

## ANATOMICO-RADIOLOGICAL STUDY

## Sacral hiatus in relation to low back pain in south Indian population

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**Abstract:** *Objective:* The study was designed to identify any association between the sacral hiatus of the dry sacral bones with that of patients with low back pain (LBP). The knowledge of the sacral hiatus is important in caudal epidural block (CEB).

*Methods:* Three hundred forty three (183 male and 160 female) complete and undamaged adult South Indian dry sacral bones and Fifty two (30 male and 22 female) radiographs were included in the present study. The above radiographs were of patients with history of LBP. The osteological observation and the radiographic study were compared to find any associations of LBP with the location of the apex of the sacral hiatus.

*Results:* In dry male sacrum, in 39.3 % cases the sacral hiatus was inverted U shape and in 50.6 % cases the female sacrum was inverted V shape. Deficient dorsal wall of the sacrum was observed in 2.7 % and 12.5 % in male and female sacra, respectively. The apex of the sacral hiatus was observed the most at S4 level (81.4 % in male and 61.2 % in female). Deficient dorsal wall was found in 40 % of male and 27.2 % female patients presented with LBP. The apex of the sacral hiatus in the LBP patients observed at the S4 level was 46.6 % in male and 54.5 % in female respectively.

*Conclusion:* The patients with LBP had a higher percentage of deficient dorsal walls in comparison to the osteological findings (Fig. 12, Tab. 7, Ref. 12). Full Text (Free, PDF) [www.bmj.sk](http://www.bmj.sk).

**Key words:** sacrum, sacral hiatus, deficient dorsal wall, lower back pain, radiogram.

The sacrum is a large triangular bone and placed between the two innominate bones and forms postero-superior wall of the pelvic cavity. Five sacral vertebrae are fused to form the sacrum, increases or decreases in the case of sacralisation or lumbalisation, respectively. The spines of the sacral vertebrae are raised and represented as fused sacral spines (1). The sacral hiatus is located at the caudal end of the sacrum and bordered laterally by two sacral cornua. Anatomic variations in the sacral hiatus, may relate to the failure of Caudal Epidural Anesthesia (CEA), transpedicular and lateral mass screw placement (2). The sacral hiatus functions as a landmark when caudal analgesia is given in urology, proctology, general surgery and obstetrics and gynecology practice (3).

The sacral hiatus shows variations in the development leading to highly placed gap in the midline, sometimes there may be incomplete fusion of the laminae of all the sacral vertebrae leading to a midline gap. This leads to decreased surface area for the attachment of extensor muscle at the back which may lead to painful conditions

of the back (4). In the present study we investigate the association between the incidences of the sacral hiatus apex location in the dry sacral bones, with that of patients who presented with a history of LBP. Present study will add to the existing knowledge on sacral hiatus and its importance in various surgical interventions.

#### Patients and methods

Three hundred forty three (183 male and 160 female) complete and undamaged adult South Indian dry sacral bones of known sex, were obtained from the bone bank of the Kasturba Medical College, Manipal, India. Each sacrum was studied for the shape of the sacral hiatus and location of the apex of the sacral hiatus. Fifty two (30 male and 22 female) radiographs were obtained from the department of imaging and radiodiagnosis, Kasturba Medical College, Manipal. The above radiographs were of patients with history of LBP (including axial, referred and radicular type of pain). Each sacrum was studied for different features of sacral hiatus with regards to the shape of hiatus and the location of the apex of the sacral hiatus in the dry human sacra and in the radiographs of the patients presented with LBP.

