

A MORPHOMETRIC STUDY OF VARIATIONS IN SACRAL HIATUS OF DRY HUMAN BONES

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ABSTRACT

Introduction: The present study was carried out on 100 dry sacra to evaluate the different morphometrical variations of Sacral Hiatus according to sex among the population of west Bengal.

Materials and Methods: The different parameters of 100 Sacrum (50 male, 50 female) were studied by naked eye observation and measured with the help of Martin's callipers.

Observation and results: The most common shape of Sacral Hiatus was Inverted-U shaped, followed by Inverted-V shaped. The apex was most commonly present at the level of 4th Sacral segment and the base of the Sacral Hiatus was present most commonly against the body of 5th Sacral segment. The mean length of the Sacral Hiatus of male Sacra was 19.86mm, whereas that of female Sacra was 21.12 mm.

Conclusion: No significant sexual dimorphism exists considering all the parameters of Sacral Hiatus. There are anatomical variations in the shape and level of the Sacral Hiatus which may lead to failure of caudal anaesthesia.

KEY WORDS: Dry Sacra, Sacral Hiatus, Epidural, Caudal Anaesthesia.

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INTRODUCTION

The Sacrum is a large, triangular, shield-shaped bony structure, at the base of the spine forming postero-superior wall of the pelvic cavity wedged between the two hip bones [1]. The vertebral canal of Sacrum (Sacral canal) runs throughout the greater part of the bone; above, it is triangular in form; below, its posterior wall is incomplete, from the non-development of the laminae and spinous processes. It lodges the Sacral nerves, and its walls are perforated by the anterior and posterior Sacral foramina through which these nerves pass out.

The opening present at the lower end of Sacral canal is known as Sacral Hiatus. Sacral hiatus is

formed, because laminae of fifth Sacral Vertebrae (occasionally fourth), fails to fuse. It is located at the lower end of median Sacral crest inferior to the fourth (or third) fused Sacral spines. The Sacral Hiatus contains lower Sacral and coccygeal nerve roots, filum terminale externum and fibro-fatty tissue. The hiatus is covered by superficial posterior sacrococcygeal ligament which is attached along the margin of the hiatus. the floor of Sacral Hiatus gives attachment to the deep posterior sacrococcygeal ligament.

Sacral Hiatus have been utilized for administration of epidural/caudal anaesthesia in obstetrics as well as in orthopaedic practice

for treatment and diagnosis. The present study is an attempt to evaluate the different morphometrical variations of Sacral Hiatus according to sex among the population of west Bengal, India.

Aims and Objectives: The knowledge of anatomical variations of Sacral Hiatus is significant during administration of caudal/epidural anaesthetic medication. Specific objectives of this study are:

1. Determine the position of apex and base of Sacral Hiatus.
2. To study the degree of variation in shape of Sacral Hiatus.
3. To study the degree of variation in length, antero-posterior diameter and transverse width of Sacral Hiatus.
4. To study sexual dimorphism.

MATERIALS AND METHODS

The measurements of the parameters pertaining to the present study was carried out on 100 dry adult bones (Sacrum) belonging to skeletons of unknown age and stature obtained according to sex (50 Male and 50 Female), determined on the basis of various sex determining reference points [2,3]. These were collected by simple random method over a period of one year between the years 2010 and 2011 from Department of Anatomy and 1st year students of Batch 2011-2012 of Nil Ratan Sircar Medical College, Kolkata. The measurement was done on intact parts of the normal bones. Bones showing fracture or any kind of pathology were not considered.

The different parameters of each Sacrum were studied under the following headings:-

- a) Shape of Sacral Hiatus was noted by naked eye experience.
- b) Level of apex of Sacral Hiatus was noted with respect to Sacral vertebra.
- c) Level of base of Sacral Hiatus was noted with respect to Sacral vertebra.
- d) Length of Sacral Hiatus was Measured from apex to mid-point of base with the help of Martin's calipers.
- e) Antero-posterior diameter of Sacral Hiatus at the apex was measured with the help of Martin's

calipers.

f) Transverse width of Sacral Hiatus at the base was Measured between the inner aspect of inferior limit of Sacral cornua with the help of Martin's calipers.

Data collected by this method has been tabulated according to sex and has been statistically analysed.

OBSERVATIONS AND RESULTS

Observations were made under following headings:

Shape of Sacral Hiatus: There were many variations in the shape of Sacral Hiatus. The most common shape of Sacral Hiatus was Inverted-U shaped, found in 24 (48%) of male and in 32 (64%) of female Sacra.

Table 1: Shape of sacral hiatus.

