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Sacral Anatomical Malformations

Jeewanjot Sekhon¹, AjitPal Singh^{1*}, Varun Chopra¹ & Abhilasha²

¹Dept. of Anatomy, Desh Bhagat Dental College & Hospital, Sri Muktsar Sahib (Punjab)

²Dept. of Anatomy, JCD Dental College & Hospital, Sirsa (Haryana), India

Corresponding Author: Dr. AjitPal Singh
Prof. & Head, Dept. of Anatomy
Desh Bhagat Dental College & Hospital
Sri Muktsar Sahib (Punjab), India
Mobile: +91 8427001562

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Abstract

Sacrum a large triangular fusion of five sacral vertebrae is found wedged between the two innominate bones and forms postero-superior wall of pelvic cavity. An arched sacral hiatus is usually observed below the fourth or the third sacral spine. The present study was conducted in the Department of Anatomy at Desh Bhagat Dental College and Hospital, Sri Muktsar Sahib. Total 20 dry human sacra were studied with regard to the level of apex of sacral hiatus, level of base of hiatus, shape of hiatus and sacral foramina morphologically.

In the present study the most prominent shape of the hiatus was inverted-U (45%). The apex

of hiatus was commonly found at the level of 4th sacral vertebra in 50% of sacra while the base was more commonly found at the level of 5th sacral vertebra (55%). The knowledge of anatomical variations of sacral hiatus is of great significance as sacral hiatus is the site of caudal epidural anaesthesia and its knowledge may help improve its success rate.

Key Words: Sacrum, Variations, Sacral hiatus, Vertebrae, Lumbosacral Region, Anterior sacral meningocele.

Introduction

The anomalies or congenital malformations have been described even from the oldest of times and they are produced by the pathological modifications of the normal development during intrauterine life [1]. A great number of congenital malformations can appear at the level of skeleton, being localised on the skull, at the level of spinal column and of the limbs. The greatest incidence of the anomalies was registered at the level of the spinal column, spina bifida being the most common congenital malformation where the osseous median line is incompletely closed, the majority of cases occurring in lumbosacral region, especially at the level of sacrum bone [2]. The spinal dysraphism (spina bifida, spinal defects, defect of the neural tube, opened spinal column) comprises all the forms of the congenital affections of the spinal column resulting into a defect neuronal arch through which meninx or neuronal elements can protrude [3]. Sacrum a large triangular fusion of five sacral vertebrae is found wedged between the two innominate bones and forms posterosuperior wall of the pelvic cavity. The blunt, caudal apex articulates with coccyx and the promontory or the base which articulates with the 5th lumbar vertebra at the lumbosacral angle. The spines of the sacral vertebrae are fused with each other. An arched sacral hiatus is usually observed below the 4th or the 3rd sacral spine on the dorsal aspect of sacrum. It is produced by the failure of the laminae of the 5th sacral vertebra to meet in midline [4]. If the laminae of the higher sacral vertebra are not fused, then there will be a higher sacral hiatus. The sacral hiatus contains lower sacral and coccygeal nerve roots, filum terminale externa, fibrofatty tissue and covered by skin, subcutaneous fat and sacrococcygeal membrane. Sacral hiatus has been utilised for administration of epidural anaesthesia in obstetrics [5] as well as in orthopaedic practice for

treatment and diagnosis [6]. The reliability and success of caudal epidural anaesthesia depends upon anatomical variations of sacral hiatus as observed by various authors [6-8]. Caudal epidural block (CEB) is necessary in various clinical procedures for providing analgesia and anaesthesia in the specific region of surgery. It involves injecting the drug into the epidural space through the sacral hiatus. In adults it is occasionally difficult to determine the location of the sacral hiatus and subsequently the caudal epidural space. There are likely chances that the drug injected for caudal epidural block may enter the subarachnoid space if dural sac and subarachnoid space are extending till the level of third sacral vertebra as suggested by Patil et al, 2012 [9]. Clinicians should also be aware of this variation so as to avoid injecting an analgesic or anaesthetic drug into subarachnoid space while injecting it into epidural space. Anterior sacral meningocele (ASM) is a very rare presentation of spinal dysraphism characterized by the herniation of the meningeal sac through a bone defect in the anterior aspect of the sacrum. It is primarily an isolated congenital anomaly, but it may be associated with underlying connective tissue disorders including neurofibromatosis type 1 (NF-1), marfan syndrome and ehlers-danlos syndrome [10,11].

