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ORIGINAL ARTICLE

Variable Morphology of Sacrum in General Population

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ABSTRACT

Background: One of the large trilateral bones present at the base of the vertebral column is named as sacrum. The body weight transfers from trunk to pelvis and lower extremities. Different studies considering sacral morphological variations are conducted in the western world. The scope and knowledge of these studies in the eastern world is limited. Different sacral anatomies are reported by the scientists.

Objective: The purpose of the study was to investigate and measure thoroughly the variable morphologies of sacrum**.**

Study design: It is an investigational and cross-sectional study facilitated by statistical approach.

Material and Methods: The study was conducted on 223 skeleton samples. These samples were preserved in the anatomy department of Mufti Mehmood Teaching Hospital Dera Ismail Khan and Bacha Khan Medical Complex Swabi during the period from October 2021 to June 2022. The human research ethical committee of the hospital approved the study. The vernier caliper was used to measure the correlation parameters of variability. The morphological features were calculated. The study also calculated the sacral variation incidence. The sacra with any kind of bony defects were excluded from the study.

Results: The anatomical differences reported in the 223 samples were observed to be 59%. Out of the 223 patients the 81 were females and 142 were males. The five variations were reported in the sacral regions, while two samples have the rare sacral variations. The mean age of the included sample was observed to be 44 years. The age of the people whose sacral samples were included in the study was between 21-72 years. The percentage incidence of accessory auricular faces was observed to be 12.5%. The sacral skewness was observed in 24% cases. The 17% showed the transitional vertebra, while sacral spina bifida occulta was seen in 28% samples.

Conclusion: This large scale anatomical study provides information about the apparent changes in the morphology of different sacral variables. This study provides comprehensive data about the different sacral variations. The detailed information about the human sacrum is provided. The apparent identification methods by western medical officers are also considered in this work which may help our medical staff to identify the sacral variations.

Keywords: Sacrum variations, Sacrum morphology, Accessory auricular faces, Transitional vertebra and Sacral spina bifida occulta

INTRODUCTION

One of the highly variable bones of the skeleton is named as sacrum. It is present at the base of the vertebral column. It is one of the large trilateral bones of the skeleton. The in-depth knowledge of sacral variations is necessary for the diagnosis and treatment of the sacral-related diseases[1-2]. The physicians and anatomists are interested in determining the morphology of sacrum. The rare sacrum variations are reported by different studies.

It is the keystone of the Homo sapiens. Sacrum has significant in the human body as it link the iliac bone and spine. It also play vital role in hip stability. It is also known as holly bone. It is also known as hieron ostoun[3]. The names are depicting that the sacrum is the sanctuary of the genitalia. It plays a vital role in protection of genitalia. This is considered the sacred bone of the human body, as it is located at the lower part of the body.

Different studies reported that the sacrum consisted of four bones and five vertebrae. The three longitudinal crests are present on the dorsal surface of the sacrum. The in-depth analysis of numerical and morphological variation of sacrum is required for medical education[4-5]. The techniques used during surgeries can be changed by studying sacrum variations. Sacrum bone has integrative classification. The anatomical variation has the potential effects on female labor. For measuring the capacity of the vaginal delivery, the diameter of the pelvic inlet, outlet and midpelvis are normally assessed. To evaluate the relationship between the sacrococcygeal platform and lower sacrum, the knowledge of the sacral curvature variations and inclination is required. For the treatment of the pelvic arrest the anatomists study the effect of sacral variations on the pelvic outlet[6].

The abundant anatomical divergences are reported in the study. The number of variations in sacral morphology is observed. It also has a higher incidence of numerical variations. For achieving successful results in clinical settings the sacral anatomical variation knowledge is necessary[7-8]. It is the key to achieve better and successful standards not only in clinical settings but also in sacrum related diseases. This knowledge facilitates the surgeon to avoid the surgical complications. It is also vital in forensics identification techniques and obstetrics. The 20% anomalies present in the sacra are considered as significant anomalies[9-10].

MATERIAL AND METHODS

The 223 sacrum samples included in the study were obtained from the anatomical department of Mufti Mehmood Teaching Hospital Dera Ismail Khan and Bacha Khan Medical Complex Swabi during the period from October 2021 to June 2022. The ethical committee of human research approved the study. The skeletons were preserved according to the standard protocols of the hospitals. Out of the 223 patients the 81 were females and 142 were males. The five variations were reported in the sacral regions, while two samples have the rare sacral variations. The calculated mean age of the samples was 44 years. It ranged between 21 to 72 years. The samples with defective bone were excluded from the study

The three investigators observed the variations in the sacra. The differentiating variations compared with the normal variations were recorded. The morphological features of the sacrum were studied as recorded by other anatomists. They classified the features accordingly. The classification was performed according to the classification performed by Albrecht et al., The developmental asymmetry of the sacrum was named as sacral skewness.