Parameters	Male (No. And percentage)	Female (No. And percentage)
Inverted-U Shaped	24 (48%)	32 (64%)
Inverted-V Shaped	16 (32%)	13 (26%)
Dumbbell Shaped	1 (2%)	2 (4%)
Irregular	5 (10%)	3 (6%)
Bifid	4 (8%)	0 (0%)

Apex of Sacral Hiatus: The level of the apex was quite variable and extended between middle of 3rd Sacral Vertebra to middle of 5th Sacral Vertebra.

Table 2: Level of Apex of Sacral Hiatus with respect to level of Sacral Vertebra.

Level of apex	Male	Female
3 rd Sacral vertebra	9 (18%)	14 (28%)
4 th Sacral vertebra	38 (76%)	35 (70%)
5 th Sacral vertebra	3 (6%)	1 (2%)

Base of Sacral Hiatus: Base of Sacral Hiatus was present between middle of 4th Sacral segment to the lower end of 5th Sacral segment.

Table 3: Level of Base of Sacral Hiatus with respect to level of Sacral Vertebra.

Level of Base	Male	Female
5 th Sacral Vertebra	45 (90%)	48 (96%)
4 th Sacral Vertebra	5 (10%)	2 (4%)

Length of Sacral Hiatus: The length of the Sacral Hiatus ranged between 7 mm to 45 mm for male Sacra and between 7 mm and 42 mm for female Sacra.

Table 4: Length of Sacral Hiatus from apex to mid-point of base.

Length of Sacral Hiatus (mm)	Male	Female
Lowest value	7	7
Highest value	45	42
Arithmetic Mean	19.86	21.12
Standard Deviation	8.58	9.85

Antero-Posterior diameter of Sacral Hiatus at the apex: In the present study, Sacra having antero-posterior diameter of Sacral Hiatus at apex between 3-6 mm was observed in 37 (74%) of male and 40 (80%) of female Sacra.

Table 5: Antero-posterior Diameter of Sacral Hiatus at the level of apex.

A-P Diameter of Sacral Hiatus at apex (mm)	Male	Female
Lowest value	3	2
Highest value	8	6
Arithmetic Mean	4.66	4.34
Standard Deviation	1.26	1.04



Fig. 1: Inverted U-shaped Sacral Hiatus.



Fig. 2: Inverted V-shaped sacral hiatus.



Fig. 3: Dumbbell shaped Sacral Hiatus.

Transverse width of Sacral Hiatus at the base:

In the present study, it has been found that the range of transverse width of Sacral Hiatus at base varies from 5-14 mm in both male and female Sacra.

Table 6: Transverse width of Sacral Hiatus at the level of Base.

Transverse width of Sacral Hiatus at Base (mm)	Male	Female
Lowest value	5	5
Highest value	14	14
Arithmetic Mean	10.06	9.84
Standard Deviation	2.17	2.26



Fig. 4: Bifid Sacral Hiatus.



Fig. 5: Irregular Sacral Hiatus.



Fig. 6: Complete agenesis of dorsal wall.

DISCUSSION

The detailed morphometric study of sacral hiatus is of great relevance, since this route is frequently utilized for caudal epidural anaesthesia in perineal surgery and caudal

analgesia for a painless delivery.

In the present study, I found variations in the shape of Sacral Hiatus and made an attempt to classify them. Inverted U-shaped Sacral Hiatus were the most common, found in 48% of male and 62% of female Sacra followed by inverted-V shaped which was present in 32% of male and 26% of female Sacra. These two shapes were considered as normal. In 3% of Sacra (1 male and two female), shape of the Sacral Hiatus was like a dumbbell, which was very low compared to previous authors like Nagar S K [4] in 36 (13.3%), Suma HY et al [5] in (12.3%) and Kumar V et al [6] in 14 (7.43%). Bifid Sacral Hiatus was seen in 4% (4 male Sacra only) which was similar to that reported by Nagar SK [4] and Parashuram R [7]. Irregular shaped Sacral Hiatus were present in 5% of male and 3% of female Sacra. Variations of dorsal wall of Sacral canal in the form of complete agenesis was present in 2 Sacra which was not included in present study. Nagar [4], Sekiguchi et al [8] and Trotter et al [9] reported complete agenesis in 1.5, 1.0, and 1.8% cases, respectively.

Strandring et al [1] suggests that the apex of Sacral Hiatus is present at 4th Sacral vertebra. Knowledge of level of apex of Sacral Hiatus is very important. If the apex is higher, more precaution should be taken while deciding length of the needle to be introduced into the canal. On the other hand, low apex requires long needle. Apex was located against 4th Sacral Vertebra in most of the studies including ours with the incidence ranging from 60 to 76% [4,5,6,7]. In our study Apex was located at 4th Sacral Vertebra in 73% (38 male and 35 female), which was almost similar to study done by Parashuram R [7] in 140 (72.2%) numbers of Sacra. This incidence was lower in study done by Nagar SK [4] (55.9%) and Sekiguchi M et al [8] (65%). All studies including the present study noted that location of Apex can vary from upper part of 3rd Sacral Vertebra to lower part of 5th Sacral Vertebra. In all studies, location of base varied from 4th Sacral Vertebra to Coccyx. In our study, base was seen most commonly against 5th Sacral Vertebra in 93% cases, which is similar to the study conducted by Parashuram R [7] (93.3%) of cases. In present study, incidence of Base at 5th Sacral vertebra is much higher in comparison to 72.6%

in study done by Nagar SK [4] and 62% in Aggarwal A et al [10]. Incidence of base against 4th Sacral Vertebra was 7% which was closer to study done by Nagar and Aggarwal A et al. Length of Sacral Hiatus varied from 7 mm to 45 mm and the arithmetic mean was 20.49 mm (male 19.86 and female 21.12). This is closely similar to that reported by earlier workers namely Kumar V et al [6], who observed arithmetic mean length of Sacral Hiatus as 20 mm in males and 18.9mm in females in North Indians.

Antero-posterior diameter of Sacral canal at the apex of Sacral Hiatus is important as it should be sufficiently large to admit a needle. In the present study the antero-posterior diameter ranged from 2 mm to 8 mm with arithmetic mean of 4.50 mm. Arithmetic mean of antero-posterior diameter reported by various workers are similar like Nagar SK- 4.8mm (range of 2 - 14mm), Kumar V et al - 4.8mm (range of 0 - 12mm) and Sekiguchi M et al- 6.0mm.

In the present study, Sacra having antero-posterior diameter of Sacral canal at apex of less than 3mm is found in 21% of cases which is higher than the earlier studies. Nagar (2004) noted (15.6%) of Sacra with antero-posterior diameter less than 3 mm. In the present study, Sacra having antero-posterior diameter of Sacral canal at apex of 4-6 mm is found in 77% of cases which is higher than Parashuram R (68.1%) and Nagar (64.2%) of cases. The mean antero-posterior diameter was 4.5 mm which was comparable to Kumar et al (4.8 mm) and Parashuram R (4.25 mm).

In the present study, the transverse width of Sacral Hiatus range was 5-14 mm with arithmetic mean of 9.95 mm. Arithmetic mean of transverse width of Sacral Hiatus at base, reported by various workers are Parashuram R- 11.42 mm (range of 1-19 mm), Sekiguchi M et al- 10.2 (2.2-18.4) mm and Trotter et al- 17 mm (range of 7-26 mm),. In more than half the cases (54%), transverse width of Sacral Hiatus at base was 6-10 mm and in 98% of cases between 6-15 mm.

In this study the transverse width of Sacral Hiatus range was 5 mm to 14 mm in both Male and Female with arithmetic mean of 10.06 mm in Male and 9.84 mm in female which was lower than study of Kumar et al (1992) who reported a

range of 5-20 mm with arithmetic mean of 13 mm in male Sacra and a range of 8-18 mm with arithmetic mean of 12.5 mm in female Sacra of his series.

CONCLUSION

The present study has been carried out to determine the average mean and standard deviation of various parameters of Sacral Hiatus according to sex, study the sexual dimorphism, and to work out, if any, sexual dimorphism exists regarding the Sacral Hiatus.

Regarding sexual dimorphism, analysing the results using statistical tests, it was seen in this study, that no significant sexual dimorphism exists considering all the parameters of Sacral Hiatus.

There are anatomical variations in the shape and level of the Sacral Hiatus which may lead to failure of caudal anaesthesia. Failure in the formation of spinous process may lead to defective muscle attachment, causing low backache. Hence the bony landmarks are very important in identifying the boundaries of the hiatus. This underlines the need to know normal anatomy and variations of Sacral Hiatus.

The abnormal bony irregularities encountered in the present study are:-

- 1) Irregular Shape- 8%
- 2) Bifid Shape- 4%
- 3) Dumb-bell Shape- 3%
- 4) Complete Spina Bifida- 2%

These anatomical variations may be a factor in failure of caudal epidural Anaesthesia. When the anaesthetist notices an abnormality of Sacral Hiatus, he should choose lumbar epidural anaesthesia or other procedures to avoid the risk of soft tissue injury and toxicity of Anaesthetic drugs.

In the present study, 21% bones showed narrowed Sacral canal at the apex (0–3 mm), and in 2 bones complete Spina Bifida was found. This should be kept in mind while applying caudal epidural anaesthesia in the population of West Bengal, India.

Conflicts of Interests: None

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