ORIGINAL RESEARCH PAPER

Volume-8 | Issue-7 | July - 2019 | PRINT ISSN No. 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

RADIOLOGICAL STUDY OF SACRUM IN PATIENTS WITH LOW BACK PAIN

Anatomy

Dr. Anupam Baske Assistant Professor, Department of Anatomy, B.S.M.C. ,Bankura, West Bengal.

Dr. Gopal Chandra Mondal* Associate Professor, Department of Anatomy, NRSMCH, Kolkata, West Bengal. *Corresponding Author

ABSTRACT

Sacrum is the fused lower five sacral vertebrae along with the coccyx at the caudal end of the vertebral column and it has the hiatus containing the rootlets of sacral and coccygeal spinal nerve. The compressive effect in the course of exit of the lower spinal nerve or anything else is the cause for low back pain. This prompted us to carry out the present study, which aimed to observe the vertebral level of apex and base of sacral hiatus & the length and transverse diameter of sacral hiatus among the patients with low back pain attending the radiology department of North Bengal Medical College and Hospital.One hundred patients were analysed. 50 had the history of chronic low back pain i.e. study group.and a group of 50 another age and sex-matched patients was considered in the study i.e. comparison group.Patients above 20 years age group attending the Radiology OPD with the digital radiograph of the antero-posterior view of lumbo-sacral spine,with history of low back pain was considered.In the present study, it was proved that deficiency on the dorsal surface of the sacrum is higher among the low back pain patients in whom it is one of the causes of the disease firmly established a larger study involving the living patients suffering from low back pain.

KEYWORDS

Sacrum, low back pain,sacral radiology

INTRODUCTION:

Sacrum is formed by fusion of five sacral vertebrae and forms the caudal end of the vertebral column. The vertebral canal of Sacrum (Sacral canal) runs throughout the greater part of the bone. The opening present at the caudal end of sacral canal is known as sacral hiatus. It is located inferior to the fourth (or third) fused sacral spines at the lower end of median sacral crest.[1,2]The Sacral hiatus contains lower sacral and coccygeal nerve roots, filum terminale externa and fibro-fatty tissue.[3] The fifth sacral spinal nerves and coccygeal nerve emerge through the sacral hiatus close to the medial side of the sacral cornua. The sacral hiatus is covered only by skin, a subcutaneous fatty layer and the sacro-coccygeal membrane[4,5]The shape of the sacral hiatus shows many variations. Sometimes lamina of more than one sacral vertebra or laminae of all sacral vertebrae remain non fused. In these conditions a wide gap is formed in that region. Hence the surface area for muscular attachment is decreased which may lead to pain sensation at the back region.[6,7] A cross-sectional descriptive study was conducted among the patients with history of low back pain attending the Department of Radiologyin atertiary care hospital of West Bengal with the following objectives:

- To find out the position of sacral hiatus in radiograph
- To measure the length and transverse diameter of sacral hiatus radiologically
- To elicit correlation of low back pain with sacral parameters in patients presenting with history of low back pain

MATERIALS AND METHODS:

Data collected from 100 patients were analysed. Out of that 50 had the history of chronic low back pain i.e. study group. For the sake of descriptive comparison (on the basis of 1:1) a group of 50 another age and sex-matched patients was considered in the study i.e. comparison group.All patients above 20 years age group attending the Radiology OPD with the digital radiograph of the antero-posterior view of lumbo-sacral spine, with history of low back pain, have been approached for this study. Proved cases with advanced malignancy were excluded.After taking proper permission from the authorities of the respective departments, data were collected in the department of radiology, from the report of the digital X-ray of LS spine (AP view) of the patients with history of low back pain. Visits were made in the department of radiology twice a week (once in the Monday and once in Wednesday; if anyone is holiday or could not been attended for the departmental other academic assignment, then the visit has been made in the next possible day) in the six months time. All patients matching the inclusion and exclusion criteria have been incorporated in the study. Following parameters were studied:

a) Vertebral level of apex of sacral hiatus , b)Vertebral level of base of sacral hiatus c) Diameter (mm) of sacral hiatus (in between two sacral cornua) d) Length (mm) of sacral hiatus (From the apex upto the mid-point of base) e) Demographic parameters: Age (in years), gender.

RESULTS AND ANALYSIS:

The study revealed that majority i.e. 38% of the study subjects belonged in the age group of 31-40 years.