The unilateral or bilateral presence, quantity and location of the AAS were determined for its characterization. The auricular surface width and AS diameter and diameter was measured. The sacral SBO characterization was also recorded. The sacral split

account for more than one-fourth of sacral canal was was labeled as degree I, while the other that account for more than one-fourth was labeled as degree II, degree was given to the sacral split that account for more than half, while that account for more than three-fourth was labeled as degree IV. The number and direction of sacral skewness and multiple variations was also calculated for its characterization. The k-independent sample nonparametric test was performed by using SPSS software.

RESULTS

To proceed with this study 223 samples were selected; among them 130 samples have some anatomical differences with an incidence level of about 59 %. The 130 variable samples contain 81 males and 49 females. Overall 223 samples, comprising 142 from males and 81 from females were collected. In this study, five variations of the sacral region were considered, among them, three of the variations are previously identified, and their information is also available in the database, while two rare variations were also found, which are multiple variations and skull asymmetry. The three most common variations are SBO of the sacral, TV, and SBO of the sacral region. The skewness of the skull was observed in 53 samples and its data is represented in the given table 1. The turning of the sacral was observed towards the right side.

Table 1: Skewness of sacral's distribution with respect to gender and location.

Location	No. of male (n)	No. of female	Total samples (n, %)
Left side	11	9	20 (37.7)
Right side	18	15	33 (63)
Total number (%)	29 (54.6)	24 (46)	53 (100)

When the SBO of the sacral region was analyzed, it was observed in 63 samples (27.8 %). All the data related to its four degrees and regions are represented in the tables below. A decrease in the incidence of a degree from 62.8 % to zero was observed.

Table 2: Degree of SBO of sacral region.

Degree	No. of Male (n)	No. of Female (n)	Total Specimens
I	28	12	40 (62.8)
II	9	7	16 (25.0)
III	5	2	7 (12.0)
IV	0	0	(0)
Total Number (%)	42	21	63 (100)

A significant difference exist there (x^2= 46.138; P = 0.0)

Table 3: Segments of SBO of the sacral region.

Degrees (n)					
Segment	I	II	III	IV	Total samples (n, %)
S_{1-2}	26	12	3.0	0.0	41 (63)
S_{2-3}	1.0	0.0	0.0	0.0	1.0 (1.6)
S_{3-4}	6.0	0.0	0.0	0.0	6.0 (9.5)
S_{4-5}	4.0	0.0	0.0	0.0	4.0 (7.5)
S_{3-5}	1.0	0.0	0.0	0.0	1.0 (1.6)
S_{2-5}	0.0	1.0	0.0	0.0	1.0 (1.6)
S_{1-5}	0.0	3.0	4.0	0.0	7.0 (12)
S_S	2.0	0.0	0.0	0.0	2.0 (3.6)
Total samples (n)	40	16	7.0	0.0	63 (100)

About 28 samples of AAS were observed among 223 samples. The boundary or border of ASS was not properly shaped, and an elliptical or oval shape was observed. The exact place of AAS was variable; it may be bilateral or unilateral.

During this research work, multiple variations were observed in the experimental specimens. About eight different variations were included in the course of this work as shown in the below table. About 46 samples had these variations that included about 21 % of incidence sacral. Among these eight variations (LS + sacral asymmetry) was present more abundantly. While three of the variations (AAS+LS), (AAS+ sacral asymmetry), and (lumbarization + sacral asymmetry) were most common in male patients. The three variations were present at the same time in female patients.

Table 4: AAS distribution.

	No. of Male (n)	No. of Female (n)	Total Specimens (n, %)
AAS (unilateral)	6.0	4.0	10 (37.0)
ASS (bilateral)	14.0	4.0	18.0 (63)
Total number (n) (%)	20	8.0	28 (100)

Table 5: Eight Multiple variations in samples.

Variations	No. of Male (n)	No. of Female (n)	Total Specimens (n, %)
AAS along with LS	4.0	0.0	4.0
AAS along with sacral SBO	6.0	3.0	9.0
AAS along with sacral asymmetry	5.0	0.0	5.0
Lumbarization + SBO sacral	2.0	2.0	4.0
Sacral asymmetry + lumbarization	2.0	0.0	2.0
Sacral SBO + LS	2.0	3.0	5.0
Sacral Asymmetry + LS	2.0	8.0	10
Sacral Asymmetry + SBO of sacral	3.0	3.0	6.0
Sacral asymmetry+ AAS+ LS	0.0	1.0	1.0
Total Number	26 (54.0)	20 (46)	46 (100)

When AS and AAS of the sacrum samples were compared, no observable variations between males and females were visualized by statistical analysis and the probability value was greater than 0.05. The given table represents the relations between two characteristics.

Table 6: Relation between AS and AAS of samples.

	No. of males (n= 35, average ± standard deviation)	No. of females (n= 10, average ± standard deviation)	t	P
TDAAS	9.5 ± 3	11.0 ± 2.9	-1.502	0.170
VDAAS	7.5 ± 4.0	11.0 ± 6.1	-1.610	0.122
TDA	28.0 ± 3.0	28.0 ± 3.2	0.521	0.601
VDA	50.0 ± 6.0	49.0 ± 6.5	0.423	0.670

DISCUSSION

With the help of this study, different internal (anatomical) variations of the sacrum were further elaborated within the species of human being. About more than 57 % of different variations are observed within the population. Among the eight different variations of sacrum discussed in this research work, two of the variations were rarely reported, and our study also emphasized these two rarely occurring variations. For these two rarely occurring variations, no database was available, and the exact reason for the initiation of these two variations was not confirmed. These two rarely known variations were skewness of sacrum and multiple variations at the same time[11-12]. By our research, it was found that the multiple variations are not a rarely occurring issue, it is present in 21 % of the sample population of its victims. There is the probability that this multiple variations issue may occur in more than eight fusions which are described in this study. Among these eight variations discussed here, the most common combinations are (AAS + SBO of sacral), and (LS + Skew of sacral) [13].

According to the literature available, the incidence of AAS is more common in America, Turkey, and Greece. In our own population under study, it is observed up to 12 %. However, we cannot infer any appropriate prediction from the above-mentioned data, because it is very limited for the more elaborated conclusion. But we can say that this ASS issue is more prevalent in western culture as compared to the eastern one.

Furthermore, extensive research was made on the number of other parameters like VDA, TDAAS, VDAAS, and TDA, No observable difference was found[14-15]. The morphology of AAS was quite different in different samples of the population when it was compared with the AAS of the western population. Different unnecessary SIJ is present in the lateral region of the sacrum.

From the left side of SIJ, it gets attached with the foramen of the sacrum and at the iliac portion. In the experimental population, the location of AAS was in the posterior region of the crest or at the inferior portion of the crest. Different variations were observed in the samples under experimentation which conclude that there is a huge diversity of localization of AAS. Many researchers provide information about the SBO in the sacral region, the SBO is the most common deformity of the spinal cord[16].

When urinary X-ray photage of more than 3000 people in the western population were analyzed, the SBO was detected in 23 % of the patients with spinal cord disease. When a CT scan of the patients belonging to the middle-east population was observed, the overall 18 % prevalence of SBO issues was observed among patients with spinal cord issues. The X-ray reports of the pelvic region of the European population predicted a very low rate of incidence of SBO. Different variations in the results obtained from different populations may be due to the different methods of sample collection, the usage of different protocols for dealing with the patients, and different ways of analyzing the reports and results[17]. The merits of disease category and classification of different multiple variations also differ among each population. A difference exists between the visual result prediction and a prediction by diagnosing through CT scan and X-ray photographs.

Our results seem more promising, and with less personal error. It does not have any inconsistent results as in the case of other experiments.

The inconsistency in the results of other researchers was may be due to some genetic variations and environmental stress. In order to eradicate this inconsistency, there is a need to study the sacra more elaborately on a large population pool, and coordination of different experts is also required[18-19].

Different groups should study these sacral issues and variations in more detail by reducing the complications. During injecting any medication in the sacral region, the SBO should be considered. There is not an effective identification method for the diagnosis of these multiple variations of the sacrum.[20] .The medical staff usually predict these variations by simply looking at the anterior and posterior iliac spine. During identification by radiography, bilateral symmetry is preferable. The AS and AAS can also be diagnosed by radiography, any negligence may lead to serious issues in the sacral region and a number of clinical manifestations[21-22].

CONCLUSIONS

The anatomical study was performed on a large scale, which gives information about the apparent changes in the morphology of different variables. More comprehensive data about the different sacral variations is obtained in this study. This study will help for detailed information about the human sacrum. The apparent identification methods by western medical officers are also considered in this work which may help our medical staff to identify the sacral variations.

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