#### Results

##### *Shape of sacral hiatus in dry human sacra.*

Four different sacral hiatus shapes (Inverted U; Inverted V, Irregular; Deficient dorsal wall) were observed in both the male

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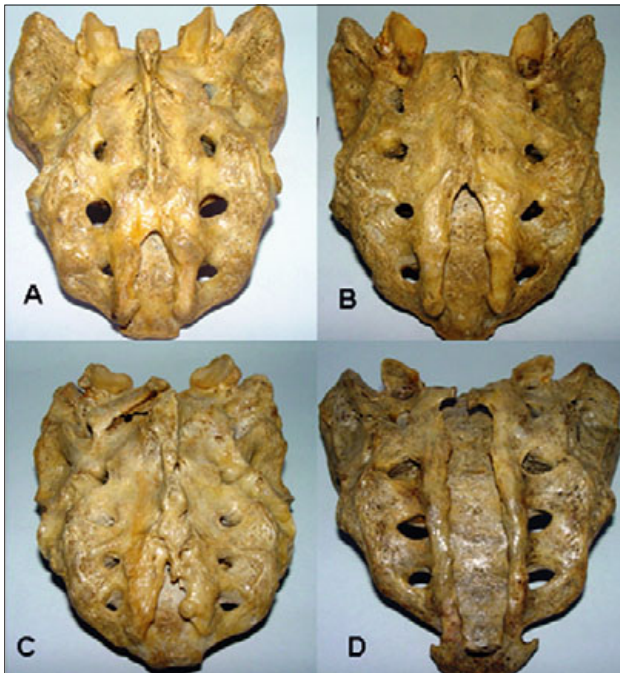


Fig. 1. Various shapes of the sacral hiatus. A, Inverted U; B, Inverted V, C, Irregular; D, Deficient dorsal wall.

and female dry human sacra (Fig. 1). The incidence of various shapes of sacral hiatus both in male and female sacra was tabulated in the Table 1 (Figs 2, 3). Deficient dorsal wall of the sacrum was observed in 2.7 % and 12.5 % in male and female sacra, respectively.

*Apex of the sacral hiatus.*

The apex of the sacral hiatus was observed at various levels in both the dry human sacra and the radiographs of the patients with LBP (Figs 4–8). The incidence of the above was tabulated in the Table 2 and Table 3, respectively (Figs 9–12). The apex of

Tab. 1. Incidence of shapes of sacral hiatus in dry human sacrum: (Total 343 sacra).

Shape of hiatus	Male (183)	Female (160)
Inverted – V	55 (30%)	81 (50.6%)
Inverted – U	72 (39.3%)	9 (5.6%)
Irregular	51 (27.8%)	52 (32.5%)
Deficient dorsal wall	5 (2.7%)	20 (12.5%)

Tab. 2. Incidence of apex of the sacral hiatus in dry human sacrum: (Total 343 sacra).

Vertebral level	Male (183)	Female (160)
Deficient dorsal wall	5 (2.7%)	20 (12.5%)
S2	4 (2.1%)	3 (1.8%)
S3	17 (9.2%)	27 (16.8%)
S4	149 (81.4%)	98 (61.2%)
S5/Abscent	8 (4.3%)	12 (7.5%)

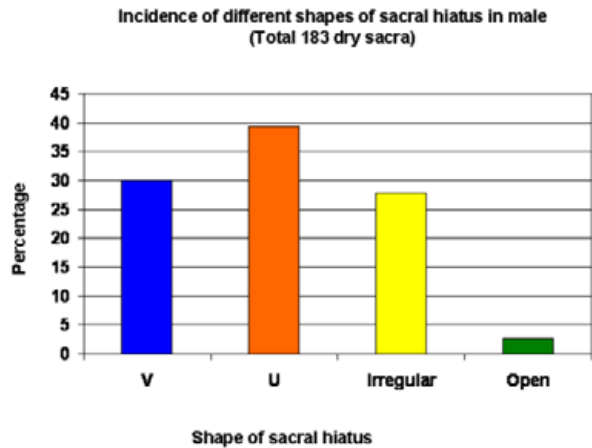


Fig. 2. Histogram showing the incidence of various shapes of sacral hiatus in dry male sacra.

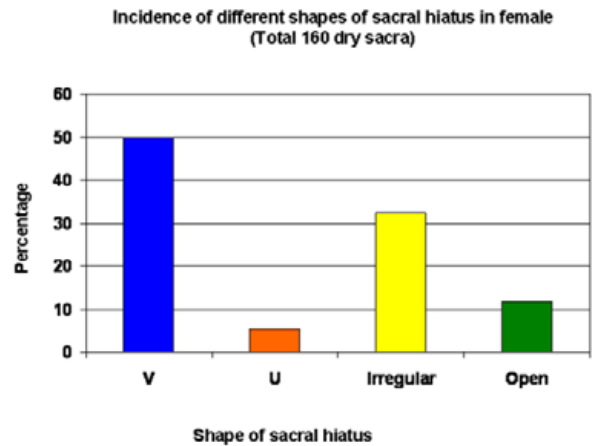


Fig. 3. Histogram showing the incidence of various shapes of sacral hiatus in dry female sacra.

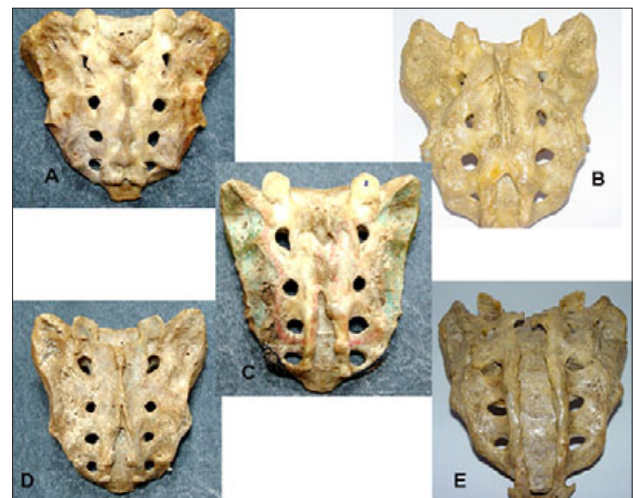


Fig. 4. The apex of the sacral hiatus at various levels in dry human sacra. A, S5/Absent; B, S4; C, S2; D, S3; E, Deficient dorsal wall.

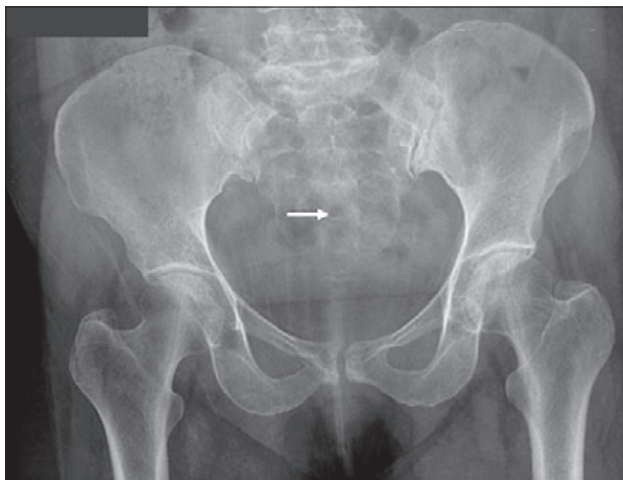


Fig. 5. Incidence of apex of the sacral hiatus in radiogram at the level of S4.

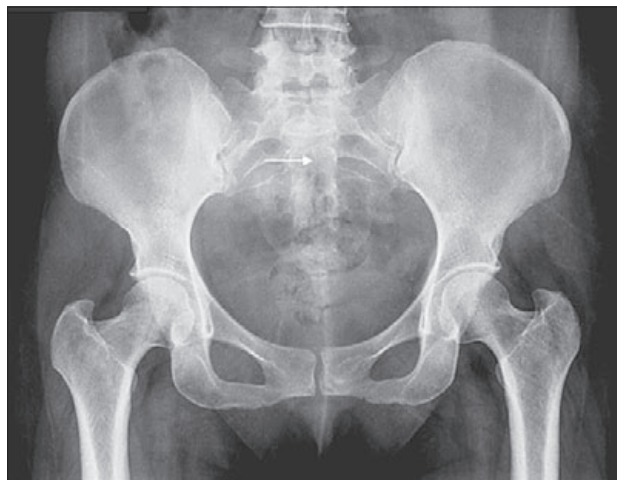


Fig. 7. Incidence of apex of the sacral hiatus in radiogram at the level of S2.

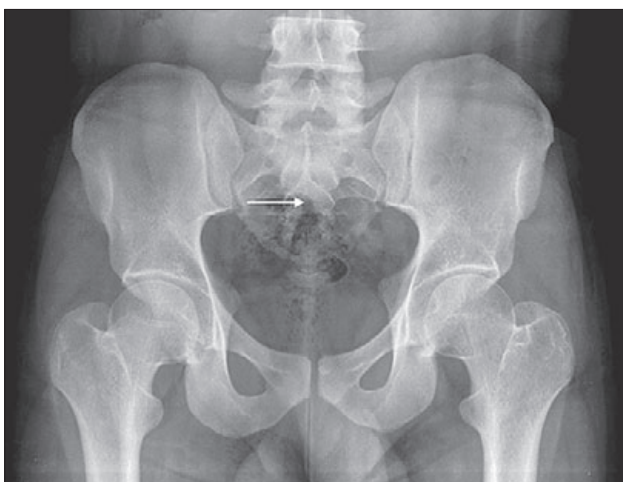


Fig. 6. Incidence of apex of the sacral hiatus in radiogram at the level of S3.

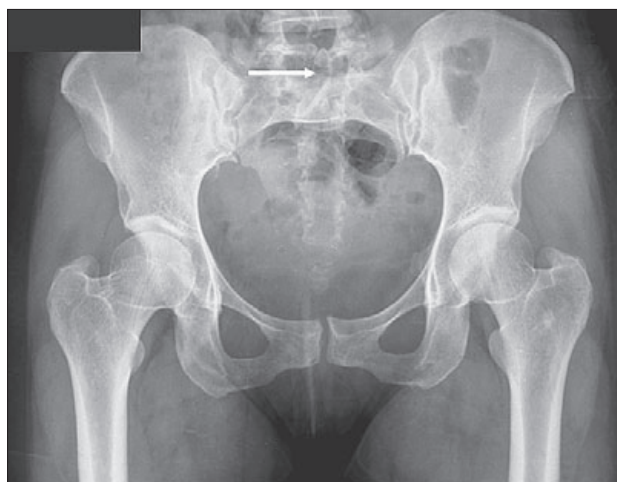


Fig. 8. Incidence of apex of the sacral hiatus in radiogram with deficient dorsal wall.

the sacral hiatus was observed the most at S4 level (81.4 % in male & 61.2 % in female) in the dry human sacra. Deficient dorsal wall was found in 40 % of male and 27.2 % female patients presented with LBP. The apex of the sacral hiatus in the LBP patients observed at the S4 level was 46.6 % in male and 54.5 % in female respectively.

Tab. 3. Incidence of apex of the sacral hiatus in radiogram with history of low back pain: (Total 52 radiograms).

Vertebral level	Male (30)	Female (22)
Deficient dorsal wall	12 (40%)	6 (27.2%)
S2	1 (3.3%)	2 (9%)
S3	3 (10%)	2 (9%)
S4	14 (46.6%)	12 (54.5%)
S5/Absent	0 (0%)	0 (0%)

### Discussion

Clear understanding of the normal anatomy of the sacral hiatus and the surrounding structures is one of the key factors for a successful CEB. The sacral hiatus is located at the caudal end of the sacrum and bordered laterally by two sacral cornua. Only skin, subcutaneous fat tissue, and the sacrococcygeal ligament cover the hiatus. When the needle has passed through the sacrococcygeal ligament, the hiatus communicates with the epidural space directly (5).

Irregularly shaped hiatus was found in 30 % of sacra in our study and was similar to the observations of Nagar (27.4 %) (6) (Tab. 4). These findings were unlike that of Kumar and colleagues (7); they found the irregular shaped hiatus in 7.4 % cases. Inverted U shaped hiatus was seen in 23.6 % in the current study and is also similar to Nagar's (6) findings of 41.5 % and higher than that of Kumar et al (20.7 %) (7). Kumar and colleagues

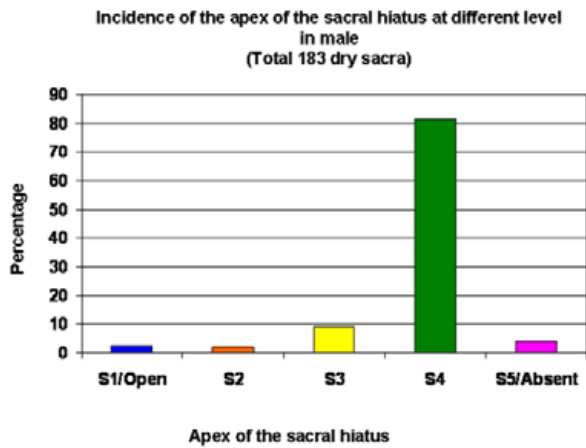


Fig. 9. Histogram showing the incidence of the apex of the sacral hiatus at different levels in male.

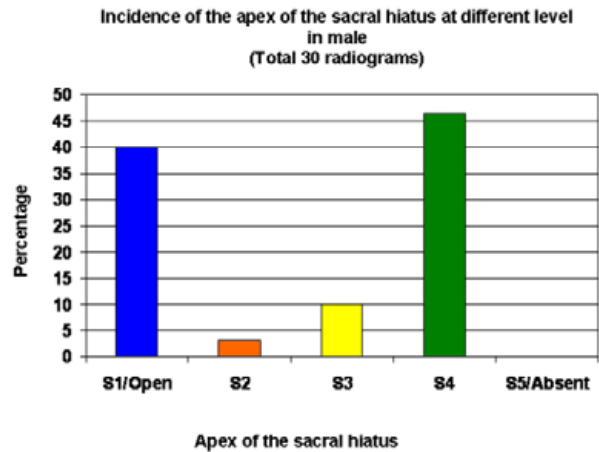


Fig. 11. Histogram showing the incidence of the apex of the sacral hiatus in radiogram with the low back pain at different levels in male.

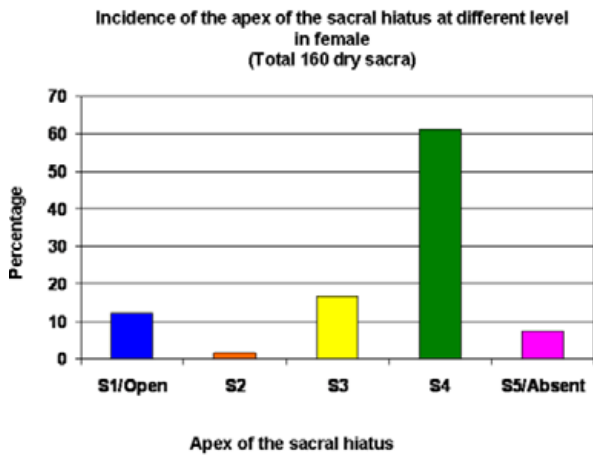


Fig. 10. Histogram showing the incidence of the apex of the sacral hiatus at different levels in female.

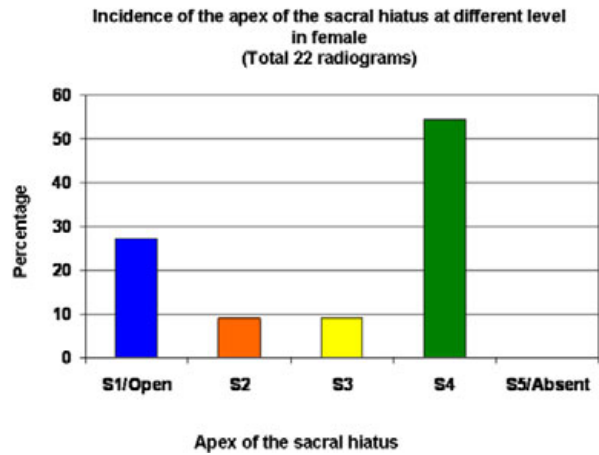


Fig. 12. Histogram showing the incidence of the apex of the sacral hiatus in radiogram with the low back pain at different levels in female.

have found a high incidence of inverted V shaped hiatus (60.3 %) (7), whereas we found it to be 39.6 % and Nagar (6) in 27 % of cases. Open hiatus was more frequent in our study with a percentage of 7.2, as compared to Kumar et al (7) and Nagar (6), who had the incidence 1.4 % and 1.5 %, respectively.

One of the factors of CEB failure is anatomic variation. The sacral hiatus is the most important bony landmark for CEB since the apex of the sacral hiatus shows the existence of a sacral canal. Clinicians sometimes experience difficulties palpating the sacral hiatus and other bony landmarks. Therefore, it is important to clarify the anatomic variations of the sacral hiatus without soft tissue (5). Most of the text book description says that level of the apex of sacral hiatus lies at the lower third of the body of 4th sacral vertebra (3). We compared the level of the apex of the sacral hiatus in cases of male human sacra with the data published by Letterman and Trotter (3) (Tab. 5). Sacra with open dorsal wall (2.7 %) and with the level of the apex of sacral hiatus at S4 (81.4 %) were found more frequently in the present

study in comparison to Letterman and Trotter (3). Letterman and Trotter (3) found the level of the apex of sacral hiatus at S2&S3 (50 %) and having absent sacral hiatus (18 %) in more cases in comparison to the present study. Trotter et al, in 1944 studied the levels of the apex of the hiatus in female sacrum, the incidence of which is compared with the present study (Tab. 6) (8).

Tab. 4. Incidence of various shapes of sacral hiatus by various author's irrespective of sex.

Shape of sacral hiatus	Kumar et al., 1992	Nagar, 2004	Present study, 2008
Inverted V	60.3 %	27.0 %	39.6 %
Inverted U	20.7 %	41.5 %	23.6 %
Irregular	7.4 %	27.4 %	30.0 %
Deficient dorsal wall	1.4 %	1.5 %	7.2 %
Absent	0.9 %	1.1	–
Other types	9.8 %	1.5	–

**Tab. 5. Incidence of apex of the sacral hiatus in the present study compared with that of Letterman & Trotter, 1944 (Male sacrum).**

Apex of the sacral hiatus	Letterman & Trotter, 1944	Present study, 2008
Deficient dorsal wall	0.7 %	2.7 %
S2+S3	50.0 %	11.3 %
S4	32.0 %	81.4 %
S5/absent hiatus	18.0 %	4.3 %

**Tab. 6. Incidence of apex of the sacral hiatus in the present study compared with that of Trotter et al, 1944 (female sacrum).**

Apex of the sacral hiatus	Letterman & Trotter, 1944	Present study, 2008
Deficient dorsal wall	0.3 %	12.5 %
S2+S3	45.0 %	18.6 %
S4	35.0 %	61.2 %
S5/ absent hiatus	20.0 %	7.5 %

**Tab. 7. Incidence of apex of the sacral hiatus by various author's irrespective of sex.**

Apex of the sacral hiatus	Kumar et al.,1992	Sekiguchi et al.,2004	Nagar,2004	Present study2008
Deficient dorsal wall	1.4 %	1.0 %	--	7.2 %
S2	4.9 %	4.0 %	3.4 %	2.0 %
S3	8.9 %	15.0 %	37.3 %	12.8 %
S4	76.2 %	65.0 %	55.9 %	72.0 %
S5/absent hiatus	8.4 %	15.0 %	3.4 %	5.8 %

