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The mystery of morphometric measurements of the coxal bone

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Abstract

Coxal bone, which is included in the structure of the pelvic skeleton, is in close relationship with the pelvic organs and great vessels. The aim of this study is to show the harmony between morphometric measurements using the correlation technique, based on the idea that the proportional harmony in different parts of our body will also be in the coxal bone. In the study, 95 dry coxal bone belonging to the Turkish population were examined. In dry bones of adults, the distance between anterior superior iliac spine and posterior superior iliac spine (A), distance between anterior inferior iliac spine and posterior inferior iliac spine (B), distance between anterior superior iliac spine and anterior inferior iliac spine (C), distance between posterior superior iliac spine and posterior inferior iliac spine (D), symphysial surface length (E), symphysial surface width (F), ischial tuberosity width (G), ischion-pubis arm thickness (H), coxal bone length (I), distance between the symphysial surface and the most protruding part of the ischial tuberosity (J) were measured with caliper. There was no statistical difference in the comparison of different measurements made on the right and left coxal bone in our study. In correlation studies, between (B) and (A) (r: 0.566), between (I) and (A) (r: 0.595), between (J) and (A) (r: 0.600), between (E) and (J) (r: 0.563) measurements showed a positive correlation relationship. In this study, excellent agreement was found in different morphometric measurements in coxal bone.

Keywords: Coxal bone, correlation, harmony, clinical, morphometry

Introduction

The human pelvis consists of coxal bone, sacrum, and os coccyx bone to form the pelvic ring. The pelvic skeleton connects the trunk to the lower extremities. The sacrum and coxal bone are bones that participate in the formation of the birth canal [1-2]. The pelvic canal serves as a passageway for reproduction and functions to support the abdominopelvic organs [3]. Therefore, it is clinically important to know the anatomical structure of the bones in this formation, including the coxal bone that forms the pelvic skeleton [1-3].

Most studies on the pelvic bone are on morphometric measurements in sex determination. The pelvis is the best area both metrically and morphologically and gives 95%-98% accurate results [4-5].

One of the most important steps in identifying the skeletal remains is the measurements made on the bones found at the crime scene. Morphomeric measurements of the pelvic bone provide important information about the bone remains found at the crime scene in forensic cases [4]. In particular, the coxal bone shows dimorphism in both sexes due to the direct effects of reproductive

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hormones on bone. Due to its different characteristics, it is still used in sex determination [2].

While determining the chronological age, frequently used osteological structures are hand-wrist bones, clavicle, rib bones, cervical vertebrae, skull bones and coxal bone [6-7]. Studies of coxal bone in the literature have generally been on age and gender determination. However, the variety of studies on coxal bone has increased in the recent past.

Serious pelvic fractures are associated with high mortality in the elderly and high morbidity in the young, and the incidence of pelvic ring injuries is increasing in the general population [8]. Surgical techniques are used to re-establish stabilization of the injured pelvis using a plate/screw fixation structure for pelvic bone reduction [9,10]. Pelvic ring symmetry is considered a surgical rule when creating a patient-specific repair model for the injured pelvic bone in terms of contralateral geometric shape [11-13]. Although the pelvic ring is considered to be a symmetrical entity, asymmetry in the pelvic ring may occur due to changes in its anatomy, function or biomechanics, or when clinical cases are affected by treatment. This condition can also be caused by degenerative or inflammatory processes [14].

It will provide us with an idea to evaluate the presence of symmetry or ascites in the pelvis with the morphological measurements on the coxal bone and the concordance between the measurements. With this study, it is aimed to obtain data that will contribute to the evaluation of the pelvis asymmetry, which is frequently emphasized today, and to develop a perspective.

Materials and Methods

In the study, measurements were made on 95 coxal bones. All bones were obtained from Erciyes University Anatomy Department laboratory. Ethics committee decision was not required since measurement was made in dry bone. However, approval was obtained from the Erciyes University Anatomy Department that the study could be performed. Of these bones, 50 belonged to the right side and 45 belonged to the left side. Sex and age determination could not be made in coxal bone. Measurements were made with a caliper with an accuracy of 0.1 mm. All measurements were repeated by the same person twice. In dry bones, the distance between anterior superior iliac spine and posterior superior iliac spine (A), distance between anterior inferior iliac spine and posterior inferior iliac spine (B), distance between anterior superior iliac spine and anterior inferior iliac spine (C), distance between posterior superior iliac spine and posterior inferior iliac spine (D), symphysial surface length (E), symphysial surface width (F), ischial tuberosity width (G), ischion-pubis arm thickness (H), coxal bone length (I), distance between the symphysial surface and the most protruding part of the ischial tuberosity (J) were measured with caliper. Comparisons between these measurements were made statistically (Figure 1-3).

