DOI: 10.37990/medr.1178662 Med Records 2023;5(1):176-82

MEDICAL RECORDS-International Medical Journal

Research Article

Morphometry and Variation in Os Sacrum

Gokce Bagci Uzun[1], Merve Aydin[1], Burcu Kamasak[2], Busra Zencirci[3], Tufan ULCAY[2], Hidir Pekmez[1], Mehtap Nisari[4]

[1]Malatya Turgut Özal University, Faculty of Medicine, Department of Anatomy, Malatya, Türkiye
[2]Kirsehir Ahi Evran University, Faculty of Medicine, Department of Anatomy, Kirsehir, Türkiye
[3]Adiyaman University, Faculty of Medicine, Department of Anatomy, Adiyaman, Türkiye
[4]Eciyes University, Faculty of Medicine, Department of Anatomy, Kayseri, Türkiye

Abstract

Aim: The merger of the fifth lumbar vertebrae with the first sacral vertebrae is called the sacralisation of the lumbar vertebrae. The purpose of this study, changes in the os sacrum with sacralisation were detected, and morphometric measurements were made.

Materials and Methods: Measurements on 30 sacrum bones in the laboratory from the Department of Anatomy were performed using a digital caliper with a sensitivity of 0.01 millimeters (mm). Os sacrum measurements were taken.

Results: In one of the examined sacrums, it was found that tuberositas ossis sacri had the form of a pit, and on the underside of it, there was a pronounced groove. The processus transverse of the last lumbar vertebra fused with the os sacrum was not noticeably fused. Partial sacralisation was detected in the linea transversa at the anterior junction of the os sacrum and the last lumbar vertebra. It was determined that 21 of the sacrums had four foramina sacralia, and 9 of them had five variational foramina sacralia.

Conclusion: It was determined that structural changes might occur in the sacrum and that the number of foramina sacralia may be different. We believe that knowing the morphometric measurements of the sacrum will guide clinicians in the analysis of sacrum fractures and sacrum.

Keywords: Sacrum, sacralisation, morphometry

INTRODUCTION

The sacrum is formed by the fusion of five sacral vertebras. It is a wedge-shaped bone present between the two hip bones and takes part in forming the bony pelvis. It is triangular with its upper end or base, which articulates with the fifth lumbar vertebra, lower end or apex, which articulates with the coccyx, and its auricular surfaces articulating with the two hip bones in an adult individual (1-3). The anterior surface of this bone is concave, and the posterior surface is convex (1). The process of basis ossis sacri to the front is called promontorium. On the sides of the base, there are joint protrusions called Processus articularis superior. The canal in the os sacrum is called canalis sacralis, and the openness under this canal is called hiatus sacralis (4).

The protrusions on the sides at the apex are called cornu sacrale (5). On its outer side, called the pars lateralis, is a joint face called facies auricularis making a joint with ilium in place. It is ear-shaped. The rough area on the posterior inner side of these articular surfaces, where the ligaments are attached, is tuberositas ossis sacri. On the front of the os sacrum, there are four pairs of holes called foramina sacralia anterior, through which the front branches of the spinal nerves pass. Between these holes are lines called linea transversae, which match the fusion places of the vertebral bodies (4). The os sacrum has three crista structures on the back of the convect. Crista sacralis mediana is formed by the merger of processus spinosus, crista sacralis medialis by the merger of processus articularis, and crista sacralis lateralis by the merger of processus transversus (5). There are four pairs of holes on the back called foramina sacralia posterior (4). Above the bases, part of the basis ossis sacri makes joints with the last lumbar vertebrae. The top part, called apex ossis sacri, joints with os coccygeus. The os sacrum gives strength and stability to the pelvic skeleton (6). The os sacrum, which transmits body weight to the lower extremities,

CITATION
Bagci Uzun G, Aydin M, Kamasak B, et al. Morphometry and Variation in Os Sacrum. Med Records. 2023;5(1):176-82. DOI: 10.37990/medr.1178662

Received: 22.09.2022 **Accepted:** 29.12.2022 **Published:** 15.01.2023
Corresponding Author: Gokce Bagci Uzun, Malatya Turgut Özal University, Faculty of Medicine, Department of Anatomy, Malatya, Türkiye, **E-mail**: gokce.bagciuzun@gmail.com - gokce.bagciuzun@ozal.edu.tr

plays a vital role in the upright posture (7). The merging of the fifth lumbar vertebrae with the first sacral vertebrae is called the sacralisation of the lumbar vertebrae. The combination of the rarer 1st sacral vertebrae with the 5th lumbal vertebra is called the lumbalization of the sacral vertebrae (7, 8). Lumbosacral transitive vertebrae formed in this way are a congenital problem (7). The fusion of the Os sacrum 5th vertebrae and the 1st coccygeal vertebrae is called sacralisation of the coccygeal vertebrae. Lumbar vertebral sacralisation results in the 5th double foramina in the sacrum (8). The vertebral combination in sacralisation can be complete or partial. Sacralisation is more easily distinguishable since the articulation line will be pronounced in partial fusion (9).