Table-1: Distribution of study subjects as per gender in two groups (N=100)

Group	*Male*	*Female*	*Chi-square, df, p*
	No. (%)	No. (%)	
Study	23 (46.0)	27(54.0)	X2=0.000 d.f=1
Comparison	23(46.0)	27(54.0)	P=1.00
Total	46 (46.0)	54 (54.0)	---------

X2= Chi Square: df=Degree of Freedom: p= p-value

Overall female participant were slightly more than the male but in both the groups they were in comparable number and the difference was found to be statistically insignificant.

Table-2: Distribution of study subjects as per gender in different age groups (N=100)

Age (yrs) group	Male	Female	Total	Chi-square, df, p
	No. (%)	No. (%)	No. (%)	
≤30	12(37.5)	20 (62.5)	32 (100)	X2=3.530
31-40	16(42.1)	22(57.9)	38(100)	Df=2 P=0.171
>40	18(60.0)	12(40.0)	30(100)	
Total	46(46.0)	54(54.0)	100(100)	----------
X2= Chi Square: df=Degree of Freedom: P= p-value				

Table-3: Distribution of participants as per the anatomical position of apex of sacral hiatus across gender (N=100)

Gender	*Anatomical level of apex*		*Chi-square, df, p*
	Lower level of S4 vertebra & above	At 5 th sacral vertebra No. (%)	
	No. (%)		
Male	40(86.96)	06 (13.04)	X2=0.088,
Female	48(88.89)	06(11.11)	df= 1, P=0.767
Total	88(88.0)	12(12.0)	----------
	X2= Chi Square df=Degree of Freedom P= p-value		

X2= Chi Square df=Degree of Freedom P= p-value

Majority (88.0 percent) of the patients was found to have the apex of their sacral hiatus at the level of fourth sacral vertebrae or slightly above it. So far as the anatomical position of the apex of the sacral hiatus is concerned, no significant difference between the gender could be found out.

Table-4: Distribution of participants as per the anatomical position of apex of sacral hiatus between groups (N=100)

Gender	*Anatomical level of apex*		*Chi-square, df, p*
	Lower level of S4 vertebra & above No. (%)	At 5 th sacral vertebra No. (%)	
Male	40(86.96)	06 (13.04)	X2=0.088,
Female	48(88.89)	06(11.11)	df= 1
			P=0.767
Total	88(88.0)	12(12.0)	----------
	X2= Chi Square df=Degree of Freedom P= p-value		

X2= Chi Square df=Degree of Freedom p= p-value

Though in a higher proportion of patients of comparison group the sacral apex was found to lie at the level of S4 vertebra significant.

Table-5: Distribution of participants according to the anatomical position of the base of sacral hiatus across gender (N=100)

Anatomical level of base	*Gender*		*Fisher exact test, p (two tailed)*
	Male	*Female*	
	No. (%)	*No. (%)*	
At level of S4 vertebra & above	04(8.0)	02(4.0)	P=0.4095
At level of S5 vertebra	42(92.0)	52(96.0)	
Total	46(100)	54(100)	---------

Analysis of data reflected that 94.0 percent of study subject was found to have the base of the sacral hiatus at the level of 5th sacral vertebrae. The anatomical position of the base of the sacrum was found to have no statistically significant difference between the genders **[p=0.4095 in 2 tailed Fisher exact test]**

Table-6: Distribution of participants as per the anatomical position of base of sacral hiatus between two groups (N=100)

Groups	*Level of anatomical position of sacral base*		*Fisher exact test, p (two tailed)*
	At level of S4 vertebra & above	*At level of S5 vertebra*	
	No. (%)	*No. (%)*	
Study	03(6.0)	47 (94.0)	1.000
Comparison	03(6.0)	47(94.0)	
Total	06(6.0)	94(94.0)	----------

In respect of the anatomical position of base of the sacral hiatus two groups were perfectly comparable.

Table-7: Distribution of participants according to the length of their sacral hiatus across the gender (N=100)

Length of sacral hiatus (mm)	*Gender*		*Chi-square, df,p*
	Male	*Female*	
	[No. (%)]	*[No. (%)]*	
≤15	20(28.0)	28(36.0)	X2=1.062, df=3, P=0.786
16-20	18(40.0)	17(44.0)	
21-25	07(28.0)	07(12.0)	
>25	01(4.0)	02(8.0)	
Total	46(100)	54(100)	----------

X2= Chi Square df=Degree of Freedom p= p-value

The length of the sacral hiatus was estimated in the present study and the overall value was 16.33±4.15 mm with range of 11-27 mm. According to the length of the sacral hiatus the participants were divided in to different categories. The majority (44.0 percent) of the study subjects was found to have sacral hiatus in the range of 16-20 mm length. In this regard no statistically significant difference could be observed in the distribution between the genders.