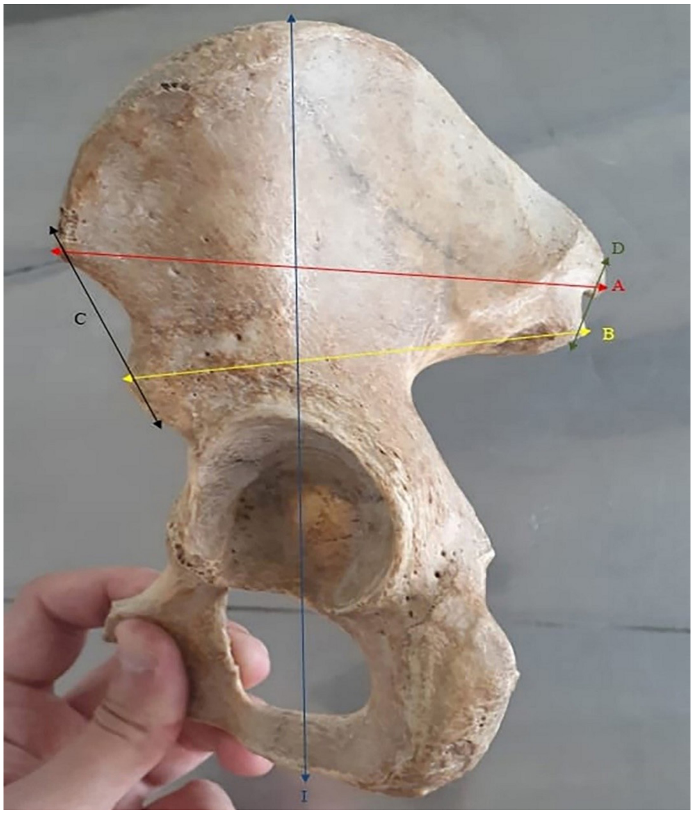

Figure 1. Measured parameters on bone (distance between anterior superior iliac spine and posterior superior iliac spine (A), distance between anterior inferior iliac spine and posterior inferior iliac spine (B), distance between anterior superior iliac spine and anterior inferior iliac spine (C), distance between posterior superior iliac spine and posterior inferior iliac spine (D), coxal bone length (I))

Figure 2. Measured parameters on bone (symphysial surface length (E), symphysial surface width (F))

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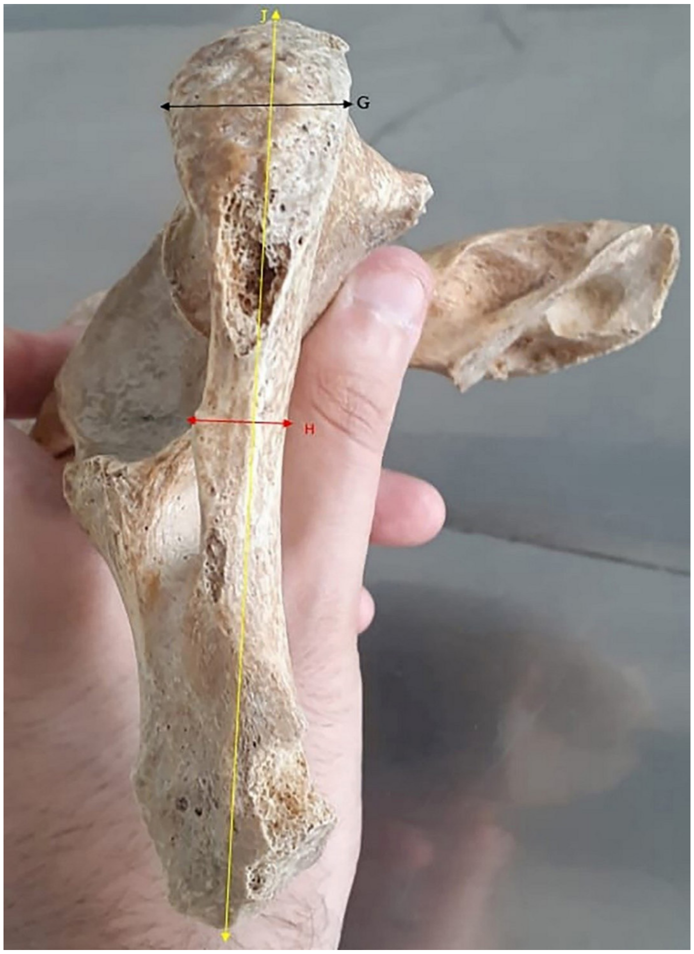

Figure 3. Measured parameters on bone (ischial tuberosity width (G), ischion-pubis arm thickness (H) distance between the symphysial surface and the most protruding part of the ischial tuberosity (J))

Statistical analysis

Descriptive analyses were used in this study. In the measured data, one-sample normal distribution analysis was conducted by testing 5 parameters (skewness-kurtosis, standard deviation/ mean, histograms, Q-Q plots and Shapiro Wilk Test). The normally distributed parameters and those with an adequate number of data points are presented as mean ± standard deviation (MEAN±STD), while the non-normally distributed parameters and those with an inadequate number of data points are presented as median (minimum-maximum). Pearson's correlation (r) analysis was conducted among the parameters that were normally distributed and had an adequate number of data points. The IBM SPSS 23.00 statistics program was used in the analyses in this study.