Since the lumbar vertebrae will be included in the 5th lumbar vertebrae on the sacrum, more work will fall on the remaining lumbal vertebra joints as the 4th lumbal vertebrae will not behave like the 5th (10). This condition can sometimes cause pain (8-10). Sacralisation can cause spinal radicular pain due to the narrowing of the intervertebral foramina and spinal nerve compression (7). This condition is called Bertolotti syndrome (11). Our aim in our work; The aim is to determine the variation by making morphometric measurements of the sacrum bone and to evaluate the sacrum bone morphometrically by analyzing these measurements. In addition, it is to contribute to both sacral region operations, anatomists, and the literature.

MATERIAL AND METHOD

In this study, measurements on 30 sacrum bones, in the laboratory the from the Department of Anatomy, were carried out using a digital caliper with a sensitivity of 0.01 millimeters (mm). Measurements of the following parameters were taken in the os sacrum.

Parameters for measurements are shown in Fig. 1-4 [10].

1. MVKL: Midventral straight length: Sloping distance between promontorium and anteroinferior sacral border.
2. STW: Superior base width; Maximum transverse length between the dorsocranial corners of facies auricularis.
3. VTW: Ventral base width; Maximum transverse width between the junction points of facies auricularis superior and inferior.
4. DTW: Dorsal base width; The minimum transverse width of the dorsal part of the basis ossis sacri.
5. SVCW: Sacral vertebral corpus width; The first sacral segment is the maximum transverse width.
6. SVCD: Sacral vertebral corpus depth; The first sacral vertebrae is the maximum anteroposterior depth.
7. SVCL: Sacral vertebral corpus length; The length of the first sacral vertebrae sagittal corpus.
8. FADW: Flat width of Facies auricularis; The maximum width of the auricular faces.
9. FADL: Flat length of Facies auricularis. Auricular faces maximum vertical length.
10. PPY: Posterior pediculus height. Distance between the first sacral vertebra superior boundary and the upper limit of the first Sacral foramen.
11. IFAD-IFPD: Distance between anterior boundaries of Processus articularis superiors-Distance between posterior boundaries of Processus articularis superiors.
12. AMFD, PLFD: Anteromedial and posterolateral facet depth: Vertical distances between the first sacral vertebral corpus rear boundary and the frontal planes that pass through the anteromedial and posterolateral boundaries of processus articularis superiors.
13. IPD: Interpedinculus distance, the maximum transverse distance between the first sacral vertebrae pediculus.
14. CSAD: Transverse distance between cornu sacrales.
15. FSPW: Foramina sacralia pelvina width: The maximum transverse widths of the foramen located anterior to the os sacrum.
16. FSPL: Foramina sacralia pelvis length: Maximum longitudinal lengths of foramina in the anterior of Os sacrum.
17. FSDW: Foramina sacralia dorsalia width: Maximum transverse widths of a foramen in the posterior of Os sacrum.
18. FSDL: Foramina sacralia dorsalia length: Maximum longitudinal lengths of a foramen in the posterior of Os sacrum.
19. MLL-MTL: Maximum longitudinal length-Maximum transverse length (Values measured in Foramina Sacralia Dorsalia).

The following indices were calculated to determine the morpho-structural features of the os sacrum and its base.

1. LSI: Longitudinal slope index: Midventral straight length/midventral inclined length x 100.
2. VBI: Ventral base index: Ventral base width/superior base width x 100.
3. DBI: Dorsal base index: Dorsal base width/ superior base width x 100.
4. SHI: Sacral height index: Ventral base width/ midventral straight length x 100.