Table-8: Distribution of participants according to the category of length of sacral hiatus across two groups (N=100)

Length of sacral hiatus (mm)	**Group**		**Chi-square, df,p**
	Study	**Comparison**	
	[No. (%)]	[No. (%)]	
≤15	17(34.0)	31(62.0)	X2=10.369 Df=3 P=0.016
16-20	20(40.0)	15(30.0)	
21-25	10(20.0)	04(8.0)	
>25	03(6.0)	0	
Total	50(100)	50(100)	----------

X2= Chi Square df= Degree of Freedom P= p-value

The table shows that significantly higher proportion of study subjects in the comparison group belonged in the group having length of sacral hiatus 15 mm or less

Table-9: Distribution of participants as per their age groups and category of length of sacral hiatus (N=100)

Length of sacral hiatus (mm)	**Age groups**			**Chi-square, df, p**
	≤30 y	**31-40 yrs**	**40 yrs**	
	No. (%)	**No. (%)**	**No. (%)**	
≤15	17(53.13)	17(44.74)	14 (46.67)	X2=2.072, Df=6, P=0.913
16-20	11(34.38)	13(34.21)	11(36.67)	
21-25	04(12.50)	06(15.79)	04(13.33)	
>25	0	02(5.26)	01(3.33)	
Total	32(100)	38(100)	30 (100)	----------

X2= Chi Square df= Degree of Freedom p= p-value

Length of the sacral hiatus had no significant variation across the age categories. The length of the sacral hiatus was also found not to vary across the age groups.

Table-10: Distribution of participants as per the length of sacral hiatus between the gender (N=100)

Gender	*Length of sacral hiatus (mm)*	
	mean±sd	*'Unpaired*
Male [n1=46]	17.10±3.82	Unpaired t =1.746, Df=98, P= 0.084
Female[n2=54]	15.66±4.33	
Total	16.33±4.15	----------

According to the lengthof the sacral hiatus the patients in two genders were comparable leaving no statistically significant difference in between.

Table-11: Distribution of participants as per the category of diameter of sacral hiatus and gender (N=100)

Diameter of sacral hiatus (mm)	*Gender*		*Chi-square, df, p*
	Male	*Female*	
	[No. (%)]	*[No. (%)]*	
≤10	33(71.74)	46(85.19)	X2=2.833, Df=2, P=0.243
11-15	12(26.09)	07(12.96)	
>15	01(2.17)	01(1.85)	
Total	46(100)	54(100)	----------

X2= Chi Square df= Degree of Freedom P= p-value

Overall diameter of sacral hiatus was estimated to be 9.27±2.43 mm. According to the diameter of the sacral hiatus three groups were created. It was revealed in the above table that no variation among categories created based on the diameter of the sacral hiatus could be explored across the genders. It was also noted that majority (79.0 percent) of the patients had the diameter of sacral hiatus in the range of 10 mm or less.

Table-12: Distribution of participants as per their age groups and category of diameter of sacral hiatus (N=100)

Diameter of sacral hiatus (mm)	**Age groups**			**Chi-square, df, p**
	≤30 yrs	**31-40 yrs**	**40 yrs**	
≤10	26(81.25)	28(73.68)	25(83.34)	X2=2.157, Df= 4, P=0.707
11-15	06(18.75)	09(23.68)	04(13.33)	
>15	0	01(2.63)	01(3.33)	
Total	32(100)	38(100)	30 (100)	----------

X2= Chi Square df= Degree of Freedom P= p-value

Majority i.e.79 percent of the participants had sacral hiatus of diameter of 10 mm or less. However, higher age group was shown to have higher proportion of individual with hiatus with diameter of 10mm or less.No variation in the distribution of participants among the diameter categories was revealed between the age groups.

Table-13: Distribution of participants as per the diameter of sacral hiatus between genders (N=100)

Gender	*Diameter of sacral hiatus (mm)*	*'Unpaired*
	Mean ± sd	
Male	9.50±2.59	Unpaired t =0.845, Df=98,
Female	9.09±2.29	P=0.400
Total	9.34±2.58	----------

The above Table-13 shows that there was no statistically significant difference between the genders in respect of the diameter of the sacral hiatus.