Material & Methods

The present study was conducted in the Department of Anatomy at Desh Bhagat Dental College and Hospital, Sri Muktsar Sahib. Total 20 dry human sacra were studied with regard to the level of apex of hiatus, level of base of hiatus, shape of hiatus and sacral foramina. Observations were substantiated with photographs.

Observations

In the present study, the apex of hiatus was found at the level of 4th sacral vertebra in 50% of sacra and a rare variation in 5% it was found at the level of 1st sacral vertebra (Table 1, Fig.1 & 2). In 55% sacra the base of hiatus was located at the level of 5th sacral vertebra and least at the level of coccyx (20%) (Table 2, Fig.3). Amongst the shape of hiatus inverted U was the most predominating shape (45%). One of the sacrum had enlarged first anterior sacral foramen on right side (Table 3, Fig.4,5,6). \

Table 1: Location of apex of hiatus in relation to the level of sacral vertebra

Sr.No.	Location of apex	No. Of sacra	Percentage
1	5 th sacral vertebra	0	0
2	4 th	10	50%
3	3 rd	6	30%
4	2 nd	3	15%
5	1 st	1	5%



Fig 1: Location of apex of hiatus at the level of 4th sacral vertebra



Fig 2: Location of apex of hiatus at the level of 1st sacral vertebra

Table 2: Location of base of hiatus in relation to sacral/coccygeal vertebra

Sr. No.	Location of base	No. Of sacra	Percentage
1	5 th sacral vertebra	11	55%
2	4 th	5	25%
3	Coccyx	4	20%



Fig 3: Location of base of hiatus at the level of fifth sacral vertebra.

Table 3: Shape of sacral hiatus

Sr. No.	Shape	No. of Sacra	Percentage
1	Inverted U	9	45%
2	Inverted V	8	40%
3	Others	3	15%



Fig 4: Shape of hiatus – Inverted U



Fig 5: Shape of hiatus – Inverted V



**Fig 6: Enlarged first anterior sacral foramen
on right side**

Discussion

Sacrum consists of five sacral vertebrae and the number may vary according to the variation present i.e. sacralisation or lumbarisation. The development of sacrum resembles the ossification of atypical vertebrae. The secondary centres of ossification appear after puberty and all the sacral vertebrae start fusing with each other. Any defect in the formation of the primary centres may lead to incomplete formation of sacral canal and incomplete ossification of the laminae [4]. The incomplete fusion of the posterior elements of 5th or 4th sacral vertebra results in the formation of sacral hiatus. Kumar et al, 2009 [12] noted various shapes of sacral hiatus, most common being inverted V (76.23%) and inverted U (27.5%), while in the present study the frequency percentage of shapes were variable, the most common being the inverted U (45%) which is in relevance with Aggarwal et al [13] (40.35%). This hiatus is covered by sacro coccygeal membrane and forms an important landmark to perform the caudal epidural block [9]. In 45% of cases, the apex of sacral hiatus is located at the level of S3 and S4 vertebra and it is of great significance as apex of sacral hiatus is an important landmark for carrying out successful caudal epidural block. In the present study apex of sacral hiatus was