RESULTS

In one of the sacrums, tuberositas ossis sacri, which is the rough area where the ligaments are attached, was observed to be in the form of a pit on the posterior-inner side of the facies auricularis in the pars lateralis. A prominent groove was detected on the underside of this pit area. The last lumbar vertebrae fused with the os sacrum were found to be noticeably unmapped by the processus transversus (Figure 5) (Figure 6). It was observed that the foramina sacralia formed by the combination of the os sacrum and the last lumbar vertebrae were different from other foramina (Figure 6). It was determined that 21 of the examined sacrums had four foramina sacralia, and 9 of them had variation and five foramina sacraliae (Figure 6). Measurements of right and left foramina were taken. Variated and normal sacrums and MLL and MTL values were not statistically significant (p>0.05) (Table 1). In sacrum measurements, 21 normal sacrum and nine variation sacrum values MVIL, DBW, SBW, SVCW, IFPD, AMFD, PLFD, IPD, IFPD, and DBI values were found to be statistically significant (p<0.05) (Table 1).

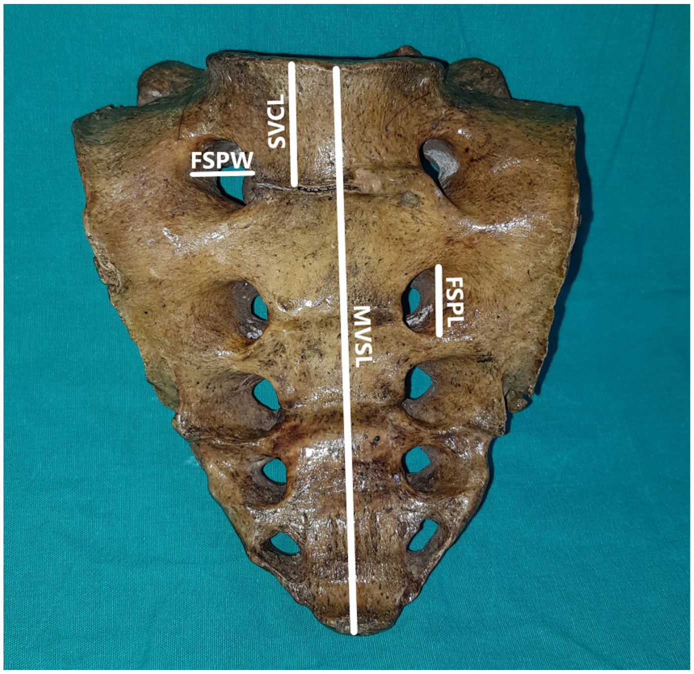

Figure 1. Anterior (facies pelvina) view of the os sacrum

MVSL: Midventral straight length, SVCL: Sacral vertebral corpus length, FSPW: Foramina sacralia pelvina width, FSPL: Foramina sacralia pelvina length

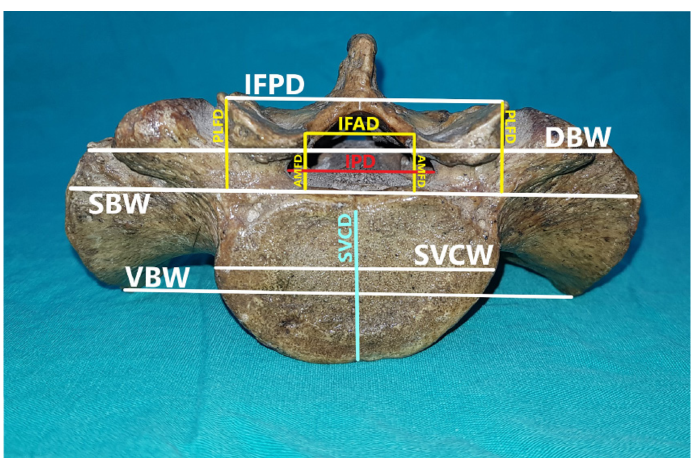

Figure 2. MSuperior view of the os sacrum

VBW: Ventral base width, SVCW: Sacral vertebral corpus width, SBW: Sacral base width, AMFD: Anteromedial facet depth, PLFD: Posterolateral facet depth, DBW: Dorsal base width, IFAD: Interfacet anterior distance, IFPD: Interfacet posterior distance, IPD: Interpedinculus distance

