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Antropological Measurement of the Sacroiliac Joint

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A B S T R A C T

This study was done on 65 isolated pelvic bones. These cadavers belonged to adult people of mature and old age, and they had no pathological changes. These measurements were performed on osteological collection of Department of Anatomy Drago Perović. Many geometrical parameters of facies auricularis were measured, which we considered important for further studies, simulations of joint's action, transfer calculations of the forces from spine to hip joint. We used paper, which partially adapted to the surface of facies auricularis, so the values are closer to real ones than projection values. The results have shown that the average surface of facies auricularis is 13.46 cm^2. There was no statistical significance found between left and right cadavers. For easier orientation we divided surface of facies auricularis into two parts: vertical and horizontal. Height of the vertical part was 3.99 cm, while the width was 2.05 cm. Height of horizontal part was 2.07 cm and the width 3.62 cm.

Key words: *facies auricularis, sacroiliac joint, pelvic bone, os coxae*

Introduction

Research of the sacroiliac joint started in time of antique. Hippocrates was one of the earliest researchers. Researches continued during the next centuries, up till today, pausing during the middle age, because the section was prohibited. In the modern society with the use of today's imaging methods (like 3D computed tomography, high resolution CT, planar and SPECT bone scintigraphy, magnetic resonance) the knowledge has been especially improved. Despite all that, there are still many unknown facts about function and biomechanic of this joint.

Two bones, whose embryological development is very complex, take part in shaping sacroiliac joint. Os sacrum is developed from five sacral vertebrae, vertebrae sacrales I–V, which grow together into a single bone around age of 15. *Os coxae* is created from three parts: *os ilium*, *os ischii* and *os pubis*. Because of such development frequent variation of this area is not surprising. There are variations in vertical and anteroposterior direction, and in shape of the joint's surface[1,2] (Figure 1 and 2).

This joint is extremely important for the transfer of the forces from the trunk to lower extremities. Authors used to deny movements in sacroiliac joint, while today, many studies showed that, movements in this joint, although relatively small, are very important[1,3], which is best seen in pregnancy and labor[4]. Possible movements, because of inadequacy of joint's surfaces and tight ligaments, are mostly sliding and rotation. Many authors consider rotation around transversal axis, which goes through second sacral segment as most important movement of this joint. This movement is important in flexion and extension of the spine[1]. Still, movements of this joint are shadowed by the movements of the spine. Because of that this joint is mostly noticed only during diseases. Many pathological changes have been described, congenital anomalies, inflammatory diseases, traumatic lesions and neoplastic processes. The importance of this joint in clinical medicine can be seen in the fact that the sacroiliac joint is a source of pain in the lower back and but-

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Fig. 1. Pelvic bone – facies auricularis.

tocks in approximately 15% of the population[5,6]. This pain doesn't have to be caused by some pathological change in the joint itself. Still, there is no reliable clinical method that could define stability of this joint[7]. Many radiological methods for defining pathological changes of this joint have been already described. But X rays can be as hurtful as useful for the patient so it is very important to use them as rarely as possible. That is why it is necessary to know the basic anatomy and biomechanic of this joint. The microscopic anatomy of this joint has been well researched, but for understanding the transfer of the forces it is important to know precise size of the surface of the joint's contact area, which is the goal of this study. It is important for simulations of the walk, results of biomechanical analysis and calculations of the transfer of the forces from the spine to hip joint.

In our references there wasn't many information about surface of the sacroiliac joint, except at the beginning of the last century[8], and in some younger studies centered on something else, while the information about the surface is only signed[9], but these studies do not represent systematic research of *facies auricularis* on larger number of bones. We haven't found any research that accurately measured surface of *facies auricularis*, especially not on this number of bones. Some researches have measured parameters on pictures of bones[10], but they got projection values, which are quite different from real values because of curved *facies auricularis* in all three dimensions and irregular surface. Approximations done on these same bones[11,12] are, by it's definition, larger than actual values. Punctual specification of difference between approximate and actual surface makes it possible for future authors to get more accurate values from approximate on their specimens, and punctual measurements show whether it is justified or not to use approximate values, which is important for future practice.

