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RESEARCH

MORPHOLOGICAL AND MORPHOMETRICAL STUDY OF SACRAL HIATUS IN MALE AND FEMALE SACRUM OF SOUTH INDIAN POPULATION

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Abstract

Background: The sacrum is a big triangular bone that is created by the fusion of five sacral vertebra. It may be found towards the caudal end of the vertebral column. To provide caudal anaesthesia, a needle is inserted into the epidural space through the sacral hiatus while the patient is laying in the natal cleft. This sort of epidural anaesthesia is used to anaesthetize the lower limbs as well as the sacral roots. The success of caudal anaesthesia is heavily dependent on anatomical landmarks, as well as understanding of the real form, dimensions, and size of the sacral hiatus, as well as the variations of this structure. This study was conducted with the intention of elucidating the morphological and morphometrical characteristics of the sacral hiatus in male and female sacrums. The aim and objectives are to investigate from a morphological and morphometrical standpoint, the sacral hiatus will be studied. **Materials and Methods:** The present research was carried out at the LN. Medical college & Research Center in Bhopal, India, at the Department of Anatomy. This study utilizes 69 human sacrum that were collected from the Maharaja's Institute of Medical Sciences in Nellimarla, Gayatri vidyaparishad Medical College, NRI Institute of Medical Sciences, and GEMS Medical College, Srikakualm. On these specimens, anatomical measurements were taken with the use of vernier calipers, and the results were recorded, tabulated, and analysed. The accuracy of these measurements was 0.1 mm. **Result:** In 41 (59.4%) of sacrums, the SH was shaped like an inverted "U." This was the most prevalent configuration. At the level of S4 in 32 of the cases (46.3%), the sacra apex was present. The level of the base of the sacral hiatus was found to be at the S5 vertebrae in 54 (78.2%) of the sacrums. 33 (47.8%) female and 36(52.1%) male sacrum. In the course of our research, we came across some unusual shapes, such as inverted j-shaped and inverted w-shaped objects. **Conclusion:** It is possible that identifying a single bone feature will not aid in the process of locating SH. These anatomical variances could be a contributing cause in the failure of caudal epidural anaesthesia. When we are administering caudal epidural anaesthesia, it is important that we pay attention to the anatomical changes of the sacral hiatus.

INTRODUCTION

The sacrum is a big, triangular bone that is created by the fusion of five sacral vertebrae. It is located at the back of the pelvic cavity and forms the poster superior wall.[1,2] A sacral hiatus is an aperture that can be found at the caudal end of the sacral canal. This space is generated as a result of inadequate midline fusion of the posterior parts of the fifth (or sometimes the fourth) sacral vertebra. The substance of the SH is made up of the nerve roots of the lower sacral region, the nerve roots of the coccygeal region, the filumterminale, and fibro-fatty tissue. This region is utilised for the administration of epidural anaesthesia in the field of orthopaedics for the diagnosis and treatment of a variety of disorders, in the field of obstetrics for the purpose of painless delivery, and for the purpose of treating patients who suffer from low back pain. Even though the Caudal Epidural Block (CEB) has a wide variety of clinical uses, it can be challenging to define the anatomical placement of the sacral hiatus and the caudal epidural

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space, particularly in adults. This is especially the case when the patient is an adult. It is possible for the clinician to ascertain the sacral hiatus by the determination of the landmarks, which also has the potential to boost the success rate of CEB. During CEB, the sacral hiatus as well as the sacral cornua are essential clinical markers.[3]

The accuracy with which the sacral hiatus is localised is critical to the success and dependability of the caudal epidural block. There is a possibility that changes in the anatomy of the sacral hiatus are to blame for unsuccessful caudal epidural anaesthesia. It is necessary to have a detailed knowledge of the anatomical variations in sacral hiatus that result in discrepancies in its shape and size in order to achieve optimal access into sacral epidural space and to avoid the risk of dural sac puncture. This is because these variations cause the sacral hiatus to take on a variety of different forms. One of the bones that differs significantly between the sexes is the sacrum. The "Sacral Index" has always been the most common method for determining whether or not a sacrum belongs to a male or female. The formula that is used to determine the sacral index is as follows: Sacral Index is Width of Sacrum multiplied by 100 and divided by Height of Sacrum times.[4]

The purpose of this study was to determine whether or not there are any significant differences between males and females in terms of the metrical values of the various sacral parameters, as well as the anatomical variations of the sacral hiatus in terms of its shape, length and breadth, antero-posteriordiameter, and transvers width.