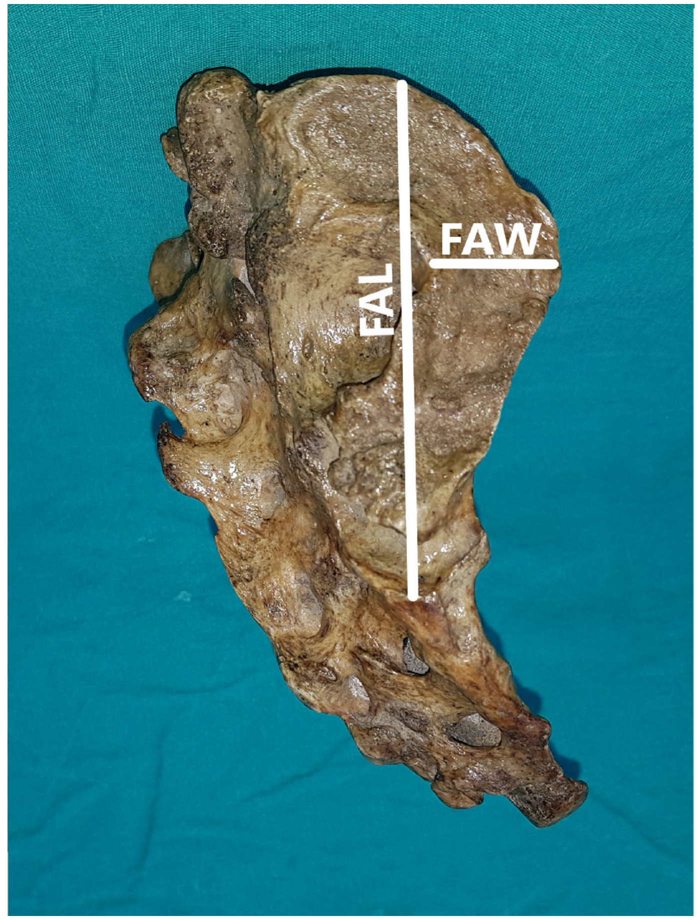

Figure 3. MLateral view of the os sacrum

FAL: Facies auricularis length, FAW: Facies auricularis width

Figure 4. Dorsal (facies dorsalia) view of the os sacrum

CSD: Cornu sacrale distance, PPH: Posterior pediculus height, FSDL: Foramina sacralia dorsalia length, FSDW: Foramina sacralia dorsalia width

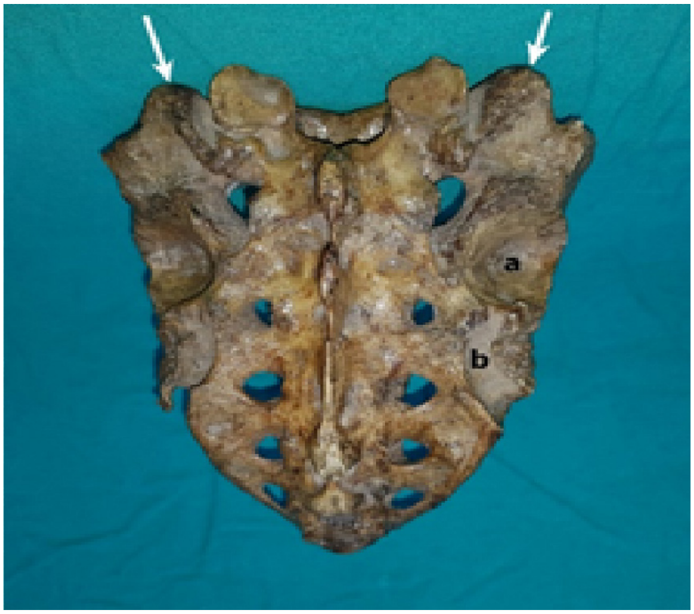

Figure 5. The view of os sacrum from facies posterior (facies dorsalia). a: Tuberositas ossis sacri, b: The prominent sulcus formation, the structures indicated by the white arrows show the processus transversus of the first sacral vertebra, which is not fully fused with the sacrum

Figure 6. The view of the os sacrum from the facies pelvina (facies anterior), five foramina sacraia anterior (arrow) and partial sacralisation is seen in the structure called linea transversa in the circle