In our study level of the apex of the sacral hiatus at S2&S3 was 18.6 % and at S5/ absent sacral hiatus was 7.5 %. In the study done by Trotter et al (8) the level of the apex of the sacral hiatus at S3&&S2 was 45 % and the sacrum having sacral hiatus at S5/ absent sacral hiatus was 20 %. Both the above values are more frequent as compared with our study. But in our observation the sacra with the level of the apex of sacral hiatus at S4 were 61.2 % and those having completely open dorsal wall were 7.5 %, in the study of Trotter et al (8) it was 35 % and 0.3 % respectively. Both of the above were more frequent in our study.

The percentage of the location of the apex of the sacral hiatus was mentioned by various authors irrespective of sex in dry human sacra and the results of the present study were compared (Tab. 7). In our study the percentage of sacra with the hiatus at the level of S4 was 72 %. It is the most common level as observed by other authors (5, 6, 7). The incidence of the level of the apex of the sacral hiatus at S3 level in our study is 12.8 % which is again very close to the observation made by Kumar et al (8.9 %) (7). But Nagar (37.3 %) (6) and Sekiguchi et al (15 %) (5) both got higher values than our study. The incidence of sacral hiatus at S2 was more often observed by Nagar (3.4 %) (6) where as in our study it was 2 %. Observations of Kumar et al (7) and Sekiguchi et al (5) were 4.9 % and 4 %, respectively both are quite higher than the present study. The incidence of location of the apex of the sacral hiatus at S5/absent, in the present study was 5.8 % and it is very close to that of Nagar (3.4 %) (6). But the studies of Kumar et al (7) and Sekiguchi et al (5) indicate 8.4 % and 15 %, respectively, both values are higher than the values observed in the present study.

CEB is widely used for the diagnosis & treatment of lumbar & spinal disorders in orthopedic field. In clinical studies success rate of caudal epidural block has been reported to be about 70–80 %. White et al reported that 82 % of patients with lumbar pain had pain relief 1 day after caudal epidural block (9). Stitz

and Sommer have reported that patients with successful CEB using the fluoroscopic guidance are approximately 94 % (10). Black has reported that in 7.7 % cases the CEB failed due to the absence of sacral hiatus (11). According to Sekiguchi et al (5) CEB failure might occur in 3–11 % of patients because of anatomic abnormalities, among that 4 % of cases the sacral hiatus was absent. In the present study, 4.3 % cases of male and 7.5 % cases of female sacral bones the sacral hiatus was absent. When the above data was compared with the radiographs of the patients with LBP, it was discovered that none of the cases the sacral hiatus was at the level of S5 (Sacral hiatus absent). According to Senoglu et al (12) deficient dorsal wall may be a cause of CEB failure which they reported in 6.2 % cases. In the present study we found the deficient dorsal wall in 7.2 % cases. When the above data was compared with the radiographs of the patients with LBP, it was found that the dorsal wall was deficient in 40 % of male and 27.2 % of female subjects. The above data indicate that the patients with LBP will have very high rate of CEB failure.

## Conclusion

The present study on the dry human sacra and its comparison with the radiographs of the patients with LBP will add our exiting knowledge in the anatomy of sacral hiatus and will be of help to the clinicians for proper CEB. The above data indicate that patients with LBP may have a higher rate of failed CEB. The radiological study of sacral hiatus coincides with the observations made in dry human sacra, except for the percentage of cases in which dorsal wall was open, which was observed in high percentages in the patients with LBP. The patients who complained of back ache had sacral hiatus either at the level of S4 or a complete absence of the dorsal part of the sacrum (deficient dorsal wall).

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