Results

Measurements were made on 95 dry bones in total. There was no statistically significant difference between the measurements of the right and left coxal bone. Measurements of bones are shown in Table 1.

In the correlation relationship between morphometric measurements; While the correlation between A-E, A-F, B-E, B-F, C-H, B-I, C-I, D-I, E-F, E-I, F-I, G-I, H-I measurements was low positive; It was determined that the correlation between A-B, A-G, A-I, A-J, B-J, E-J, F-G, F-J, G-J and I-J measurements was moderately positive (Table 2).

The acetabulum was also evaluated in the study. Of the 95 acetabulum, 39 were straight, 10 were irregular, 28 were inclined and 18 were angular.

Table 1. Morphometric measurements of coxal bone

	Right (Mean±SD)	Left (Mean±SD)	Sig. (p) value
A	157.84±9.60	153.45±11.38	0.058
B	117.99±8.99	120.29±8.90	0.227
C	45.58±4.43	44.51±3.39	0.205
D	33.01±5.62	34.84±9.01	0.273
E	43.28±5.53	44.80±5.32	0.190
F	22.27±3.49	22.42±3.27	0.842
G	31.86±3.56	30.54±3.57	0.077
H	17.03±1.30	17.20±1.83	0.620
I	198.53±14.03	200.87±12.45	0.403
J	119.92±8.66	119.90±9.45	0.993

Parametric data were shown as Mean±Std and Independent Samples t-Test was used for pairwise comparisons

Table 2. Correlation of morphometric measurements of coxal bone

A		**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
	r	1	0.566^{C}	0.162^{A}	0.208^{A}	0.347^{B}	0.483^{B}	0.543^{C}	0.163^{A}	0.595^{C}	0.600^{C}
	sig(p)		***0.000	0.129	0.051	**0.001	***0.000	***0.000	0.128	***0.000	***0.000
B											
	r	0.566^{C}	1	0.025^{A}	0.032^{A}	0.310^{B}	0.305^{B}	0.436^{B}	0.173^{A}	0.455^{B}	0.524^{C}
	sig (p)	***0.000		0.812	0.766	**0.003	**0.003	***0.000	0.099	***0.000	***0.000
C											
	r	0.162^{A}	0.025^{A}	1	0.096^{A}	0.179^{A}	0.246^{A}	0.126^{A}	0.076^{A}	0.333^{B}	0.259^{A}
	sig (p)	0.129	0.812		0.367	0.088	*0.017	0.223	0.465	0.001	*0.013
D											
	r	0.208^{A}	0.032^{A}	0.096^{A}	1	0.109^{A}	0.161^{A}	0.252^{A}	0.133^{A}	0.307^{B}	0.210^{A}
	sig (p)	0.051	0.766	0.367		0.316	0.134	0.017	0.211	0.003	0.051
E											
	r	0.347^{B}	0.310^{B}	0.179^{A}	0.109^{A}	1	0.412^{B}	0.281^{A}	0.120^{A}	0.468^{B}	0.563^{C}
	sig (p)	0.001	0.003	0.088	0.316		***0.000	**0.007	0.255	***0.000	***0.000
F											
	r	0.483^{B}	0.305^{B}	0.246^{A}	0.161^{A}	0.412^{B}	1	0.522^{C}	0.286^{A}	0.439^{B}	0.677^{C}
	sig (p)	***0.000	**0.003	*0.017	0.134	***0.000		***0.000	**0.006	***0.000	***0.000
G											
	r	0.543^{C}	0.436^{B}	0.126^{A}	0.252^{A}	0.281^{A}	0.522^{C}	1	0.273^{A}	0.423^{B}	0.531^{C}
	sig (p)	***0.000	***0.000	0.223	*0.017	**0.007	***0.000		**0.008	***0.000	***0.000
H											
	r	0.163^{A}	0.173^{A}	0.076^{A}	0.133^{A}	0.120^{A}	0.286^{A}	0.273^{A}	1	0.318^{B}	0.164^{A}
	sig (p)	0.128	0.099	0.465	0.211	0.255	**0.006	**0.008		**0.002	0.118
I											
	r	0.595^{C}	0.455^{B}	0.333^{B}	0.307^{B}	0.468^{B}	0.439^{B}	0.423^{B}	0.318^{B}	1	0.564^{C}
	sig (p)	***0.000	***0.000	**0.001	**0.003	***0.000	***0.000	***0.000	**0.002		***0.000
J											
	r	0.600^{C}	0.524^{C}	0.259^{A}	0.210^{A}	0.563^{C}	0.677^{C}	0.531^{C}	0.164^{A}	0.564^{C}	1
	sig (p)	***0.000	***0.000	*0.013	0.051	***0.000	***0.000	***0.000	0.118	***0.000	