Table 1. Normal and variation values on the sacrum bone

Variable	G	N	Mean	Median	SD	Min	Max	25%	50%	75%	T	p
MVSL	N	21	105.95	106.38	13.81	75.9	131.19	95.45	106.38	116.8	-2.64	0.007
	V	9	123.37	117	14.83	112.78	150.34	114.12	117	134.41		
MVIL	N	21	107.01	107.8	12.99	81.9	130.9	97.18	107.8	116.99	-2.87	0.003
	V	9	123.27	124.2	11.33	102.26	135.6	115.71	124.2	132.76		
SBW	N	21	112.88	114.44	9.99	78.77	127.45	109.02	114.44	118.35	-0.973	0.349
	V	9	105.92	112	19.85	55.03	118.3	104.94	112	116.85		
VBW	N	21	107.77	109.9	8.49	84.35	118.7	102.08	109.9	113.66	-0.475	0.657
	V	9	107.26	107.6	6.43	98.14	116.96	102.05	107.6	113.06		
DBW	N	21	90.38	90.9	10.9	71.01	109.9	81.22	90.9	100.78	-3.23	0.001
	V	9	105.62	105.2	7.41	93.05	115.67	100.31	105.2	112.83		
SBW	N	21	112.88	114.44	9.99	78.77	127.45	109.02	114.44	118.35	-4.27	0.000
	V	9	52.36	54.42	6.88	43.1	64.29	45.9	54.42	56.84		
SVCW	N	21	50.39	51.69	7.23	25.26	60.8	48.06	51.69	53.85	-3.91	0.000
	V	9	30.48	29.8	4.91	20.69	36.6	28.59	29.8	35.39		
FAW	N	21	24.54	23.69	5.31	11.92	32.83	21.48	23.69	28.3	-0.068	0.965
	V	9	38.57	19.2	25.79	15.2	77.8	16.84	19.2	61.4		
FAL	N	21	45.81	54.2	20.53	8.25	69.62	22.73	54.2	62.05	-3.91	0.965
	V	9	24.54	19.7	12.49	15.71	55.48	16.43	19.7	27.29		
PPH	N	21	22.86	22.75	2.62	18.8	28.56	21.02	22.75	24.27	-1.06	0.304
	V	9	28.26	23.25	15.47	4.31	56.23	22.56	23.25	39.2		
IFAD	N	21	25.9	25.16	10.65	11.34	57.26	19.45	25.16	30.75	-1.47	0.150
	V	9	37.44	31.44	19.02	13.25	60	19.76	31.44	57.3		

DOI: 10.37990/medr.1178662 Med Records 2023;5(1):176-82

IFPD	N	21	51.83	53.91	12.56	22.03	69.6	45.15	53.91	60.54	-3.91	0.000
	V	9	14.85	7.9	14.45	5.25	47.62	6.5	7.9	21.61		
AMFD	N	21	7.96	7	3.25	3.36	16.71	5.47	7	10.01	-4.09	0.000
	V	9	22.85	20.9	11.09	11.25	46.66	14.89	20.9	28.18		
PLFD	N	21	18.19	17.55	2.82	12.9	24	16.24	17.55	20.6	-3.91	0.000
	V	9	28.61	29.1	4.6	19.06	34.4	26.41	29.1	31.87		
IPD	N	21	33.1	31.4	7.21	25.1	58.24	28.7	31.4	34.56	-3.41	0.000
	V	9	18.05	15.99	8.75	9.3	40	14.1	15.99	18.83		
CSD	N	21	14.06	14.4	4.19	4.1	19.43	10.95	14.4	18.1	-1.69	0.094
	V	9	17.38	17.1	3.71	11.16	22.45	14.63	17.1	20.85		
FSPW	N	21	14.55	15.5	3.8	5.3	18.84	12.6	15.5	17.75	-1.92	0.056
	V	9	21.88	17.15	13.51	14	57.3	15.76	17.15	21.02		
FSPL	N	21	14.38	15.3	3.27	8.67	20.1	11.79	15.3	16.61	-0.18	0.859
	V	9	89.72	14.3	228.87	8.9	700	11.11	14.3	16.63		
FSDW	N	21	12.25	10.5	5.78	6.3	30.09	8.86	10.5	13	-2.35	0.017
	V	9	158.74	18.2	427.99	8.98	1300	11.95	18.2	20.23		
FADL	N	21	45.81	54.2	20.53	8.25	69.62	22.73	54.2	62.05	-2.24	0.025
	V	9	24.54	19.7	12.49	15.71	55.48	16.43	19.7	27.29		
PPH	N	21	22.86	22.75	2.62	18.8	28.56	21.02	22.75	24.27	-1.06	0.304
	V	9	28.26	23.25	15.47	4.31	56.23	22.56	23.25	39.2		
IFAD	N	21	25.9	25.16	10.65	11.34	57.26	19.45	25.16	30.75	-1.47	0.150
	V	9	37.44	31.44	19.02	13.25	60	19.76	31.44	57.3		
IFPD	N	21	51.83	53.91	12.56	22.03	69.6	45.15	53.91	60.54	-3.91	0.000
	V	9	14.85	7.9	14.45	5.25	47.62	6.5	7.9	21.61		
AMFD	N	21	7.96	7	3.25	3.36	16.71	5.47	7	10.01	-4.09	0.000
	V	9	22.85	20.9	11.09	11.25	46.66	14.89	20.9	28.18		
PLFD	N	21	18.19	17.55	2.82	12.9	24	16.24	17.55	20.6	-3.91	0,000
	V	9	28.61	29.1	4.6	19.06	34.4	26.41	29.1	31.87		
IPD	N	21	33.1	31.4	7.21	25.1	58.24	28.7	31.4	34.56	0	0.084
	V	9	18.05	15.99	8.75	9.3	40	14.1	15.99	18.83		
CSD	N	21	14.06	14.4	4.19	4.1	19.43	10.95	14.4	18.1	-1.69	0.094
	V	9	17.38	17.1	3.71	11.16	22.45	14.63	17.1	20.85		
FSPW	N	21	14.55	15.5	3.8	5.3	18.84	12.6	15.5	17.75	-1.92	0.056
	V	9	21.88	17.15	13.51	14	57.3	15.76	17.15	21.02		
FSPL	N	21	14.38	15.3	3.27	8.67	20.1	11.79	15.3	16.61	-0.18	0.859
	V	9	89.72	14.3	228.87	8.9	700	11.11	14.3	16.63		
FSDW	N	21	12.25	10.5	5.789	6.3	30.09	8.86	10.5	13	-2.35	0.017
	V	9	158.74	18.2	427.99	8.98	1300	11.95	18.2	20.23		
FSDL	N	0	12.3	11.86	3.27	7.16	19.9	9.9	11.86	13.79	-1.99	-1.99
	V	0	15.74	17.91	4.290	8.98	20.5	11.95	17.91	19.58		
LSI	N	0	99.46	95.73	11.44	87.39	128.48	91.64	95.73	105.11	-0.24	0.824
	V	0	100.62	97.81	12.97	84.07	121.91	89.28	97.81	110.67		
VBI	N	0	95.77	95.74	6.19	80.04	107.08	92.21	95.74	99.79	-0.38	0.722
	V	0	107.6	95.5	39.45	89.29	212.54	92.27	95.5	97.96		
DBI	N	0	80.59	79.75	10.97	55.72	98.87	71.5	79.75	89.9	-3.28	0.001
	V	0	104.43	95.04	29.64	87	182.12	90.58	95.04	102.25		
SHI	N	0	86.629	87.72	14.24	56.92	104.47	76.32	87.72	99.89	-0.29	0.790
	V	0	86.48	88.07	10.17	66.66	102.46	79.79	88.07	92.29		