MATERIALS AND METHODS

The current research was carried out at the LN Medical College & Research Center in Bhopal, India, and samples were collected from the Andhra Medical College, Maharani Peta, Visakhapatnam, Andhra Pradesh, India, NRI Institute of Medical Sciences, Thagarapuvalasa, Andhra Pradesh, India, Gaytri Vidyaparishad Medical college, Madhurawada, Visakhapatnam, Andhra Pradesh, India, and GEMS Medical College, Srikakulam, Ragolu, Andhra Pradesh, India, at the Department of Anatomy. This study uses 69 human sacrum that were gathered from three different locations. All of the sacrums were dry and undamaged when they were examined. Any bone that showed signs of injury, fracture, or disease was omitted from the study. Vernier Callipers were utilised for each and every one of the measurements. In this study, linear recordings were made to the closest millimetre, and statistical analyses were conducted. Research was conducted on each sacrum to examine the various aspects of sacral hiatus in relation to,

1) Shape of hiatus
2) Level of apex of hiatus -The highest point on arch shaped gap on dorsal surface.5
3) Level of base of hiatus - It was observed whether base corresponds with 5th sacral vertebra, 4th sacral vertebra or coccygeal vertebrae.[5]
4) Length of hiatus – measured from apex to midpoint of the base.[5]
5) Anteroposterior diameter of sacral hiatus at the apex
6) Transverse width of sacral hiatus at the base – measured between the inner aspect of inferior limit of sacral cornua.
7) Sacral index for each sacrum was calculated using formula: Sacral index = (sacral width / sacral ventral straight length) x 100

Vernier callipers were used to perform anatomical measurements on these specimens, and an accuracy of 0.1 mm was recorded for each measurement. In order to identify a male sacrum, the demarking point (D.P.) of a particular measurement had to be greater than three standard deviations above the mean value for a female, whereas in order to identify a female sacrum, the D.P. of the same measurement had to be less than three standard deviations above the mean value for a Excel and SPSS version were used to tabulate the data and do statistical analysis on it. The analysis included finding the mean, standard deviation, range, student t test, demarking points, and percentage of recognised bones (20).

RESULTS

In the present study, 69 adult sacra (36 male & 33 female) were studied.

Table 1: Gender wise distribution of sacrum

Gender wise	Frequency (n)	Percentages (%)
Male	36	52.2
Female	33	47.8
Total	69	100

Table 2: Shapes of sacral hiatus

S.no	Shapes of sacral Hiatus	Frequency(n=69)	Percentage (%)
1	Inverted U	41	59.4
2	Inverted V	19	27.5
3	Dumbell	5	7.2
4	Elongated	2	2.8
5	Inverted j	1	1.4
6	Inverted w	1	1.4

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Table 3: Location of apex in relation to level of sacral vertebra (n = 69)

S.no	Location of Base	Frequency (n=69)	Percentages (%)
1	S3	2	2.89
2	S4	32	46.37
3	Bet S4 &S5	9	13.04
4	S5	26	37.68
Total		69	100

Table 4: Location of base of hiatus in relation to sacral / coccygeal vertebra (n = 69)

S.no	Location of Base	Frequency (n=69)	Percentages (%)
1	S4	9	13.04
2	S5	54	78.26
3	Below S5/ Coccygeal vertebra	6	8.69

Table 5: Comparison of Morphometry of sacral hiatus between male and female

Parameters	Mean (± SD)		t-value	p-value
	Male	Female		
Measurements of length of sacral hiatus	18.2(±5.97)	17.1(±4.68)	0.834	0.407
Measurements of anteroposterior diameter at apex	6.89(±2.15)	8.41(±0.94)	3.72	<0.001
Measurements of transvers diameter at base	13.49(±2.5)	11.01(±2.1)	4.2	<0.001
Significant-<0.001				

