*Asian Journal of Orthopaedic Research*

*3(3): 23-27, 2020; Article no.AJORR.57039*

# Impact of Axial Angulation of Sacral Vestibule S2 on Sacral Vestibule Morphometry: A Plain CT Based Study North West Indian Population

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***Authors' contributions***

*This work was carried out in collaboration among all authors. Author TK designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author SD managed the analyses of the study. Author DK managed the literature searches. All authors read and approved the final manuscript.*

***Article Information***

Editor(s):
(1) Dr. Ikem, Innocent Chiedu, Obafemi Awolowo University, Nigeria.
Reviewers:
(1) Preksha Barot, GMERS Medical College, India.
(2) Liudmila Ivanova, Kuban State Medical University, Russia.
Complete Peer review History: http://www.sdiarticle4.com/review-history/57039

***Original Research Article***

***Received 02 March 2020***
***Accepted 09 May 2020***
***Published 24 May 2020***

## ABSTRACT

**Background:** The present study was done to analyze of the impact of the axial angulation of sacral vestibule S2 on morphometry of sacral vestibule in North-West Indian population scanned in our institute, which will help us in planning to operate the posterior pelvic fractures with closed fixation, thereby avoiding the hazards of open fixation.
**Methods:** This study was done in the Department of Orthopaedics and Radiology at Dr Rajendra Prasad Govt. Medical College, Kangra at Tanda over a period of one year. All the patients of the age more than 18 years submitting for either abdominal or of pelvic pathology, presenting for CT scans to the Department of Radiology in the institute were studied.
**Results:** The axial angulation of S2 ranged from -1° to 8° with a mean of 3.51°±2.88° respectively. There was found significant difference in axial angulation of S2 between age-groups 18-30 and 41-50 years (2.77±1.95 vs. 3.45±2.90; P=0.018), age-groups 18-30 and 51-60 years (2.77±1.95 vs. 3.0±3.46; P=0.001).There was found weak relation between axial angulation of S2 and age-groups 18-30 years (r=0.029; P=0.720), 31-40 years (r=0.009; P=0.937), 41-50 years (r=0.105; P=0.227), 51-60 years (r=0.020; P=0.772) and >60 years (r=-0.226; P=0.479).There existed

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significant difference in axial angulation of S2 (P=0.045) between males and females. There existed weak relation between interspinous distance with axial angulation of S2 (r=0.011; P=0.781).There was found week relation between height with axial angulation of S2 (r=-0.034; P=0.406).

**Conclusion:** This study is the first study of sacral vestibule S2 in North Western part of India which will help us to study anthropometry of sacral vestibule S2, thereby and will help us for planning to operate the posterior pelvic fractures with closed fixation, thereby avoiding the hazards of open fixation.

*Keywords: Sacral vestibule; axial angulation of the vestibule; interspinous distance.*

## 1. INTRODUCTION

The word sacrum was derived from Greek word hieron osteon and was first time used by Romans. A more acceptable explanation may be that the holiness of the sacral bone was an attribute borrowed from the old Egyptians, who considered this bone sacred to Osiris, the god of resurrection and agriculture [1]. The sacrum in human anatomy is a large, triangular bone at the base of the spine, that forms by the fusion of sacral vertebrae S1–S5 between 18 and 30 years of age [2].

The sacral vestibule concept has been desribed by Carlson et al. which is defined as the three dimensional screw channel available in the narrowest part of iliosacral screw channel. It has two components S1 and S2. The S2 is smaller and associated with increased chances of spinal nerve root injury. The S1 vestibule, located above the sacral foramina and between the sacral foramina and the slope of the sacral wing. Anteroposteriorly, the vestibule is dumbbell shaped, but it is elliptical on the saggital section [3].