seen more predominantly at the level of 4th sacral vertebra (50%). Earlier studies also reported 4th sacral vertebra to be the common level for apex i.e. Kumar et al, 2009 [12] found in 76.23%, Sekiguchi et al [6] in 64% and Seema et al [14] in 56.67% cases. Thus, exact localisation of the sacral hiatus would certainly help in the easy passage of needle into the sacral canal [15]. It has been found in many studies that the incidence of failure of caudal epidural block in 7% of cases has been attributed to the presence of bony septum in the sacral hiatus, hiatal agenesis or complete agenesis as found in spina bifida [6]. Abnormal spina bifida may also result in exposure of all the structures in the sacral canal. The attachment of muscles like erector spinae and multifidus may also be altered in case of any anomaly involving the dorsal surface of sacrum [16]. Radiographic studies conducted by Paul (1938) on one thousand patients who complained of pain in the lower part of the back and legs suggested that approximately 30% showed an anomaly of the lumbosacral spine [17]. Sadler is of the opinion that HOX gene is responsible for patterning of the shapes of vertebra [4,18]. In the present study base of sacral hiatus was seen most commonly at the level of 5th sacral vertebra (55%) which is similar with studies by Kumar et al, 2009 [12] 81.17% and Seema et al [14] 71.67%. On the other hand it was least found at the level of coccyx (20%). The knowledge about shape and extent of sacral hiatus is important because, it is the site where caudal analgesia is given in urology, proctology, general surgery and obstetrics & gynecology [15]. The caudal epidural block is widely used for the diagnosis & treatment of lumbar and spinal disorders by orthopaedicians with success rate of 70%-80% [6]. The sacral hiatus contains lower sacral and coccygeal nerve roots, filum terminale externa and fibrofatty tissue [19]. If the apex of sacral hiatus extends high up as is seen in the present study (fig.no.2) then it may contain second, third, fourth and fifth sacral nerve roots also apart from it containing the usual structures. These nerve roots are then exposed and thus are liable to be damaged by any trivial injury in the regional area. It is generally accepted that a scimitar shaped sacrum (a smooth concave unilateral sacral defect) is considered to be diagnostic of ASM on plain radiograph [11]. However, bone defects vary from an enlarged foramen to complete sacral agenesis [10]. Two types of ASM exist- congenital and acquired. Congenital ASM appears to be true anterior dysraphism featuring a spectrum of bony anomalies, from minor bony defects to complete lower sacral agenesis [20,21]. Congenital ASM is usually sporadic in

presentation, but predominantly autosomal-dominant with variable penetrance [22-24]. X-linked cases have been reported [21]. Acquired ASM features abnormal structure of the duramater and is related to connective tissue disorders [22]. It may be seen in Marfan's and Marfanoid syndromes, in neurofibromatosis, in Ehlers-Danlos syndrome, in ankylosing spondylitis and in osteogenesis imperfecta [21,23,24]. It may be present without these pathologies. ASM does not regress [22], symptomatic ASM requires surgical intervention for patient's comfort and safety. From a gynaecological perspective, on palpation ASM can mimic an ovarian cyst or other adnexal cystic mass but ASM will be located more posteriorly [23]; from obstetric viewpoint, ASM can present a mechanical obstacle to delivery [24-26]. Knowledge of structural modification of sacrum is essential.

Conclusion

Orthopaedicians and anaesthetists need to be aware of such variations as sacral hiatus is the site where caudal analgesia and epidural anaesthesia are administered. Other problems like lower backpain and other neurological symptoms may arise due to such conditions. It is important from gynaecological and obstetric perspective too as ASM can mimic ovarian cyst or other masses and can present an obstacle to delivery.

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Authors Column



Dr. AjitPal Singh, Vice Principal, Prof. & Head, Dept. of Anatomy, Desh Bhagat Dental College & Hospital, Sri Muktsar Sahib, Punjab was always motivated to work independently and collaboratively with other bio-medical professionals and always keen to learn and develop his professional skills with a focus on new research development. After completing Ph.D. in Life Sciences from the Punjab University in 2005, Dr. Singh started independent research work and published 26 papers in National & International Journals. He wrote one book – chapter also. He has attended 32 National Conferences and 3 International Conferences held in Italy, Japan and in USA. Prof. Singh is Life Member of several scientific bodies and is the recipient of Mother Teresa Gold Medal award in 2012.