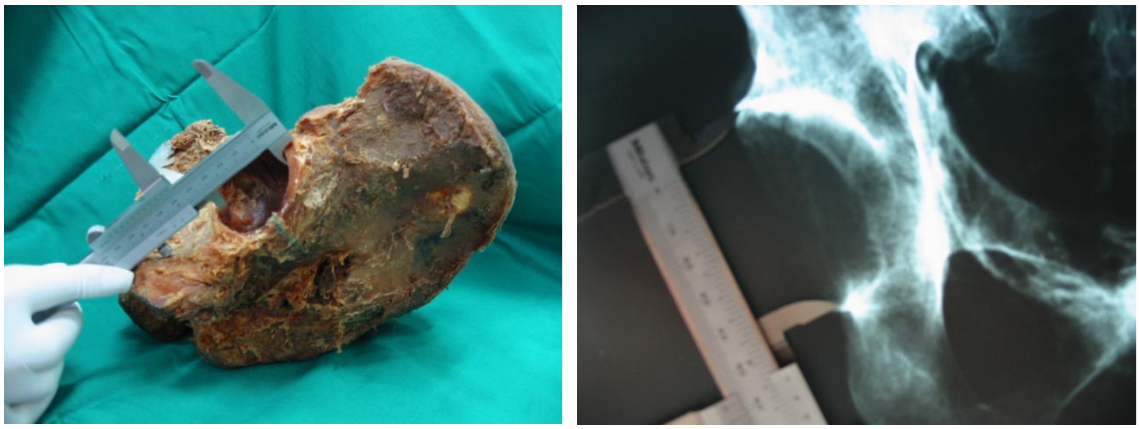

Figure 2 The Vernier caliper was used to measure the diameter of the acetabulum in the cadavers and all views of radiographs

Statistical Analysis

The Scheffe test was used to analyze the acetabular diameters measured from the pelvic radiographs in 0 to 90-degree in comparison to the direct measurement from the cadaver. The intraobserver and interobserver reliability was analyzed with one-way ANOVA and intraclass correlation coefficient

Results

This study was performed in 10 cadavers (5 males and 5 females) with the mean age of 69.7 years (ranging from 42 - 86 years) (Table 1). Twenty hips were studied by taking radiographs in 10 positions. The mean diameter of the acetabulum measured directly from the cadaver was 44.18 ± 4.44 mm., while those measured from the pelvic radiographs in 90-degree, 80-degree, 70-degree, 60-degree, 50-degree, 40-degree, 30-degree, 20-degree, 10-degree, and 0-degree were 56.16 ± 3.97, 55.14 ± 4.81, 54.13 ± 4.48, 52.67 ± 4.88, 51.59 ± 4.96, 50.74 ± 4.65, 49.13 ± 4.68, 47.63 ± 4.59, 45.47 ± 4.43, and 44.44 ± 4.68 mm. respectively.

The 0-degree view gave the most accurate value. The diameters measured from the 0- to 40-degree views were not statistically different from that obtained from the direct measurement, while the diameters measured from the 50- to 90-degree views were statistically different (p-value <0.001) (Table 2). The intraobserver and interobserver reliability of the 3 observers showed excellent correlations (p-value <0.0001).

The intraobserver reliability of the 3 observers showed excellent correlations (p-value< 0.0001) (Table 3), and the interobserver reliability between the 3 observers also showed excellent correlations (p-value < 0.0001) (Table 4).

Table 1 Demographic data

Specimen Number	Age (Years)	Sex
1	66	M
2	68	M
3	85	M
4	70	M
5	86	M
6	46	F
7	72	F
8	63	F
9	79	F
10	66	F

Table 2 The Scheffe test table of the acetabular diameter

Measurement	P-value
90 degrees	<0.001
80 degrees	<0.001
70 degrees	<0.001
60 degrees	0.004
50 degrees	0.028
40 degrees	0.107
30 degrees	0.997
20 degrees	1.000
10 degrees	1.000
0 degrees	1.000

Discussion

It is necessary to evaluate the diameter of the

Table 3 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
Direct	0.9968	<0.0001	0.9981	<0.0001	0.9983	<0.0001
90 degrees	0.9969	<0.0001	0.9959	<0.0001	0.9991	<0.0001
80 degrees	0.9995	<0.0001	0.9990	<0.0001	0.9984	<0.0001
70 degrees	0.9987	<0.0001	0.9977	<0.0001	0.9983	<0.0001
60 degrees	0.9987	<0.0001	0.9975	<0.0001	0.9987	<0.0001
50 degrees	0.9991	<0.0001	0.9993	<0.0001	0.9987	<0.0001
40 degrees	0.9990	<0.0001	0.9981	<0.0001	0.9981	<0.0001
30 degrees	0.9982	<0.0001	0.9983	<0.0001	0.9981	<0.0001
20 degrees	0.9975	<0.0001	0.9980	<0.0001	0.9980	<0.0001
10 degrees	0.9970	<0.0001	0.9982	<0.0001	0.9956	<0.0001
0 degree	0.9980	<0.0001	0.9972	<0.0001	0.9975	<0.0001

ICC = Intraclass correlation coefficient

Table 4 The interobserver reliability analysed with one way Anova and intraclass correlation coefficients

Measurement Method	ICC	P-value
Direct	0.9977	<0.0001
90 degrees	0.9971	<0.0001
80 degrees	0.9989	<0.0001
70 degrees	0.9980	<0.0001
60 degrees	0.9979	<0.0001
50 degrees	0.9990	<0.0001
40 degrees	0.9982	<0.0001
30 degrees	0.9980	<0.0001
20 degrees	0.9977	<0.0001
10 degrees	0.9970	<0.0001
0 degree	0.9974	<0.0001

ICC = Intraclass correlation coefficient

acetabulum as a step in the preoperative planning in order to estimate the size of the acetabular cup in the surgical procedure of the acetabulum[1,2] especially in the total hip arthroplasty. We know that one of the problems of using the radiographs is the magnification effect[5-8]. Such measurement of the acetabular diameter from the radiographs gives an overestimated value. Usually the measurement of the acetabular diameter was performed in the antero-posterior view of the pelvic radiograph, 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. This study is designed to determine which view of the cadaveric pelvic radiographs, among the 0- to 90-degree views from which the measurement of the acetatabular diameter is made, gives the most accurate result in comparison to the direct measurement from the cadaver, and also to determine whether it can be used to estimate the diameter of the acetabulum as an alternative method to the use of the template.

From our study, among the 0- to 90-degree views of the cadaveric pelvic radiographs, the 0-degree view gave the most accurate value comparing to the direct measurement from the cadaveric pelvis. The diameter measured from 0- to 40-degree views were not statistically different from the direct measurement from the cadavers, so the diameter of the acetabulum measured from 0-40 degree views can be used as a guide to choose the proper prosthetic size as an alternative to the use of the commercial template or when the template is not available. In this study, the intraobserver and interobserver reliability also showed excellent correlations.

Clinical Relevance

The results of our study can be applied clinically and demonstrated the best view of the pelvic radiograph for estimating and measuring the acetabular diameter as a guide to choose the proper prosthetic size and as an alternative method to the use of the commercial template.

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