A Comparison of Radiographic Acetabular Measurements in Elderly Patients with and without Osteoarthritis


Detroit Medical Center, McLaren Regional Medical Center, USA.

Abstract

This paper analyzed anatomical similarities and differences of the acetabulum between patients with hip OA, compared to patients without OA. Review of AP pelvic radiographs in patients with femoral neck fractures (patients with OA were excluded) and patients with OA of the hip scheduled for THA. No significant difference exists in AI or CE angle between the 2 groups, but patients without OA had a significantly higher DW ratio. Depth: Width CE angle ratio increased significantly with age in both the entire sample, and in the female-only subgroup. The study provides radiographic means to measure normal values which can serve as a possible reference point for proper prosthesis placement in total hip arthroplasty procedures and in hip fracture repair.

Introduction

Osteoarthritis is a degenerative joint disease affecting the articular cartilage and osseous structures of the affected joints. This disease is more common in women than in men, and has numerous predisposing factors, including previous injury to a joint, obesity, as well as numerous genetic components [1-3]. Primary, or idiopathic, OA has been correlated with femoral acetabular impingement (FAI) and developmental dysplasia of the hip (DDH) [5]. DDH is generally accepted as an etiology of hip OA and is categorized as primary or secondary to dislocation or subluxation.

To better understand acetabular development in patients with primary acetabular dysplasia (PAD), Kobayashi et al., studied the center edge angle (CEA) and Sharp’s angle (acetabular index) of the unaffected contralateral hip of patients diagnosed with unilateral developmental dysplasia of the hip. He noted significant differences in the measurements of children after the age of six years, with the critical point of measurement at twelve years of age. They also found that patients with a CE angle of <15° did not develop a normal acetabulum [6]. Rhee et al. [7] investigated measurements such as the Shenton line in skeletally mature patients to assess proximal femoral subluxation an indication of acetabular dysplasia. Jacobsen et al. [8] describe hip dysplasia and age as being associated with hip OA, using joint-space width <2mm on plain radiographs as the indicator for hip OA.

When assessing hip anatomy on plain films, CEA, Acetabular Index (AI) and Depth:Width (D:W) ratio are commonly used [9]. Accepted normal values for adults for the CEA and AI angles have been established through past research, most notably for younger patients (between 20-30 years of age) [10, 11]. There is limited or no data available pertaining to normal values for CEA, AI and D:W ratio in elderly patients. The elderly population is the sector of the population most notably effected by OA, and therefore most likely to receive orthopedic intervention such as arthroplasty to combat this pathology, or hip fracture repair in the trauma setting.

The purpose of this article is to analyze the anatomical acetabular measurements in elderly patients, and compare these measurements in patients who have already developed osteoarthritis of the hip verses those elderly patients who have not. We will compare these parameters to previously identified normal reference ranges. This may in turn allow us to better understand the anatomical differences driving the needs for arthroplasty, while obtaining an overall improved understanding of the osseous anatomical

*Corresponding Author:
Jason Samona DO,
Detroit Medical Center, McLaren Regional Medical Center, USA.
Tel: 248-9396263
E-mail: jasonsamona@yahoo.com

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variants of the hip. These values may also serve as a guide to the orthopedic surgeon in terms of proper prosthesis placement and need for osseous modification through surgical means to obtain a more anatomically acceptable placement for total arthroplasty components and hip fracture repair prostheses. We hypothesize that there will be marked differences between the two groups in all measurement parameters.

Materials and Methods

This study was an IRB-approved retrospective review preformed on 282 patients at our Institution which is a Level one Trauma Center which also has a robust Arthroplasty service. Pelvic AP radiographs of 141 consecutive patients suffering from acute femoral neck fractures with no evidence of OA and 141 patients diagnosed with symptomatic OA scheduled for THA were included in the study. Patients were excluded from the study if they had previous fractures at the hip in question, neoplastic and post traumatic OA or poor x-rays.

A sample size of convenience was utilized. The data from both groups were collected and compared to one another. All data was obtained from the hospital PACS system (CIS Cerner USA) hip radiographs ranging over a 5 year period. There was no exclusion based on race or gender.

The non-OA group consisted of 49 male patients and 92 female patients. The age range of this group ranged from 33 – 97 years with an average age of 73 years.

The osteoarthritis group consisted of 68 male and 73 female patients. The age range of this group ranged from 33 – 85 years with an average age of 58 years.

Radiographic measurements between the two groups consisted of the center edge angle of Wiberg (CEA, degrees), acetabular depth/width ratio (D:W) and acetabular index (AI, degrees) [12, 13]. Two analysts (CE, JS) made the measurements; the final measurement for each patient was the average of the two observations. The method in which each individual measurement was obtained is explained below:

Center Edge Angle

The CEA was measured according to the protocol described by Wiberg et al. in 1939 [13]. A horizontal line is created on the AP Pelvis radiograph in respect to the patient's orientation, via creating a straight line from the inferior point of one tear-drop line to the inferior point of the contralateral tear-drop line. This “horizontal” could also be recreated by measuring from the inferior margin of one ischium to the inferior margin of the contralateral ischium, thus ensuring accuracy by comparing for parallelism between these two horizontal lines. An angle was then drawn, extending from the lateral edge of the acetabulum to the center of the femoral head and then extending vertically from that point. (Figure 1)

Acetabular Index

The protocol described by Sharp et al. in 1961 was used to obtain this measurement [12]. A line extending from the lateral edge of the acetabulum was made to intersect the inferior point of the tear-drop line. The “horizontal”, as previously described, was used to form a resultant angle when these lines were made to intersect, designated as the acetabular index (Figure 2).

