

# Morphometric evaluation of acetabulum

## Acetabulum'un morfometrik olarak incelenmesi

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### Abstract

**Aim:** The acetabulum is a pit located on the outer surface of the hip bone and articulates with the femur head. It consists of three bones: *Os Ilium*, *Os Ischii*, *Os Pubis*. The joining of these three bones starts at 14-16 years and continues until the age of 23. The purpose of this study is to assist clinicians in hip operations by performing morphometric measurements of the acetabulum.

**Methods:** In this observational study, *Os Coxae* in the bone collection were measured in the anatomy laboratory. 96 *Os Coxa* (50 right, 46 left) were used in the Anatomy Department of Erciyes University. With the help of a digital caliper, the following nine parameters were measured on the left and right dry bones separately and evaluated: The mean length between *Corpus Ischii* acetabulum edge and the acetabulum anterior edge (CIAE-AAE), transverse diameter of *Incisura Acetabulum* (IATD), *Incisura Acetabulum* length (IAU), mean acetabulum depth (AD), mean length between the edge of the acetabulum on the inferior side of *Spina Iliaca Anterior* and the posterior edge of the acetabulum (SIAIAK-AKU), *facies lunata* area, *Limbus Acetabuli* length, mean length between the midpoints of *Incisura Acetabuli* and *limbus*, and the shape of the acetabulum. The images obtained from the dry bones were transferred to the computer and the area of *Facies Lunata* and the length of *Limbus Acetabuli* were calculated with ImageJ program.

**Results:** The parameters measured on the right and left sides, respectively, were as follows: CIAE-AAE: 53.04-54.67 mm, IATD: 50.57-51.44 mm, IAU:18.08-20.25 mm, AD: 24.87-22.85 mm, SIAIAK-AKU: 52.38-45.63 mm, mean *Facies Lunata* area 13.25-13.65 cm<sup>2</sup>, *Limbus Acetabuli* length 13.65-3.61 cm (mean 13.63 cm), mean distance between the midpoints of *Incisura Acetabuli* and *limbus*: 56.45-57.12 mm. The acetabulum was straight in 41 bones, irregular in 8, inclined in 27 and angular in 20.

**Conclusion:** We think that these index values of acetabulum we obtained will contribute to clinicians and the literature in hip dislocation and total hip surgeries.

**Keywords:** Acetabulum, Morphometry, ImageJ

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## Introduction

Hip joint is an important anatomical structure that has been researched by various clinical branches such as surgery, orthopedics, radiology, rheumatology, physical therapy for many years [1]. This irregular and flat joint, connecting the lower extremity to the axial skeleton, resides on the pelvic skeleton. The structures that make the joint so important are the acetabulum located on the femur head and pelvis. Acetabulum is the pit which joins the femur head on the outer surface of the hip bone, and it is joined by three bones that make up os coxae: *Os Ilium*, *Os Ishii*, *Os Pubis* [2]. Y cartilage indicates the joining of three separate bones, which begins between the ages of 14-16 years and continues until the age of 23 years. Inside the acetabulum is a horse-shaped joint cartilage and *Fossa Acetabuli* (cotyloid cavity), which is filled with fibroadipose tissue and covered with synovial tissue in the middle. There is a transverse acetabular ligament at the lower edge of this pit. Normally, the acetabulum angles forward by 20–40° and its inclination ranges between 40–50°. Bony acetabulum is wrapped with a fibrocartilage labrum. It has been determined that the labrum contributes 22% to the articulating face of the hip and increases the volume of Acetabulum by 33% [7]. Acetabulum is also becoming important in terms of gender prediction and age determination [3]. Acetabular index, defined by Hilgenreiner in 1925, is a common method for evaluating the Acetabulum roof. In this measurement, the lowest side point of the ilium's Y cartilage, and the most lateral point of the sclerotic Acetabulum are determined. If the anterior and posterior edges seem separate due to pelvic slope, the point where both lines intersect should be taken as the side point of the Acetabulum. The angle between the line that combines these two points and the line (Hilgenreiner) that combines both ilium points is defined as the acetabular index [4,5]. The hip joint is one of the most important anatomical structures which provides the continuous regular movements of the lower extremity.

The acetabulum is an especially important structure for the interventions in the region [1]. Morphology of the front protrusion of acetabulum in total hip arthroplasty carries much clinical importance [6,8]. When total hip arthroplasty (prosthesis) is planned, acetabulum's bone measurement values are needed, which can affect the position and stability of the acetabular component [3]. The diameter and depth of acetabulum are considered during surgical treatment of acetabular fractures [8]. We herein presented the morphometric measurements of the acetabulum and aimed to provide clinical benefit in hip replacement surgeries and hip dislocation treatments with these data.

## Materials and methods

In our study, *Os Coxae* from the bone collection were measured in the anatomy laboratory. We used 96 *Os Coxae* (50 right, 46 left) in the Department of Anatomy at Erciyes University. With the help of a digital caliper, the following nine parameters were measured on the left and right dry bones separately and evaluated: The mean length between *Corpus Ischii* acetabulum edge and the acetabulum anterior edge (CIAE-AAE), transverse diameter of *Incisura Acetabulum* (IATD),

*Incisura Acetabulum* length (IAU), mean acetabulum depth (AD), mean length between the edge of the acetabulum on the inferior side of *Spina Iliaca Anterior* and the posterior edge of the acetabulum (SIAIAK-AKU), *facies lunata* area, *Limbus Acetabuli* length, mean length between the midpoints of *Incisura Acetabuli* and *limbus* and the shape of the acetabulum. The images obtained from the dry bones were transferred to the computer and the area of *Facies Lunata* and the length of *Limbus Acetabuli* were calculated with ImageJ program.