A: no correlation, B: low positive correlation, C: moderate positive correlation, * Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed), *** Correlation is significant at the 0.001 level (2-tailed)

Discussion

Coxal bone is an important bone of the pelvic skeleton. Most studies have focused on morphometric measurements of coxal bone. In most of the morphometric studies, gender-age estimation was made by creating a database of coxal bone [15-17].

It draws attention to clinically important acetabulum measurements in studies of coxal bone. However, there are very few studies that look at the statistical correlation relationship between the measurements of coxal bone. Our study will contribute to the literature in this respect.

Bagci et al. in their study made measurements of the acetabulum. They reported that the most straight type of acetabulum was found on the coxal bone of the Turkish population [17]. Other studies evaluating the shape of the acetabulum [18-20] have reported that the acetabulum is mostly curved. We found the most straight type in our study. Acetabulum shapes were similar to the results of Bağcı et al.'s study. We think that this similarity is due to the study of bones belonging to the same society.

Another study looked at the volume and pelvic morphometry of the coxal bone. It was tried to make a skeletal model of a bone defect of a certain size, suitable for each patient. In this study, it was stated that determining the degree of bone loss and the size of the pelvis specific to each patient can help with appropriate

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preoperative planning, including implant selection. Considering the variability between patients in preoperative planning will increase the success of the surgery [21].

In a study, in which the volume of coxal bone and linear pelvic morphometric measurements were made, measurements were made on 50 coxal bone of cadavers obtained from anatomy laboratories in Australia. In this study, the height of coxal bone was determined as 193±11.0 mm. In our study, the height of the right coxal bone was 198.53±14.03, while the height of the left coxal bone was found to be 200.87±12.45 mm. These results show that the measurement results depending on the race differences also change.

In a study investigating pelvic shape and size in Eastern European men, the mean length of the coxal bone (pelvis) was reported as 151.92±16.81 mm. Pelvis length data in our study is larger [22]. We could not differentiate between genders. Therefore, we think that female pelvis dimensions cause variability in the data. The results obtained from coxal bone will also help in patient-specific planning of the pre-operative and intra-operative operation process.

In a study based on morphometric measurements in the coxal bone, as in our study, to increase the success of these operations due to the high complication rates in pelvic external fixation operations, measurements were made at the morphometric points determined on the ilium.

The average distance between anterior superior iliac spine and ischial tuberosity was 62.36 mm, and the average width between iliac tuberosities was 18.06 mm [23].

In the morphometric study of Demir et al. [24] with 72 dry coxae bones belonging to the Turkish adult population, the distance between spina iliaca anterior inferior and spina iliaca posterior inferior was 117.51±7.70 mm; the distance between spina iliaca anterior inferior and spina iliaca anterior superior was 41.46±5.02 mm, and the distance between spina iliaca posterior superior and spina iliaca posterior inferior was 29.10±5.25 mm reported. In our study, the same measurements on the right were 117.99±8.99, 45.58±4.43 and 33.01±5.62 mm, respectively. We saw that the results of the first measurements were similar, while the results of the second and third measurements were longer. We think that the bones we used in the measurements were due to the fact that they belonged to people living in different regions.

In the study of Sako et al. [25] on the iliac anatomy in women with developmental hip dysplasia, the distance between anterior superior iliac spine and anterior inferior iliac spine was 41±4.5 mm in the patient group and 40.0±4.6 mm in the control group; the distance between anterior superior iliac spine and posterior superior iliac spine was 152.3±8.1 mm in the patient group and 153.5±7.3 mm in the control group. In our study, these measurements were made in healthy individuals. The measurements of the same points in the right bone in our study were 45.58±4.43 mm and 157.84±9.60 mm, respectively. We found that the measurement results in our study were higher. We think that this is due to working in groups with different ethnic origins.

In the study conducted by Vacca and Vella [26] in which they determined the metric characterization of the coxal bone, the coxal bone height was 196,808±10.065, while this measurement was 198.53±14.03 mm in our study. It was seen that the results were close to each other.

Conclusion

In the correlation analysis of the data obtained from our study, we saw the concordance between the measurements. We think that these data will contribute to both pelvic morphometry studies and to increase the success of clinical interventions in the region.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
Ethics Committee approval was not required as it was a dry bone study. A study permit was obtained from the relevant Department where bones were used.

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