Stulberg and Cooperman et al. set forth the manner in which the depth:width ratio was measured in this paper [14, 15]. A line starting at the superior lateral edge of the acetabulum extended to the more inferior tear-drop, thus designating the acetabular width. A second line, representative of acetabular depth, is drawn perpendicular to the previous line representative of the acetabular width. This depth line began at the center of the width line, and extended to the center most roof of the acetabulum (Figure 3).

For each of the measured parameters (Acetabular index, Depth: Width ratio, and CE angle), as well as for patient age, the effect of diagnosis (OA or fracture) and gender was evaluated with a two-way ANOVA, with post-hoc Fisher's LSD test. For the ANOVAe, alpha was set to 0.05 for main effects, and to 0.10 for interactions. Alpha was then set to 0.05 for post-hoc tests (SigmaPlot 12.0, Systat Software, Inc.).

When it became apparent that there were significant differences in patient age between both diagnostic groups and genders, linear regressions were performed between age and each of our measured parameters, for each gender: diagnosis group. Alpha = 0.05 (Figure 4).

Results (please refer to table 1)

Age: Gender p<0.001 (F>M), Dx p<0.001 (Fx>OA), Interaction p=0.009, Males alone: Fx>OA, p<0.001, Females alone: Fx>OA, p<0.001, OA alone: F NSD M (p=0.055), Fx alone: F > M, p<0.001.

AI: Gender p=0.005 (F > M), Dx p=0.876, Interaction p=0.626 (Figure 5)

DW: Gender p=0.497, Dx p<0.001 (Fx>OA), Interaction p=0.574 (Figure 6)

CEA: Gender p=0.997, Dx p=0.399, Interaction p=0.899 (Figure 7)

Relationship between CEA and AI

If Dysplasia is defined as CEA <= 25

Chi-square p=0.131, power=0.309

If Dysplasia is defined as CEA <= 20

Chi-square p=0.131, power=0.309

Chi-square p=0.131, power=0.407

Using a 3-way CEA dysplasia definition (>25: Normal, 20-25: Dysplasia, <=20: Severely dysplastic)

Chi-square p=0.131, power=0.407

If Dysplasia is defined as AI>=43

Chi-square p=1.000, power=0.047

Chi-square p=0.131, power=0.407

If Dysplasia is defined as AI>=43
Figure 1. Center Edge Angle or Wiberg - Measured as the angle formed between a vertical line and a line formed from the center of the femoral head to the lateral edge of the acetabular roof.

Figure 2. Acetabular Index - Measured as the angle formed between the interischial (analogous to tear - drop to tear - drop line) and the line formed between the lateral edge of the acetabular roof and the tear-drop line.

Figure 3. Acetabular Depth: Width Ratio - Measured as the ratio of the distance of two lines, one line formed from the lateral edge of the acetabular roof and tear drop line and the other perpendicular line extending to the acetabular roof.

Figure 4. Age.
Fracture patients were significantly older than OA patients, both overall and within each gender. Women in the study were significantly older than the men, both overall and within each diagnostic group.

Acetabular Index was not demonstrably related to patient age in any subgroup (p > 0.14). Depth: Width ratio increased significantly with age in both the entire sample, and in the female-only subgroup (p < 0.008); in neither case did the adjusted r^2 exceed 0.039. CE Angle increased significantly with age in both the OA and the OA Female subgroups (p < 0.05); in
There was no demonstrable difference between the two groups in terms of D:W ratio. Although our data did not show any significant differences between the two diagnostic groups with respect to CEA and AI, it has limitations. Plain radiographs are affected by the technique and the position of the pelvis at the time of the x-ray. Perhaps CT scans will show a difference if they are examined. Although this is difficult to do as we do not recommend the routine use of CT scans on patients with arthritis. Also, we did have a difference in the age of our fracture patients compared to those with arthritis. This could be a potential limitation if it had any effect on the different diagnosis group. However the older age of the non osteoarthritic patients is a benefit as it shows that these more elderly patients despite increased age still did not show much change from the OA patients. The OA patients included in this study suffered from severe symptomatic osteoarthritis whom had failed previous non-surgical means of treatment to resolve their symptoms, which would deem them adequate surgical candidates for total joint arthroplasty.

Although our data did not support a direct correlation between acetabular shape and symptoms, which would deem them adequate surgical candidates for total joint arthroplasty. Although these measurements are used in pediatric population to identify DDH and show correlation with OA, this assumption cannot be made in the adult population using these parameters. The DW ratio was significantly different and may be a risk factor for developing OA, but most likely it is a late radiographic finding related to the presence of OA. We do not believe that the acetabular shape will predispose adult patients to the development of OA. The results do not support a direct correlation between acetabular shape and future development of OA. The authors of this study believe the coupling mechanism between the acetabulum and femoral head.
is of greater importance compared to looking at each morphology and radiographic findings in isolation. The measurements of this study provide radiographic means to measure normal values for osseous structures which can serve as a possible reference point for proper prosthesis placement in total hip arthroplasty procedures and in hip fracture repair. Further investigation measuring other hip parameters comparing patients with normal hips to OA hips may be warranted in future studies, along with utilization of these measurements to recreate hip anatomy in the surgical theatre in order to obtain more anatomically acceptable prosthesis placement.

References