### Statistical analysis

All data obtained from the acetabulum were entered into SPSS Statistics Software (IBM, version 15.0) to obtain mean, maximum, and minimum values. No comparisons could be made between genders because the genders were unknown. Since no two bones belonged to the same individual, the differences between the right and left bones were not statistically analyzed.

## Results

The parameters measured on the right and left sides, respectively, were as follows: CIAE-AAE: 53.04-54.67 mm, IATD: 50.57-51.44 mm, IAU:18.08-20.25 mm, AD: 24.87-22.85 mm, SIAIAK-AKU: 52.38-45.63 mm, mean *Facies Lunata* area 13.25-13.65 cm<sup>2</sup>, *Limbus Acetabuli* length 13.65-3.61 cm (mean 13.63 cm), mean distance between the midpoints of *Incisura Acetabuli* and *limbus*: 56.45-57.12 mm. The acetabulum was straight in 41 bones, irregular in 8, inclined in 27 and angular in 20 (Figure 1).

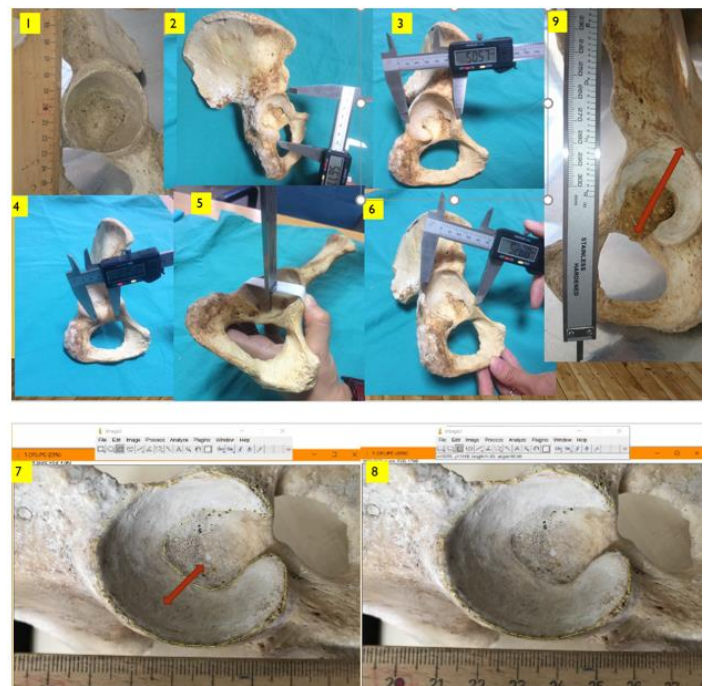


Figure 1: Parameters measured from acetabulum with the help of digital caliper on dry bone 1: Anterior acetabular ridge 2: CIAE-AAE, 3: IATD 4: IAU 5: AD 6: SIAIAK-AKU 7: Area of *Facies Lunata* 8: *Limbus Acetabuli* length 9: Length between the midpoint of *Incisura Acetabuli* and the midpoint of *Limbus Acetabuli*

## Discussion

Acetabulum is one of the most important structures of the hip joint. Deformation and ischemic necrosis of the femur head are two of its clinically significant pathologies [9]. When planning a total hip arthroplasty (prosthesis), the dimensions of acetabulum, which can affect its the size, position, and stability, are considered [3]. The diameter and depth of acetabulum are also of importance in surgical treatment of its fractures [6]. The

transverse diameter of the acetabulum was reported as  $50.99 \pm 1.99$  mm,  $54.29 \pm 3.8$  mm and  $42.54 \pm 3.6$  mm by Devi et al. [6], Taştekin et al. [8] and Parmara et al. [12], respectively. The shape of the acetabulum was mostly curved in the studies of Maruyama et al. [10], Devi et al. [6], Taştekin et al. [8], and Parmara et al. [12]. In our study, acetabulum was rarely irregular. The least found shapes of acetabulum in the study of Taştekin et al. [8], Maruyamada et al. [10], Govsa et al. [11], and Thoudam et al. [14] were irregular, flat, flat, and flat, respectively. Thoudam et al. [14] reported the most common shape of acetabulum as curved. The mean values of AD in various studies were as follows: Salomon et al. [13]:  $30 \pm 3.2$  mm, Devi et al. [6]:  $28.32 \pm 1.32$  mm, Taştekin et al. [8]:  $29.49 \pm 4.2$ , Parmara et al. [12]:  $19.07 \pm 2.47$ , Dhindsa et al. [16], on the right:  $26.7 \pm 2.7$ , on the left  $26.4 \pm 3.0$  mm. The length of incisura acetabulum reported by Taştekin et al. [8] was 16.60-4.01 mm. The values we found in our study were similar to those reported. Gangavarapu and Muralidhar reported the mean AD values as  $24.09 \pm 2.69$  mm on the right and  $25.16 \pm 2.84$  mm on the left. The AD values are important in diagnosing acetabulum-related disorders [15]. Dhindsa [16] also found that values on the right and left sides were close to each other, just as in our study.

### Limitations

Being unable to discriminate between the genders of the bones limited our study.

### Conclusion

We believe that the values of acetabulum we measured will be of use to the clinicians during hip disposition and total hip surgeries and valuable additions to the literature.

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