Original article

Anatomical study of the sacral hiatus

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Abstract:

Introduction: The sacrum is a bone which contributes to the formation of the pelvic girdle. It has piqued the interest of anatomists, forensic scientists and physicians, especially anaesthetists because of its unique value in gender estimation in medico-legal proceedings as well as the importance of its anatomical structure in relation to the technique of giving caudal anaesthesia. The aim of the present study was to evaluate specific parameters of the sacrum and to estimate the landmarks of the sacral hiatus for precision during caudal anaesthesia.

Materials and Methods: 40 complete and undamaged dry bones (sacra) of unknown sex were used which were obtained from the Department of Anatomy, Sri Manakula Vinayagar Medical College, Pondicherry. Parameters such as Distance between 2 Cornu, Sacral Hiatus length, Distance between 2 Superolateral crests, Distance between Right Superolateral crest and apex of sacral hiatus and Distance between Left Superolateral crest and apex of sacral hiatus were measured. The range and mean with standard deviation were calculated.

Results: Majority if the bones had a U shaped sacral hiatus (57.5%), followed by V shaped (25%) and irregular shaped (17.5%). The parameters recorded are presented in table format.

Conclusion: The understanding of the sacral hiatus anatomy helps to define landmarks clinically used during the procedure of caudal anaesthesia.

Keywords: Sacral hiatus, Morphometric analysis, Caudal anaesthesia

Introduction:
The sacral canal is formed by the fusion of sacral vertebral foramina and it is triangular in shape. It is the continuation of the lumbar spinal canal. The sacral canal contains the cauda equina (which includes the filum terminale) and the spinal meninges. At the middle one third of S2, subarachnoid and subdural spaces end. Here the lower sacral spinal roots and filum terminale pierce the arachnoid and dura mater. Filum terminale emerges at the sacral hiatus and traverses the dorsal surface of the fifth sacral vertebra and the sacrococcygeal joint to reach the dorsum of coccyx and the fifth spinal nerve pair emerge through the hiatus just medial to the sacral cornua.

The sacral canal contains the epidural venous plexus, filled with adipose tissue which is subject to an age-related decrease in its density. This change might determine the effective spread of local anesthetics administered for caudal anesthesia. Caudal anesthesia was first described by two French physicians, Fernand Cathelin and Jean-Anthanase Sicard. Considerable variability in the anatomy of sacral hiatus exists between individuals, races and stature. The sacral hiatus may be closed, asymmetrically open or widely open. As age advances, the overlying ligaments and the cornua thicken. Consequently the identification the hiatal margins become challenging. Anatomic variations in size, shape and orientation of sacrum pose problems in caudal anaesthesia. The average...
volume of the sacral canal is 14.4 ml, but varies from 9.5 to 26.6 ml. In adults, roughly twice the local anaesthetic dose is required to attain the same segmental spread with caudal block compared with the dose used for lumbar epidural block\(^4,5\). The indications for performing caudal epidural block are essentially the same as for lumbar epidural block. Caudal anaesthesia in paediatrics is used primarily for perioperative pain control, whereas in adults it is primarily for chronic pain management\(^3,6\).

Caudal block is indicated whenever the area of surgery involves the sacral and lower lumbar nerve roots. The technique can be used for anal surgery, gynecological procedures, surgery on the penis or scrotum, and surgeries on lower limb.

Hence the present study was made in an attempt to define different parameters to locate the sacral hiatus precisely.

The present study was to evaluate specific parameters of the sacrum and to estimate the landmarks of the sacral hiatus so that precision in the technique is attained during caudal anaesthesia.

**Materials and Methods:**
40 complete and undamaged dry sacra of unknown sex were used which were obtained from Department of Anatomy, Sri Manakula Vinayagar Medical College, Pondicherry.

**Inclusion criteria:** All intact dry adult human sacra were included in the study.

**Exclusion criteria:** Eroded, broken and neonatal bones were excluded from the study.

**Results:**
The sacra studied consisted of 40 dry bones. The distribution of the sacral hiatus were as follows:

- U shaped sacral hiatus (57.5%)
- V shaped sacral hiatus (25%)
- Irregular shaped sacral hiatus (17.5%)

The parameters measured were recorded in a tabular format and are as given below:

<table>
<thead>
<tr>
<th>S. no.</th>
<th>Parameter</th>
<th>Range (cm)</th>
<th>Mean (cm)</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dist. B/W 2 Cornu</td>
<td>0.6- 2</td>
<td>1.22 ± 0.457</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Sacral Hiatus length</td>
<td>0.8- 4.1</td>
<td>2.1 ± 1.149</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Dist. B/W 2 Superolateral crests</td>
<td>5.7- 7</td>
<td>6.23 ± 0.444</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Dist. B/W Right Superolateral crest and apex of sacral hiatus</td>
<td>5.6- 9.4</td>
<td>6.9 ± 1.449</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Dist. B/W Left Superolateral crest and apex of sacral hiatus</td>
<td>5.5- 10.4</td>
<td>7.1 ± 1.777</td>
<td></td>
</tr>
</tbody>
</table>

The distance between the 2 cornu of the sacral hiatus ranged from 0.6 to 2 cm with a mean of 1.22 cm and a standard deviation of ± 0.457.

