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Original Research Paper

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EFFECT OF CORONAL ANGULATION OF SACRAL VESTIBULE S1 ON MORPHOMETRIC ANALYSIS OF SACRAL VESTIBULE USING PLAIN COMPUTED TOMOGRAPHY IN NORTH WEST INDIAN POPULATION

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ABSTRACT **Background:** The present study was aimed to study and develop in-depth understanding of the effect of the coronal angulationof sacral vestibule S1 on morphometry of sacralvestibule in North-West Indian population presenting to our institution, which will go a long way in planning to treat the posterior pelvic injuries with percutaneous screws, thereby reducing the morbidity associated with open fixation. **Methods:** This study was conducted in the Department of Orthopaedics and Radiodiagnosis at Dr Rajendra Prasad Govt.Medical College, Kangra at Tanda over a period of one year. All the patients of the age >18 years and above submitting for either abdominal, lower spinal or non-orthopaedic pathology of pelvic region, presenting for computed tomography to the Department of Radiodiagnosis were included in the study. **Results:** There was no significant difference between coronal angulation of S1 and age-groups i.e. 18-30, 31-40, 41-50, 51-60, and >60 years.There was a significant difference in coronal angulation between age-groups 18-30 and 51-60 years (4.66±1.89 vs. 5.38±3.09; P=0.010), age-groups 18-30 and >60 years (4.66±1.89 vs. 7.17±1.90; P=0.000), age-groups 31-40 and 51-60 years (4.56±2.99 vs. 5.38±3.09; P=0.037), age-groups 31-40 and >60 years (4.56±2.99 vs. 7.17±1.90; P=0.004), age-groups 41-50 and >60 years (5.16±2.90 vs. 7.17±1.90; P=0.020), age-groups 51-60 and >60 years (5.38±3.09 vs. 7.17±1.90; P=0.049). , there was a weak relation between coronal angulation of S1 and age-groups 18-30 years (r=0.054; P=0.497), 31-40 years (r=0.155; P=0.153), 41-50 years (r=0.113; P=0.194), 51-60 years (r=0.048; P=0.478), and >60 years (r=-0.579; P=0.049).There was non-significant difference in coronal angulation of S1 (P=0.701) between males and females. There was a weak relation between interspinus distance with coronal angulation of S1 (r=0.016; P=0.697). There was no relation between height with coronal angulation of S1 (r=0.000; P=0.999). **Conclusion:** The present study, the first of its kind in North Western part of India arrived to help us anthropometricmeasurements of sacral vestibule, thereby, helping in development of local protocols for percutaneous fixation in sacral fracture.

KEYWORDS : Sacral Vestibule,coronal angulation of the Vestibule, Interspinous distance.

INTRODUCTION

The sacral bone is an inverted triangle that sits obliquely between the two innominate bones of the pelvis at the distal aspect of the spinal column. It functions mechanically to convey axial load from the lumbar spine into the lower extremities for balanced locomotion. The ventral sacral body is concave and derived from five vertebrae. The transverse processes of the sacral vertebrae coalesce to form the sacral ala, which projects laterally from the upper sacral promontory.[1]

The standard treatment of unstable sacral fractures is surgical fixation duetoa high incidence of residual morbidity under conservative treatment. The primary goal is anatomic reduction, followed by a rigid fracture fixation. There are several operating techniques like fixation with iliosacral screws or plates, triangular osteosynthesis, ilioiliac (plates, internal fixators, and bars) and trans-sacral screws or bars. In recent years, sacroiliac screws and spinopelvic internal fixators have become the preferred implants for fixation of posterior pelvic ring fractures. Whereas full weight bearing is allowed for most spinopelvic fixations, none or partial weight bearing is recommended for iliosacral screw fixations.[2]

The present study was aimed to study and develop in-depth understanding of the morphometry of sacral vestibule in North-West Indian population presenting to our institution, which will go a long way in planning totreat the posterior pelvic injuries with percutaneous screws, thereby reducing the morbidity associated with open fixation.

Materials and Methods

This study was conducted in the Department of Orthopaedics and Radiodiagnosis at Dr Rajendra Prasad Govt. Medical College, Kangra at Tanda over a period of one year. All the patients of the age >18 years and above submitting for either abdominal, lower spinal or non-orthopaedic pathology of pelvic region, presenting for computed tomography to the Department of Radiodiagnosis were included in the study. The patients were informed about the aims and methods of the study and once consent was given for participation; they were evaluated. The evaluation included clinical assessment for height. This helped to draw comparison while arriving at morphometry of Sacral vestibule.

The following patients were excluded from the study

1. Age < 18 years.
2. The patient with pelvic ring dysmorphism.
3. Osteolytic pelvic lesions.
4. Fractures involving the posterior elements.
5. Post operated cases of above fracture
6. Not willing to participate in the study
7. Implants obscuring the lumbosacral junction.

Each patient and his attendants ware adequately informed about the aims, methods, the anticipated benefits and potential risks of the study and the discomfort it might entail them and the remedies thereof. Every precaution was taken to respect the privacy of the patient, the confidentiality of the patient's information and to minimize the impact of the study on his/her physical and mental integrity and personality. The patients were given the right to abstain from participation in the study or to withdraw consent to participate at any time of the study without reprisal. Due care and caution were taken at all stages of the research to ensure that the patient was put to minimum risk, suffer from no irreversible adverse effects and generally, benefit from and by the research. Written informed consent was obtained from all the patients and attendants included in the study.

The subjects included in this study followed the protocol generally used by the Department of Radiodiagnosis for the conditions mentioned above. The subjects were placed in the supine position with fully extended knee joint with patella facing the sky for CT examination. 3D volume reconstruction of surface anatomy of bony pelvis was then performed using available CT data.

All CT scan were included scanning by anteroposterior tomogram as well as axial images of Sacral Vestibule.All angles were measured at the CT workstation. Measurements of the angles were performed by a junior resident (the investigator) from the Department of Orthopaedics Dr. RPGMC Tanda and were supervised by consulting Orthopaedician and Radiologist.

Following parameters were noted in each patient according to the sex of the patient:

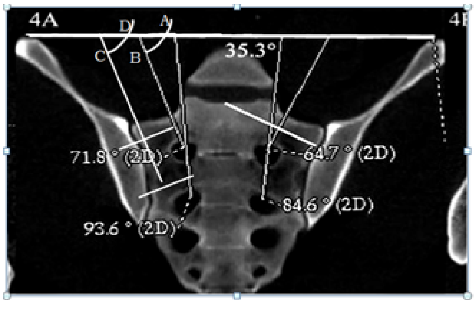
- Age of the patient
- Sex of the patient
- Coronal angulation of vestibule S1
- Interspinus distance

Statistical Analyses

Data were presented as frequency, percentages, and median (inter quartile range; IQR). Difference between quantitative variables was compared using Mann Whitney U test. Spearman correlation coefficient was used to find relation between two variables. P value <0.05 was considered significant. Statistical analyses were performed using SPSS v20.

Coronal Angulation

A coronal angulation was calculated as the angle subtended by a line drawn perpendicular to the axis of the osseous corridor and a line connecting the top of the iliac crests. The axis of coronal CT reformats was reset so that the axis was perpendicular to the superior end plate of the first sacral segment. Reformats were then made perpendicular to the first sacral osseous corridor. It was measured in degrees.



Morphological Analysis of Sacral Vestibule

Coronal Angulation

	S1
Minimum	11°
Maximum	33°
Mean	22.04°±6.59°
Median	22
IQR	16

The coronal angulation of S1 ranged from 11° to 33° with a mean value of 22.04°±6.59°.

Relation with age (Comparative analysis of coronal angulation of S1)

	Age-group	Mean±SD	Min-Max	P Value
S1	18-30a	21.59±6.23	11-33	Pab= 0.340; Pac=0.401 Pad=0.537; Pae=0.597 Pbc=0.684; Pbd=0.484 Pbe=0.992; Pcd=0.765 Pce=0.860; Pde=0.771
	31-40 b	22.60±6.86	11-33	
	41-50c	22.22±6.71	11-33	
	51-60d	22.00±6.67	11-33	
	>60e	22.59±7.04	13-33	
	31-40 b	4.56±2.99	1-10	
	41-50c	5.16±2.90	1-10	
	51-60d	5.38±3.09	1-10	
	>60e	7.17±1.90	5-10	

There was a significant difference in coronal angulation between age-groups 18-30 and 51-60 years (4.66±1.89 vs. 5.38±3.09; P=0.010), age-groups 18-30 and >60 years (4.66±1.89 vs. 7.17±1.90; P=0.000), age-groups 31-40 and 51-60 years (4.56±2.99 vs. 5.38±3.09; P=0.037), age-groups 31-40 and >60 years (4.56±2.99 vs. 7.17±1.90; P=0.004), age-groups 41-50 and >60 years (5.16±2.90 vs. 7.17±1.90; P=0.020), age-groups 51-60 and >60 years (5.38±3.09 vs. 7.17±1.90; P=0.049).

Relation with Age

		Correlation Coefficient (r)	P Value
S1	18-30	0.054	0.497
	31-40	0.155	0.153
	41-50	0.113	0.194
	51-60	0.048	0.478
	>60	-0.579	0.049
	31-40	0.040	0.715
	41-50	-0.085	0.330
	51-60	0.119	0.079
	>60	0.166	0.605

There was a weak relation between coronal angulation of S1 and age-groups 18-30 years (r=0.054; P=0.497), 31-40 years (r=0.155; P=0.153), 41-50 years (r=0.113; P=0.194), 51-60 years (r=0.048; P=0.478), and >60 years (r=-0.579; P=0.049).

Relation with Sex

		Male	Female	P Value
S1	Mean±SD	21.96±6.43	22.15±6.82	0.701
	Median	22	20	
	IQR	7.75	8.0	
	Median	7.0	5.0	
	IQR	6.0	5.0	

There was non-significant difference in coronal angulation of S1 (P=0.701) between males and females.

Relation with Interspinus distance

	Correlation Coefficient (r)	P Value
S1	0.016	0.697

There was a weak relation between interspinus distance with coronal angulation of S1 (r=0.016; P=0.697).

Relation with Height

	Correlation Coefficient (r)	P Value
S1	0.000	0.999

There was no relation between height with coronal angulation of S1 (r=0.000; P=0.999).

DISCUSSION

The sacral vestibule refers to the three-dimensional (3D) screw space that is available in the narrowest part of the iliosacral screw channel. The sacral vestibule is located in the transition zone between the sacral wing and sacral body and serves as the entrance to the sacral vertebrae. The S1 vestibule, located above the sacral foramina and between the sacral foramina and the slope of the sacral wing, is the isthmus of the transition zone between the sacral wing and the S1 vertebrae. The present study was aimed to morphometrically analyze sacral vestibule using CT at Department of Orthopaedics, Dr RPGMC Kangra at Tanda. A total of 610 patients were included in the study. The present study was aimed to study the effect of coronal angulation of the sacral vestibule S1 on morphometric analysis of sacral vestibule using plain computed tomography.

The coronal angulation of S1 ranged from 11° to 33° with a mean value of 22.04°±6.59°. There was no significant difference between coronal angulation of S1 and age-groups i.e. 18-30, 31-40, 41-50, 51-60, and >60 years.There was a significant difference in coronal angulation between age-groups 18-30 and 51-60 years (4.66±1.89 vs. 5.38±3.09; P=0.010), age-groups 18-30 and >60 years (4.66±1.89 vs. 7.17±1.90; P=0.000), age-groups 31-40 and 51-60 years (4.56±2.99 vs. 5.38±3.09; P=0.037), age-groups 31-40 and >60 years (4.56±2.99 vs. 7.17±1.90; P=0.004), age-groups 41-50 and >60 years (5.16±2.90 vs. 7.17±1.90; P=0.020), age-groups 51-60 and >60 years (5.38±3.09 vs. 7.17±1.90; P=0.049)., there was a weak relation between coronal angulation of S1 and age-groups 18-30 years (r=0.054; P=0.497), 31-40 years (r=0.155; P=0.153), 41-50 years (r=0.113; P=0.194), 51-60 years (r=0.048; P=0.478), and >60 years (r=-0.579; P=0.049).There was non-significant difference in coronal angulation of S1 (P=0.701) between males and females.There was a weak relation between interspinus distance with coronal angulation of S1 (r=0.016; P=0.697). There was no relation between height with coronal angulation of S1 (r=0.000;P=0.999).

The proper location and length, to insert iliosacral screws is parallel to the long diameter with the inclination angle of the vestibule; therefore, these both parameters are very important references for the operation. Due to smaller size in these parameters, the insertion location, direction of the screw, and the position relationships between the screws are particularly limited for female patients3. Sacral variations are common in Indian population; however, these parameters are higher than Chinese populations4.

Kaiser et al. measurements showed that coronal angulation of S1 vestibule was 22.6°±11.1°. Our results are in concordance with Kaiser et al5. We observed that after age of 60 years, coronal angulation decreases significantly with age. The above-mentioned results were comparable to our study. Therefore, the placement of iliosacral screws should be considered carefully based on the size, gender, height and ethnicity of the patient.

CONCLUSION

The present study, the first of its kind in North western part of India arrived to help us anthropometric measurements of sacral vestibule, thereby, helping in development of local protocols for percutaneous fixation in sacral fracture.

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