G: Group, Min: Minimum, Max: Maximum, SD: Standard Deviation D: Variable N: number of bones, T: Test value; Mann Whitney-U Test Value, p: p<0.05; (statistically significant difference between groups)

DISCUSSION

Os sacrum is a vital bone included in the field of fusion and stabilization in the treatment of sacral, lumbosacral, and sacroiliac deformities or injuries. The development of the sacrum resembles the boning of a typical spinal cord. The secondary centers of ossification appear after puberty, and all sacral vertebrae begin to fuse. The secondary centers of ossification appear after puberty, and all sacral vertebrae start to fuse. Any defect in the formation of primary centers causes the missing formation of the sacral canal and incomplete ossification of the layer (5,12). The convergence of the lumbal sacral vertebrae occurs as an innate anomaly. The incidence of this anomaly is between 3.6% and 18% in humans and is usually bilateral. This anomaly is caused by defects that occur during the development of lumbosacral segmentation. This is indicated as an anatomical variation (3). The sacrum bone is a critical bone in the determination of sex in death cases and is used in morphometric measurements of the bone (13). In a study, it was found that the width of the sacrum S1 corpus was lower in women than in men (14). In addition, accurate determination of the anatomical position of vertebrae in spinal surgery is essential for the prevention of errors (3, 15).

In their study of 52 sacrum bones, Yilmaz et al., (2018) calculated the average distance between the cornu sacrale and the standard deviation value as 12.63±3.02mm. In our study of the os sacrum bone, CSD (21 normal bones) / (9 bone variations) was calculated as 14.06±4.19/ 17.38±3.71mm. The CSD value was average and the variation values were not statistically significant. This value was found to be higher than the average values of Yilmaz et al. (12).

Matveeva et al., (2016) measured 72 sacral dry bones by dividing them into 3 groups. While the bones in the first group showed normal articulation, the joints were fused with L5 in the second group and completely ossified with L5 in the third group. They calculated the mean MVSL value as (mm) 107.52±9.18 in normal sacrums, 100.16±11.03 in those that fused from the joints, and 116.67±15.1 in those that completely ossified (10). In the Mahato, (2010) study, the MVSL value was estimated at 102.79±10.09 in the normal sacrum, 94.02±15.63 in part lumbarisation of S1, and 101.53± 69.02 in the full sacralisation of S1 (15). In our study, the MVSL value was measured as 106.38±13.81-117±14.83 mm in normal and variable sacrums. This was statistically significant in the comparison of the two values (p<0.007). Basaloglu et al. (2005) calculated the MVSL value (mm) as 10.43±10.20±1.02 for men and 1.24 for women (14). In our study, the MVSL value in normal sacrums was found to be similar to the value in these studies. Our variation sacrum value was found to be close to the sacrum values in the third group of Matveeva et al.