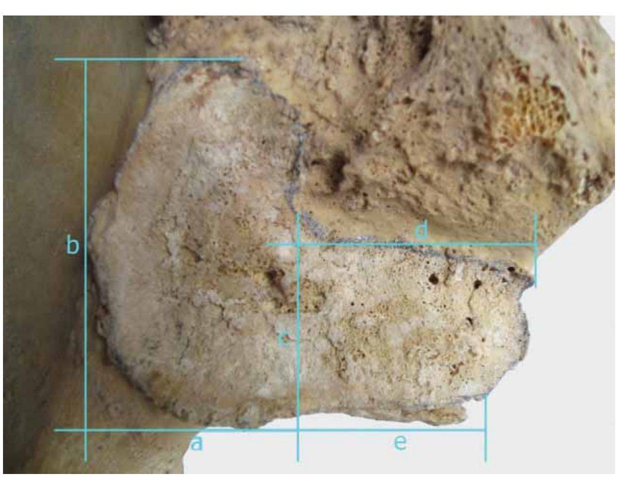

Fig. 2. Facies auricularis of the pelvic bone with measured parameters. a – width of vertical part, b – height of vertical part, c – height of horizontal part, d – cranial width of horizontal part, e – caudal width of horizontal part.

Materials and Methods

65 isolated pelvic bones of the osteological collection of department of Anatomy »Drago Perović« were included in this research. These cadavers belonged to adult people of mature and old age, and they had no pathological changes. But we have to point out that there was no data on bones gender, so we couldn't interpret results in that direction.

We measured 6 parameters, which define width, height and surface area of *facies auricularis* (Figure 3):

a – width of vertical part
b – height of vertical part
c – height of horizontal part
d – cranial width of horizontal part
e – caudal width of horizontal part

It was necessary to take more parameters besides the surface area, because of relatively large variety of shapes, so just the value of surface was not enough to create an image of *facies auricularis*, and especially it didn't pro-

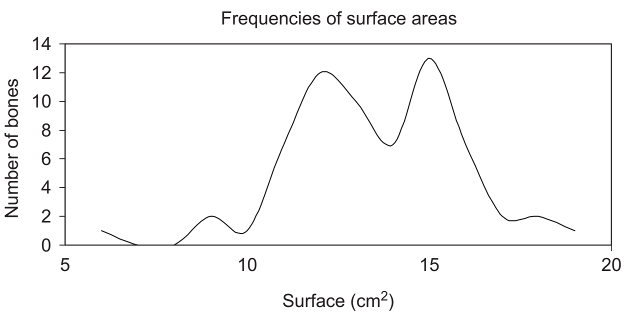

Fig. 3. Frequencies of surface areas of the facies auricularis of the pelvic bone. Most of the specimens had surface between 11 cm^2 and 17 cm^2, with noticeable exceptions. It can also be seen that there are two peaks, which would most likely refer to differences between male and female specimens.

vide more precise simulations of joint's action and calculations of the forces that influence on different parts of joints cartilage and ligaments.

We decided to measure both widths of horizontal part of *facies auricularis* (d and e) because they are often different, and obviously slantwise connected, which is not the case with other parameters.

Surface area was measured with tracing paper, which we attached firmly to the surface, and then by marking the edges we shaped the surface. The paper partially adapted to the surface of *facies auricularis*, so the values are closer to real ones than projection values. All measurements were repeated, to insure the highest accuracy.

The data we got have been statistically analyzed, to get average value, standard deviation, metering error and coefficient of variability. Calculations were done using Microsoft Excel program.

Results

All data have been statistically analyzed, and they are as follow:

Surface (Figure 3): average value was 13.46±0.86 cm^2, standard deviation 2.32. Maximal value was 18.59 cm^2, minimal value 6.42 cm^2, coefficient of variability 17.24. Metering error was ±0.14 cm^2.

a – width of vertical part: average value was 2.0538± 0.1452 cm, standard deviation 0.39. Maximal value was 2.8 cm, minimal value 0.9 cm, coefficient of variability 18.99. Metering error was ±0.05 cm.

b – height of vertical part: average value was 3.9938± 0.1899 cm, standard deviation 0.51. Maximal value was 5.0 cm, minimal value 2.1 cm, coefficient of variability 12.77. Metering error was ±0.03 cm.

c – height of horizontal part: average value was 2.0692± 0.1266 cm, standard deviation 0.34. Maximal value was 2.8 cm, minimal value 1.5 cm, coefficient of variability 16.43. Metering error was ±0.05 cm.

d – cranial width of horizontal part: average value was 3.6200±0.2457 cm, standard deviation 0.66. Maximal value was 4.8 cm, minimal value 2.0 cm, coefficient of variability 18.23. Metering error was ±0.02cm.

e – caudal width of horizontal part: average value was 3.3331±0.2328 cm, standard deviation 0.64. Maximal value was 4.6 cm, minimal value 1.6 cm, coefficient of variability 19.20. Metering error was ±0.02 cm.

We presented results in Table 1, for better view and more simple comparison.