Table 6: Parameters in sacral hiatus

Parameters	N	Range	Min	Max	Mean	SD	Demarking point
Measurements of length of sacral hiatus	69	25.9	8.6	34.5	17.7	5.3	1.8-33.6
Measurements of anteroposterior diameter at apex	69	7.87	2.25	10.12	7.62	1.8	2.22-13.02
Measurements of transvers diameter at base	69	13.13	6.99	20.12	12.30	2.6	4.5-20.1

Figure 1: Inverted w shape Sacral Hiatus Inverted u shape

The most common shape of sacral hiatus in this study is inverted U shape 41(59.4%), then inverted V 19(27.5%). Rare shapes like inverted j and inverted w shape found in 1.4% each. [Table 2]

Apex of sacral hiatus was commonly seen at S4 level 32 (46.37%) [Table 2] while the base was commonly located at the level of 5th sacral vertebra in 54 (78.26%) [Table 3].

Figure 2: Inverted J shape

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Figure 3: Dumbbell shape

Figure 4: Inverted v shape

DISCUSSION

In this current study on the morphology and morphometry of the sacral hiatus associated with regards to its clinical use in caudal epidural anaesthesia, we looked at the relationship between these two concepts.

In 1942, Edward and Hingson,[7] made history by becoming the first people to use the sacral hiatus, which is a natural gap at the lower end of the sacral canal, to their advantage in order to provide continuous caudal anaesthesia to a labouring woman. The arch-shaped sacral hiatus is described as being located at the lower end of the sacral canal in standard textbooks. When viewed from the dorsal aspect, it has the appearance of having a triangular outline. It develops as a result of the failure of the laminae of the fifth (or fourth) sacral vertebra to fuse together. Due to the prevalence of the sacral hiatus as a route for administering caudal epidural anaesthesia in a variety of clinical situations, it is imperative that a thorough grasp of the normal anatomy of the sacral hiatus and the tissues that surround it be achieved. In Indian sacra, Nagar (2004),[8] reported a variety of shapes of sacral hiatus. The most common ones were an inverted U (41.5%) and an inverted V (27.0%). In 13.3% of instances, the shape was dumb-bell, and in 1.14% of cases, it was irregular. The results obtained in this investigation were in agreement with the results obtained in the previous study; the inverted U (59.4%) and the inverted V (27.5%) shapes were the most common. These two designs offer sufficient space to allow the insertion of the needle into the sacral canal without the presence of any obstruction, making them perhaps the most advantageous shapes for CEB. In 76.23 percent of the instances, Kumar et al.[9] (1992) observed that the most prevalent shape was an inverted V or an inverted U, while in 7.43 percent of the cases, the shape was a dumbbell. Patel et al. (2011) also studied on shapes and discovered that the most prevalent type was an inverted U in (49.33%) of the cases and an inverted V in (20%) of the instances. Dumbbell shapes occurred in 4% of the cases, while cases with extended sacral hiatuses occurred in 2% of the cases. In 7.2% of the cases in our research, the shape was a dumbbell, and in 2.8% of the cases, there was an extended shape. Our findings are in line with the aforementioned standard. in contrast, Nagar,[8] recorded 14.1% irregularly shaped particles. In our research, we came across some unusual shapes, such as the inverted w (1.4%) and the inverted j (1.4%).

The apex of the sacral hiatus is a significant landmark that must be located in order to do a caudal epidural block effectively. It demonstrates a significant amount of diversity from S2 all the way up to S5. In the current investigation, the apex of the sacral hiatus was shown to be most frequently at the level of the 4th sacral vertebra in 46.37 percent of the sacra. The apex of the sacral hiatus is said to be present at the level of the 4th sacral vertebra, according to standard textbooks written by Peter L. Williams et al. in the year 2000. Nagar (2004),[8] also found that the apex was resting against the fourth sacral vertebra in 55.9% of the cases, which is inconsistent with the findings of the present study. The present study found that the apex was resting against the S2 level in 2.28% of the cases, which is lower than the 3.4% that Nagar reported.[8]

In the current study, the base of the sacral hiatus was located at the level of S5 in 72.26 percent of cases and at the 4th sacral vertebra in 13.04 percent of cases. These findings are almost identical to those found in the study carried out by Nagar,[8] in 191 (72.6%) sacra but are lower than those found in the study carried out by Vinod Kumar et al,[9] in 168 (83.17%) sacra. The level of the coccyx was observed to be the location of the base of the hiatus in (8.06), which is lower than the findings of the studies carried

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out by Nagar (16.3%) and suma et al (25.62%).[8,10,11,12]

Our research revealed that the lowest length of the sacral hiatus to be 8.6mm and the maximum length to be 34.5mm. While Kumar et al,[9] found the mean length of the sacral hiatus to be 20 millimetres in males and 18.9 millimetres in females, our study found that the average length of the sacral hiatus was 17.7 millimetres. Trotter and Lanier,[13] found that the length of the sacral hiatus in American males was 24.8 millimetres, whereas the length in females was 19.8 millimetres. According to Akhtar et al.[14] (2016), the lengths ranged anywhere from 7.12mm to 59.93mm, with a mean and standard deviation of 26.92 and 12.19mm, respectively. According to Chhabra (2014),[15] the average length was measured at 25.0510.96 mm, and its range was from 9.98 mm to 61.98 mm, which was longer than the results of our study. It's possible that differences in ethnicity or geographical location are to blame for the minute differences found in the length of the sacral hiatus when comparing results from different research. In all of the studies discussed above, including the current one, it was discovered that the mean length of the pause in females is slightly shorter than it is in males. When determining the location of the sacral canal, the size of the sacral hiatus is an important feature to consider.

It is essential to measure the anteroposterior diameter of the sacral canal at the apex of the sacral hiatus. This diameter should be large enough to accommodate a needle. In the current investigation, the diameter measured anywhere from 2.25 to 10.12 mm, with 7.62 mm serving as the mean. The mean diameter, as measured across both male (6.89) and female specimens (8.14) The findings of our research are in agreement with those of a study that was conducted by Chhabra N,[15] and Lanier et al.[16] (both of which were 6.0 1.9 mm) and Seikuguchi M et al.[17] (6.0 1.9mm). Other researchers have noticed results that are lower than those found in this study, including Trotter et al.[18] 5.3mm, Nagar 8 4.8mm (range: 2-14mm), and others (range from 0-11mm). The current study indicated that the mean difference in the anteroposterior diameter of the sacral hiatus between male and female sacra was statistically significant, with a p value of less than 0.001.

Within the scope of this investigation, the transverse width ranged anywhere from 6.99 mm to 20.12 m.

It is almost identical to the observations recorded by Kumar et al,[9] in 13mm (range 5mm-20mm) in male sacra and 12.5mm (range 8mm-18mm) in female sacra. The marithmetic mean of 12.3mm in male 13.49mm and in female 11.01mm dry human sacra is almost same. In their research on male and female sacra, Trotter and Letterman18 found that the mean transverse width of male sacra was 17mm while that of female sacra was 16mm. According to Trotter and Lanier et al,[16] the arithmetic mean transverse width of male American white human sacra was 16.6 millimetres, whereas the same measurement for female American white human sacra measured 15.9 millimetres. These measurements are larger than the ones we found in our study. In each of the aforementioned studies, the mean transverse width at the base is narrower in female dry human sacra compared to male dry human sacra. According to the findings of our research, the average difference in transverse length between males and females is statistically significant, with a p-value that is lower than 0.001.

In the current investigation, the sacral index: The sacral index of males has a mean value of 105.23, whereas the sacral index of females has a mean value of 127.33. There is a discernible gender gap in the mean sacral index values between males and females, and this gap is statistically significant. There is a discernible gender gap in the mean sacral index values between males and females, and this gap is statistically significant. The findings presented here were strikingly similar to those reported by Mishra, S. R. et al.[19] (2003-07) and Maddikunta Vet al.[20]

CONCLUSION

It is possible to draw the conclusion that the sacral hiatus and the structures that surround it commonly exhibit differences that have the potential to affect the result of CEB. If these variances are understood, it's possible that the success rate of caudal epidural anaesthesia can be improved. If the anesthesiologist finds that the hiatus is atypical, he should opt for a lumbar epidural block or one of the other available therapies in order to reduce the likelihood of soft tissue injury and the toxicity that can be caused by local anesthetics.

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