Matveeva at al., (2016) studies put the MVIL value at an average of 118.77±9.69 mm, SBW value: 112.58±7.45 mm (first group), 112.7±5.83 mm (second group), 114.61±9.75 mm (third group), DBW averaged 88.78±6.88 mm (first group), 91.5±7.2 mm (second group), 86.31±8.74 mm (third group), VBW on average (mm) 106.82±7.67 (first group), 109.37±5.88 (second group), 107.55±7.99 mm (third group), LSI on average, 90.6±4.48 mm (first group), 86.009±6.87 mm (second group), 89.85±4.38 mm (third group), DBI on average (mm), 79.79.08±5.53 mm (first group), 79.84±6.56 mm (second group), 75.45±5.62 mm (third group), SHI on average , 94.96 ± 4.51 mm (first group), 97.09±3.31 mm (second group), 93.98 ± 3.69 mm (third group) (10). Naksuwan et al., (2021), measured SBW value 95.68±119.71 mm in men, 99.29±115.46 mm in women, VBW value ±78.10-10.00 mm in men, and 80.77±109.19 mm in women. In our study, sacrum also found MVIL value statistically significant in comparison with normal (21 bones)-variation (9 bones) 107.8±12.99-124.2±11.33 mm. (p<0.05), SHI: 86.62±14.24 mm (21 bones), 86.48±10.17 mm (9 bones), a comparison was made on bones, and SHI value was statistically significant (p<0.05) (16) Our values were found to be close to third group of Matveeva et al. Additionally, our other values are SBW: 112.88±9.99 (22 bones), 105.92±19.85 (9 bones), DBW: 90.38±10.9 mm (22 bone), 105.62±7.41 mm (9 bones), VTW: 107.77±8.49 mm (22 bones), 107.26±6.43 mm (9 bone), LEI: 99.46±11.44 mm (22 bones), 100.62±12.97 mm (9 bone), calculated.

Naksuwan et al., (2021) and Matveeva et al., (2016) worked on many bones but did not compare with each other (10, 16). In our study, many values were compared with each other in our varied (9 bones), regular (22 bones) study and whether they were statistically significant.

The IPD value measured in sacrum has been studied by many researchers. El Rakhawy et al., (2010), the IPD value was calculated as 25.1. Aly et al., (2013), 43.41 mm. Kapoor et al., (2014), 21.5 mm, Sethi et al., (2015), 29.25 mm. Singh and Jafar, (2018) 25.1 mm. Basaloglu et al., (2005), in their study of 30 men and 30 women, they found a statistically significant difference between 2.4-29.7±2.5 mm men and women ± 31 in men and women (p<0.05) (14,17-20). In our study ±, 33.1±7.21 mm (22 bones), and 18.05±8.75 mm (9 bones) were measured. Singh and Jafar, in the study, the closest to our work, were found close to his work.

Sacralisation can change the biomechanical structure of the body (10). Foramina sacralia dorsalia measurements were taken in the study of Koç et al., (2014). They calculated the highest MTL (FSPL) at 38.68±4.03 mm and did not compare right or left. In our study, the highest MTL values of right and left were looked at and averaged 14.85±2.25-14.082.49 mm, right-left statistically compared and found no significant (p>0.05) (21).

Foramina sacralia dorsalia measurements were taken in the study of Koç et al., (2014). They calculated the highest MTL (FSDL) at 38.68±4.03 mm and did not compare right or left. In our study, the highest MTL values of right and left were looked at and averaged 14.85±2.25-14.082.49 mm, right-left statistically compared and found no significant (p>0.05) (21).

Basaloglu et al. (2005), in their study of 30 men and

30 women on the sacrum: SVCW, measured 52.7±6.1 5-52.6±7.9 mm, finding no statistically significant difference between men and women (p>0.05). Koç et al. (2014) calculated the SVCW value at 49.33±6.74 in their study of 30 sacrums. In our study± 50.39 23 mm (22 bones), and 30.48±4.91 mm (9 bones) were measured. Our value has been found close to the studies carried out (21).

CONCLUSION

As a result, measurements were made on dry bone in our study. Twenty-two normal sacrum measurements and nine variation bone measurements were performed. The varying values were found to be lower than normal sacrum measurements, and there was no statistically significant difference between them in the right-left measurements on the foramina. The sacrums we examined also match the data in the studies. We believe that morphometric measurements related to the sacrum and the detection and diagnosis of variances may benefit clinicians and researchers related to the sacrum.

Financial disclosures: *The authors received no support from any financial institution or organization for this study.*

Conflict of Interest: *The authors declare that they have no competing interest.*

Ethical approval: *In our country, the ethics committee was not taken because the approval of the waste board was not required in the study on dry bone.*

REFERENCES

1. Nastoulis E, Karakasi M-V, Pavlidis P, et al. Anatomy and clinical significance of sacral variations: a systematic review. Folia Morphologica. 2019;78:651-67.
2. Nagar S, Kubavat D, Lakhani C, et al. A study of sacrum with five pairs of sacral foramina in western India. Int J Med Sci Public Health. 2013;2:239-43.
3. Adibatti M, Asha K. Lumbarisation of the first sacral vertebra a rare form of lumbosacral transitional vertebra. Int J Morphol. 2015;33:48-50.
4. Kiapour A, Joukar A, Elgafy H, et al. Biomechanics of the sacroiliac joint: anatomy, function, biomechanics, sexual dimorphism, and causes of pain. Int J Spine Surg. 2020;14:3-13.
5. Standring S EH, Healy JC, Johnson D. . Gray's anatomy. London: Elsevier Churchill Livingstone; 2005, p.794.
6. Koksal I, Usta M, Orhan I, et al. Potential role of reactive oxygen species on testicular pathology associated with infertility. Asian J Androl. 2003;5:95-100.
7. Vaishnav D, Trivedi D, Chaudhary S. Sacralisation of Fifth Lumbar Vertebra: A Case Report. BJKines-NJBAS. 2020;12:671-4.
8. Singh R. Sacrum with five pairs of sacral foramina. Int J Anat Var. 2011;4:139-40.
9. Saha N, Das S, Momin AD. Unilateral Sacralisation-A Case Report. IOSR Journal of Dental and Medical Sciences. 2015;14:46-8.
10. Matveeva N, Papazova M, Zhivadinovik J, et al. Morphologic characteristics of sacra associated with assimilation of the last lumbar vertebra. Folia Morphologica. 2016;75:196-203.
11. Jancuska JM, Spivak JM, Bendo JA. A review of symptomatic lumbosacral transitional vertebrae: Bertolotti's syndrome. Int J Spine Surg. 2015;9:42.
12. Yılmaz S.,at al. Morphometric Evaluation of the Sacrum. Bozok Med J. 2018;8:13-7.
13. Mustafa MS, Mahmoud OM, El Raouf HH, Atef HM. Morphometric study of sacral hiatus in adult human Egyptian sacra: Their significance in caudal epidural anesthesia. Saudi J Anaesth. 2012;6:350.
14. Başaloğlu H, Turgut M, Taşer F, et al. Morphometry of the sacrum for clinical use. Surg Radiol Anat. 2005;27:467-71.
15. Mahato NK. Morphological traits in sacra associated with complete and partial lumbarization of first sacral segment. Spine J. 2010;10:910-5.
16. Naksuwan N, Parasompong N, Praihirunkit P, et al. Sacral morphometrics for sex estimation of dead cases in Central Thailand. Leg Med. 2021;48:101824.
17. ElRakhawy M, Labib I, Abdulaziz E. Lumbar vertebral canal stenosis: concept of morphometric and radiometric study of the human lumbar vertebral canal. Anatomy. 2010;4:51-6.
18. Kapoor Y, Sherke A, Krishnaiah M, Suseelamma D. Morphometry of the lumbar vertebrae and its clinical significance. Sch J App Med Sci. 2014;2:1045-52.
19. Sethi R, Singh V, Chauhan B, Thukral B. A study of transverse diameter of lumbar vertebral canal in North Indian population. Int J Anat Res. 2015;3:1371-75.
20. Singh B, Jafar S. A Comparative morphometric study of sacralised lumbar vertebra with the fifth lumbar and first sacral vertebra. Journal of Medical Science and Clinical Research. 2018;6:965-1.
21. Koç Polat T, Ertekin T, Acer N, Çinar Ş. Sakrum. Morphometrıc evulatıon and calculatıon of joınt surface of sacrum bone. Journal Of Health Scıences. 2014;23:67-73.