The accepted treatment of unstable sacral fractures is surgical fixation because of residual morbidity under non surgical treatment. The aim of treatment is anatomic reduction and rigid fracture fixation. There are many surgical methods like iliosacral screws fixation or plates, triangular osteosynthesis, ilioiliac and trans-sacral screws or bars. Currently, sacroiliac screws and spinopelvic internal fixators are preferred implants for fixation of posterior pelvic ring fractures. The weight bearing is allowed for most spinopelvic fixations, but none or partial weight bearing is allowed for iliosacral screw fixation techniques [4].

The aim of present study was to analyse the morphometry of sacral vestibule S2 in North-West Indian population , which help in planning for fixation of the posterior pelvic fractures with screws by closed technique thereby avoiding the hazards of open fixation there by reducing the morbidity associated with open fixation.

## 2. MATERIALS AND METHODS

This study was performed in the Department of Orthopaedics and Radiology at Dr Rajendra Prasad Govt. Medical College, Kangra at Tanda over a period of one year. All the patients of the age more than 18 years presentimg for either abdominal and pelvic pathology, presenting for CT scans to the Department of Radiology were studied.

The following patients were not included the study:

1. Age < 18 years.
2. Pelvic ring abnormalties.
3. Metastatic lesions in the pelvis.
4. Fractures of pelvic bones and sacrum.
5. Old operated cases pelvic bones and sacrum.
6. Did Not give consent.
7. In situ Implants obscuring the region of study.

Each patient and his caretakers ware informed about the aims, methods, the anticipated benefits and potential risks of the study. 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.After consent was taken from the patients, the study was performed on them.

During scanning, the subjects were made to lie in supine position with fully extended knee and hip joint.

All CT scans were performed by scanning anteroposterior scans as well as axial sections of

Sacral Vestibule S2. All measurements were taken at the workstation. All the measurements were performed by a junior resident (the investigator) from the Department of Orthopaedics Dr. RPGMC Tanda which were supervised by consulting Orthopaedician and Radiologist.

The following parameters were studied:

- Age of the patient
- Sex of the patient
- Axial angulation of vestibule S2
- Interspinous distance
- Height of the patient

## 2.1 Analysis of Available Statistics

The frequency, percentages and median (inter quartile range; IQR) were calculated. The Whitney U test was used to find the difference between quantitative variables. The relation between two variables was calculated using Spearman correlation coefficient. The significant P value was less than 0.05. The SPSS v20 software was used to perform Statistical analysis.

## 2.2 Axial Angulation

Axial angulation was measured as the angle subtended by a line drawn perpendicular to the axis of the osseous corridor and a line connecting the posterior iliac spines. The axis of axial CT reformats was reset so that the axis was perpendicular to the upper end plate of the second sacral segment. Reformats were then made perpendicular to the second sacral osseous corridor as depicted in Fig. 1.

## 2.3 Morphological Analysis of Sacral Vestibule Axial Angulation

The Table 1 depicts the axial angulation of S2 ranged from -1° to 8° with a mean of 3.51°±2.88°.

## 2.4 Relation with Age (Comparative Analysis of Axial Angulation of S2)

The Table 2 depicts that there existed a significant difference in axial angulation of S2 between age-groups 18-30 and 41-50 years (2.77±1.95 vs. 3.45±2.90; P=0.018), age-groups 18-30 and 51-60 years (2.77±1.95 vs. 3.0±3.46; P=0.001).

**Table 1. Morpholgical analysis of axial angulation of sacral vestibule S2**

| | S2 |
|---|---|
| Minimum | -1° |
| Maximum | 8° |
| Mean | 3.51°±2.88° |
| Median | 3 |
| IQR | 3 |

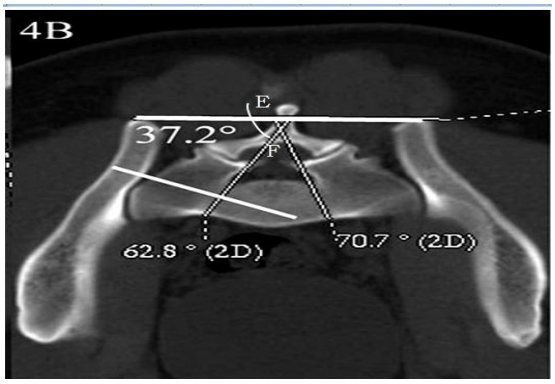


**Fig. 1. Axial section of CT image at S2 EF showing the angle of axial angulation**

## 2.5 Relation with Age

The Table 3 depicts that there existed a weak relation between axial angulation of S2 and age-groups 18-30 years (r=0.029; P=0.720), 31-40 years (r=0.009; P=0.937), 41-50 years (r=0.105; P=0.227), 51-60 years (r=0.020; P=0.772), and >60 years (r=-0.226; P=0.479).

## 2.6 Relation with Sex

The Table 4 depicts that there existed significant difference in axial angulation of S2 (P=0.045) between males and females.

## 2.7 Relation with Interspinous Distance

The Table 5 depicted that there existed a weak relation between interspinous distance with axial angulation of S2 (r=0.011; P=0.781).

## 2.8 Relation with Height

The Table 6 depicts that there existed a weak relation between height with axial angulation of S2 (r=-0.034; P=0.406).

**Table 2. Relation with age (Comparative analysis of axial angulation of S2)**

| | Age groups | Mean±SD | Max-Min | P value |
|---|---|---|---|---|
| S2 | 18-30[a] | 2.77±1.95 | 23-2 | Pab=0.193; Pac=0.018 |
| | 31-40[b] | 3.17±2.90 | 21-3 | Pad=0.001; Pae=0.711 |
| | 41-50[c] | 3.45±2.90 | 23-2 | Pbc=0.496; Pbd=0.179 |
| | 51-60[d] | 3.67±2.92 | 23-2 | Pbe=0.849; Pcd=0.479 |
| | >60[e] | 3.0±3.46 | 21-5 | Pce=0.615; Pde=0.441 |

**Table 3. Relation with age**

| | Age groups | Correlation coefficient (r) | P value |
|---|---|---|---|
| S2 | 18-30 | 0.029 | 0.720 |
| | 31-40 | 0.009 | 0.937 |
| | 41-50 | 0.105 | 0.227 |
| | 51-60 | 0.020 | 0.772 |
| | >60 | 0.226 | 0.479 |

**Table 4. Relation with sex**

| | | Male | Female | P value |
|---|---|---|---|---|
| S2 | Mean±SD | 3.33±2.84 | 3.76±2.92 | 0.045 |
| | Median | 3.0 | 4.0 | |
| | IQR | 5.0 | 5.0 | |

**Table 5. Relation with interspinous distance**

| | Correlation coefficient (r) | P value |
|---|---|---|
| S2 | 0.011 | 0.781 |

**Table 6. Relation with height**

| | Correlation coefficient (r) | P value |
|---|---|---|
| S2 | -0.034 | 0.406 |

## 3. DISCUSSION

The sacral vestibule concept has been suggested by Carlson *et al*. which is defined as the three dimensional screw space present in the narrowest part of iliosacral screw corridor. It has two components S1 and S2. The S2 being smaller and associated with increased chances of spinal nerve root injury. Anteroposteriorly, the vestibule is dumbbell shaped, but it is elliptical on the saggital section [3].

The present study was done to morphometrically analyse the axial angulation of sacral vestibule S2 using plain computed tomography on 610 pateints. The axial angulation of S2 ranged from -1° to 8° with a mean of 3.51°±2.88° respectively. There was found a significant difference in axial angulation of S2 between age-groups 18-30 and 41-50 years (2.77±1.95 vs. 3.45±2.90; P=0.018), age-groups 18-30 and 51-60 years (2.77±1.95 vs. 3.0±3.46; P=0.001).There was found a weak relation between axial angulation of S2 and age-groups 18-30 years (r=0.029; P=0.720), 31-40 years (r=0.009; P=0.937), 41-50 years (r=0.105; P=0.227), 51-60 years (r=0.020; P=0.772), and >60 years (r=-0.226; P=0.479).There existed significant difference in axial angulation of S2 (P=0.045) between males and females. There existed a weak relation between interspinous distance with axial angulation of S2 (r=0.011; P=0.781).There was found a weak relation between height with axial angulation of S2 (r=-0.034; P=0.406). Kaiser et al. measurements showed that axial angulation of S2 vestibule was 3.4 ± 4.6. Our results are in concordance with Kaiser et al. [5].

The iliosacral screw technique has many adventages like stable fixation strength, ver small wound, decreased heamorhage and very low infection rate. This technique does an effective fixation between the middle and posterior columns which properly fits biomechanical characteristics. However, this technique requires high precision for the direction and location of screws [6]. A minor change in trajectory by only 4 degrees can result in cortical perforation and neural damage. [7] Inadequate positioning of screws may damage neurovascular bundle [8]. So, the operating surgeons who does the surgery must understand the anatomy and the spatial arrangements of sacral screw corridors. To be more precise the iliosacral screws should be placed parallel to the long diameter by preoperatively knowing the length and inclination

angle of the available space, hence, these both parameters must be known prior to the fracture fixation [9].

Conflitti et al. studied upper sacral dysmorphism and studied its impact on second sacral segment iliosacral screw insertion using retrospective evaluation of a prospective trauma study. The sacral osseous corridor limits were studied using preoperative pelvic computed tomography at the second sacral osseus corridor. The S2 illiosacral screw sites relative to the sacral nerve root tunnels and the maximum possible length of corridor for S2 illiosacral screws were evaluated with postoperative pelvic CT scans. The S2 screw positions were described as intraosseous, juxtaforaminal, or extruded. They also found sacral dysmorphism in second sacral osseus cooridor [10].

## 4. CONCLUSION

This study is the first study of sacral vestibule S2 in North Western part of India which help us to study anthropometry of sacral vestibule S2, thereby, helping us for preoperative planning to fix the posterior pelvic fractures with closed fixation, thereby and avoiding the hazards of open fixation.

## CONSENT

The patients were informed about the aims and methods of the study and after consent, the study was done.

## ETHICAL APPROVAL

As per international standard written ethical permission has been collected and preserved by the author(s).

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES


1. Sugar O. How the sacrum got its name. JAMA. 1987;257:2061-3.
2. Avaialble:http://www.scientificspine.com/spinal-anatomy/sacrum-anatomy.html (Last accessed on Oct 21, 2018)
3. Carlson DA, Scheid DK, Maar DC, Baele JR, Kaehr DM. Safe placement of S1 and S2 iliosacral screws: the "vestibule" concept. J Orthop Trauma. 2000;14(4): 264-9.
4. Mehta S, Auerbach JD, Born CT, Chin KR. Sacral fractures. J Amer Acad Orthop Surg. 2006;14(12):656-65.
5. Kaiser SP, Gardner MJ, Liu J, Routt ML Jr, Morshed S. Anatomic determinants of sacral dysmorphism and implications for safe iliosacral screw placement. J Bone Joint Surg Am. 2014;96(e120): 1-8.
6. Pohlemann T, Bosch U, Gansslen A, Tscherne H. The hannover experience in management of pelvic fractures. Clin Orthop Relat Res. 1994;305:59-80.
7. Altman DT, Jones CB, Routt ML Jr. Superior gluteal artery injury during iliosacral screw placement. J Orthop Trauma. 1999;13(3):220-7.
8. Routt MLC, Simonian PT, Agnew SG, Mann FA. Radiographic recognition of the sacral alar slope for optimal placement of Iliosacral screws: A cadaveric and clinical study. Journal of Orthopaedic Trauma. 1996;10:171-7
9. Dong Q, Tian W, Ma B. Evaluation and clinical application of sacral S1 vestibule measurements in Chinese adults. Int. J. Morphol. 2014;*32*(1):202-7.
10. Conflitti JM, Graves ML, Chip Routt ML Jr. Radiographic quantification and analysis of dysmorphic upper sacral osseous anatomy and associated iliosacral screw insertions. J Orthop Trauma. 2010;24:630-6.




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