Discussion

We tried to make the most accurate measurements of surface of *facies auricularis* of the pelvic bone. These results will make further researches about this joint easier, simulations of joint's action, calculations of the forces from the spine to the hip joint.

Caudal width of the horizontal part of *facies auricularis* (e) has the largest coefficient of variability. Our predictions about variability of this parameter turned out to be true, and that is why we decided to measure it. Height of vertical part (b) has the smallest coefficient of variability.

Surface that we measured is 30% smaller than Brook's results (1924.), and 20% larger than results which Ebraheim (2003.) got on 30 cadavers. These differences are statistically significant. They can be result from metering error, nonrepresentative sample, difference in regional constitution of people, which could be result from different way of walk and transfer of forces through this joint in different areas of the world.

TABLE 1
RESULTS OF MEASUREMENTS

	Surface	a	b	c	d	e
X	13.46 cm^2	2.0538 cm	3.9938 cm	2.0692 cm	3.6200 cm	3.3331 cm
Standard Error	0.2878	0.0484	0.0633	0.0422	0.0819	0.0794
SD	2.32	0.39	0.51	0.34	0.66	0.64
Maximal value	18.59 cm^2	2.8 cm	5.0 cm	2.8 cm	4.8 cm	4.6 cm
Minimal value	6.42 cm^2	0.9 cm	2.1 cm	1.5 cm	2.0 cm	1.6 cm
Coefficient of variability	17.24	18.99	12.77	16.43	18.23	19.20
Metering error	±0.14 cm^2	±0.05 cm	±0.03 cm	±0.05 cm	±0.02 cm	±0.02 cm

Results for surface are 14% smaller than approximations done on these same bones[11,12]. Approximations were calculated by dividing surface into two rectangles, and by multiplying the length of the edges, which occupied more area, because of the irregularity of *facies auricularis*.

Although the difference between left and right *facies auricularis* of *os sacrum* has already been proved[13], we couldn't prove it for *os coxae*. Difference between average values is not statistically significant, but since we couldn't make left and right pairs, we couldn't make two dependent groups. Size of the specimen probably influenced too. It would be interesting to do such a research, and prove results of more often using of the right hand in the most of the population in this region of the body as well. This influence is a consequence of the transfer of the forces from upper portion of the body to the contra lateral side of the lower, which brings to creation of bigger and stronger structures on that side of the lower body.

Conclusion

Despite many invasive approaches to sacroiliac joint, which are necessary to diagnose or treat different pathological states, there is relatively small number of studies, which are dealing with anatomy of this joint.

With this study we helped building more precise definition of surface of this joint. In full definition of this joint there is a lack of studies about normal morphology of ligaments involved in this joint.

Using these measurements we showed that there are still many unknown things about anatomy of this joint. These results will make further researches about this joint possible, which are important for understanding and treating degenerative changes that effect more and more old people.

Based on measurements of 65 dry bones we conclude that surface of *facies auricularis* is 13. 46 cm^2, and other parameters are as follows: a = 2.0538 cm, b = 3.9938 cm, c = 2.0692 cm, d = 3.6200 cm, e = 3.3331 cm. These results are statistically significantly different than results in our references.

Without understanding basic anatomy, we can not accurately interpret images produced by new methods, and that decreases value of the methods, increases costs of treatment because of the use of more expensive methods, and last but not the least, it is bad for the patients. Considering that it is of great importance to continue with researches like this one, so all the parameters of macroscopical anatomy would be accurately defined, what is very important especially in these days, when precision and evidence based medicine is especially stressed.

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ANTROPOLOŠKO MJERENJE SAKROILIJAKALNOG ZGLOBA

SAŽETAK

Ovo istraživanje je napravljeno na 65 izoliranih zdjeličnih kostiju. Uzorci su pripadali ljudima zrele i starije dobi, i nisu imali nikakvih patoloških promjena. Mjerenja su se vršila na osteološkoj zbirci Zavoda za anatomiju Drago Perović. Mjereno je više geometrijskih parametara *facies auricularis*, koje smo smatrali važnima za daljnja istraživanja, simulacije rada zgloba, proračune prijenosa sila sa kralježnice na zglob kuka. Sva mjerenja su ponavljana kako bi se osigurala što veća točnost. Rezultati su pokazali da prosječna površina *facies auricularis* iznosi 13.46 cm^2. Nije nađena statistički značajna razlika između desnih i lijevih primjeraka. Radi lakšeg snalaženja podijelili smo površinu *facies auricularis* na dva dijela: okomiti i vodoravni. Visina okomitog dijela bila je 3.99 cm, dok širina 2.05 cm. Visina vodoravnog dijela bila je 2.07 cm, a širina 3.62 cm.