Table-14: Distribution of participants as per their length of sacral hiatus between the groups (N=100)

Group	*Length of sacral hiatus (mm)*	
	Mean ± sd	*'Unpaire*
Study	17.54±4.25	Unpaired t =3.049, Df=98,
Comparison	15.11±3.69	P=0.003
Total	16.33±4.15	----------

The above Table-14 shows that the study group had higher length of sacral hiatus and the difference was found to be statistically significant.

Table-15: Distribution of participants as per the diameter of sacral hiatus across groups (N=100)

Group	*Diameter of sacral hiatus (mm)*	
	Mean ± sd	*'Unpaire*
Study	10.27±2.66	Unpaired t =3.826, Df=98,
Comparison	8.41±2.16	P=0.000
Total	9.34±2.58	----------

The above Table-15 shows that the study group had higher diameter of sacral hiatus and the difference was found to be statistically significant.

DISCUSSION:

Low back pain is a common feature in modern day life. We have taken radiograph of known cases of low back pain, measured the sacral hiatus and compared them with the comparison group to assess whether the morphology of sacral hiatus is responsible for low back pain or not. The sacral hiatus is an important bony landmark. Clinicians sometimes experience difficulties in determining the hiatus of sacrum by palpating it clinically. It is therefore important to describe the anatomical variations of the location of sacral hiatus to guide the clinical procedure e.g. caudal epidural block. Variations in dorsum of the sacrum may have some association with clinical conditions like low back pain.Long back **Brailsford JF** [6] proposed that the variation in the development of the sacral hiatus can cause decrease area for the attachment of extensor muscle at back causing painful conditions.In spina-bifida the laminae of all the sacral vertbrae fail to fuse at back leading open sacral canal i.e. a midline gap. In spina-bifida occulta the posterior element of upper sacral vertebrae fail to fuse.**Mehmet S et al** and **Kumar V e al** [7,8] also mentioned that these kinds of anatomical variations would lead to painful condition of the back and some clinical procedural failures. Variants of sacral hiatus (SH) may be considered as the lower pole of the spectrum of failure in fusion of laminae of sacral vertebrae with spina-bifida as its highest grade which is established to be due to folic acid deficiency during pregnancy.**Malarvani T et al** [9] also supported this hypothesis that this developmental variations of the dorsum of the sacral bone leads to the decreased surface area for the attachment of extensor muscles of the back and so even a mild stress to these muscles would make it strain more and result in painful conditions of the back.So, studying the area of sacral hiatus i.e. level of its apex; its length, breadth and diameter is a pertinent issue. Knowledge of higher area of sacral hiatus as one of the causes of low back pain can be utilized for prevention of this chronic disabling condition. In the present study the percentages among male and female low back pain patients having their apex of sacrum at S4 level were revealed to be 91.30 percent and 96.29 percent, respectively and these were higher than what were observed by **Kumar et al.**[8]**.** Contrary to the observations made by Mohamed S M **et al** [10] the present study revealed that there was no statistically significant difference between the mean sacral hiatal length across the gender. Analysis in the present study reflected that the length of sacral hiatus was higher among the patients suffering from low back pain than their counterpart. This difference was found to be statistically robust.The dorsal surface of the sacral bone is the area where many of the extensor muscles of the back get attached. Weakness in the origin or insertion of any muscle leads to its frequent strains which in turn may culminate into one of the causes of low back pain in the long run.The present study revealed higher proportion of low back pain patients showing sacral apex at higher level at S4. This group of study subjects had significantly longer sacral hiatus with higher diameter i.e. larger deficient dorsum of sacra. As proposed earlier by few investigator this finding led to conclude that the low back pain patients might have higher deficiency in back of their sacrum, resulting poor attachment of the extensor group of muscles of the back, leading in turn to the development of muscular strain and thereby in the long run the patients were suffering from low back pain. The results of the present study couldn't be compared with similar other study. This was due to the lack of comparable study done on the living subjects suffering from low back pain.So, to get the hypothesis i.e. deficiency on the dorsal surface of the sacrum is higher among the low back pain patients in whom it is one of the causes of the disease firmly established a larger study involving the living patients suffering from low back pain can be conducted along with a suitable matched control/comparison group in different settings.

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