The maximum standard deviation was noted in the distances between the Superolateral crests and the apex of the sacral hiatus, the left one (± 1.777) being more than the right (± 1.449).

The distance between the left Superolateral crest and the apex of the sacral hiatus (7.1 cm) was in general more than its right sided counterpart (6.9 cm).
Discussion:

Table 2: showing comparison between different studies regarding shapes of the sacral hiatus

<table>
<thead>
<tr>
<th>S. no.</th>
<th>Study by Authors</th>
<th>Inverted ‘U’ shape (%)</th>
<th>Inverted ‘V’ shape (%)</th>
<th>Irregular (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Nadeem et al.</td>
<td>56</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>2.</td>
<td>Nagar et al.</td>
<td>41.5</td>
<td>27</td>
<td>14.1</td>
</tr>
<tr>
<td>3.</td>
<td>Osunwoke et al.</td>
<td>24.1</td>
<td>33.3</td>
<td>13.0</td>
</tr>
<tr>
<td>4.</td>
<td>Qudusia et al.</td>
<td>62.37</td>
<td>22.16</td>
<td>8.76</td>
</tr>
<tr>
<td>5.</td>
<td>Seema et al.</td>
<td>42.95</td>
<td>27.51</td>
<td>16.10</td>
</tr>
<tr>
<td>6.</td>
<td>Deepa S et al. (present study)</td>
<td>57.5</td>
<td>25</td>
<td>17.5</td>
</tr>
</tbody>
</table>

As seen from the table 2, the findings of the present study coincide with the findings of Nadeem et al., Nagar et al., Qudusia et al. and Seema et al. in all the aforementioned studies including the present study, inverted ‘U’ shaped sacral hiatus is the commonest.

The present study however does not coincide with Osunwoke et al. which states that inverted ‘V’ shaped sacral hiatus is the commonest. In the present study the length of the sacral hiatus was found to be 2.1 ± 1.15 cm. In a study by Mohamed M et al. the same was recorded to be 2.1 ± 0.8 cm. Nadeem et al. in their study quoted that the length of sacral hiatus was 2.5cm. In yet another study by Nagar et al. the sacral hiatal length was noted to be 2.28 cm. Lakshmi et al. observed that the length of sacral hiatus was 2.7 ±1.2cm. Mrudula et al. stated that the sacral hiatal length was 2.46 cm. The distance between 2 cornu (inter cornual distance) was found to be 1.22 ±0.46 cm in the present study. These findings are similar to a study by Anjali et al. wherein the inter cornual distance was 1.19± 0.27 cm. In yet another study by Nadeem et al. it was observed that the inter cornual distance was 1.95cm.

The distance between the right and left superolateral crest was 6.23 ±0.444 cm. similar findings were seen in studies conducted by Clarista et al., Lakshmi et al., and Mrudula et al. was found to be 6.5±0.5 cm, 6.15±0.44 cm and 5.65 cm respectively. The distance between right superolateral crest and apex of sacral hiatus was found to be 6.9 ±1.45 cm in the present study, whereas in studies by Lakshmi et al. and Mrudula et al. the same was recorded to be 5.83±0.94cm and 5.36 cm respectively. In yet another study by Clarista et al. the distance between right superolateral crest and apex of sacral hiatus was observed to be 6.26±0.96 cm which is similar to the findings of the present study. The distance between left superolateral crest and apex of sacral hiatus was noted to be 7.1±1.777 cm. However in other studies by Lakshmi et al., Mrudula et al. and Clarista et al. the findings were noted to be 5.9±0.95cm, 5.46cm and 6.233±0.99cm respectively. The present study was done in a small sample size of 40 dry sacra, the same parameters can be studied in a larger sample size for a better understanding of variations seen in sacra.

Conclusion:

The sacrum is a special bone, since it is used extensively in medico-legal proceedings for gender determination and for anaesthetists, while giving caudal anaesthesia. The anatomy of the sacrum should be well known to physicians, especially the aforementioned professions.
Acknowledgements:
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Conflict of interest:
Conflict of interest none to declare.

References: