Sacrococcygeal sinus angle: as a new anatomic landmark for the posterior approach of presacral lesions

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Abstract

Purpose We have discussed the importance of sacro-coccygeal sinus angle (SSA), which is a new anatomical landmark in the surgery of presacral lesions. Because of its anatomical structure, the sacrum limits the surgical exposure like a compact barrier for the posterior surgical approach. The main aim of this paper is to explain the anatomical description and clinical importance of SSA in the surgery of presacral lesions.

Methods Three groups were designated, consisting of ten patients in each group, as early childhood (group 1), late childhood (group 2) and adulthood (group 3). Patients were selected randomly. The degree of SSA measurement was performed between the line tangent to the anterior margin of the first sacral vertebra and the line from the promontorium to the tip of the coccyx. The measurement of SSA was performed on patients' lumbosacral magnetic resonance images. When the SSA forms a triangle via a parallel line starting from the inferior tip of the sacrum and running parallel to the ground, the area of the triangle also covers the field of view of the presacral region. In addition, the sacral region needed to be resected for maximum exposure is also within this area.

Results The mean SSA was measured to be $53.9 \pm 11.4^\circ$ in group 1, $77.8 \pm 11.2^\circ$ in group 2 and $74.5 \pm 12.5^\circ$ in group 3. Intergroup comparisons revealed a significant difference between group 1 and the other two groups statistically. It was found that the SSA was 20° less in group 1 as compared to the other age groups ($p = 0.0005$). The area of a triangle is calculated using the sine area formula, and according to this formula the area of a triangle increases when the degree of the angle increases, thus comprising larger part of the sacrum. This condition requires more and wide sacral resection to obtain maximum exposure in the presacral zone.

Conclusions We have observed that the SSA is significantly smaller during early childhood compared with the other age groups. This feature provides an anatomical superiority in this age group for the posterior approach in the surgical treatment of presacral masses.

Keywords Coccyx · Presacral lesions · Sacrococcygeal sinus angle · Sacrum

Introduction

The presacral region is bounded by the rectum anteriorly, sacrum posteriorly, promontorium of the sacrum and peritoneum superiorly and iliac vessels laterally [1, 10]. A wide range of pathological conditions can be seen in the presacral region [2]. Congenital masses such as teratomas, chordomas, dermoid or epidermoid tumors; tumors arising from neural elements such as schwannomas, neurofibromas and neuroblastomas; and mass lesions showing distinct features such as infiltrative rectum tumors, metastases, rhabdomyosarcomas and lymphangiomas can be seen in the presacral region [1, 3, 9, 10, 13]. Since the presacral region involves several

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different anatomical structures and related pathologies, it is a common point of interest of different disciplines and generally requires a multidisciplinary approach [2].

The type of tumor and the degree of malignancy are the most important factors that determine the prognosis of the masses in the presacral region. Moreover, the amount of tumor mass removed during the surgical procedure is also an important factor that determines the prognosis [2, 10, 12]. Therefore, the selection of the most suitable surgical approach for the maximum extent of safe resection is of great importance. Three main surgical approaches are used; anterior approach, posterior approach and a combination of these two approaches [1, 2, 13]. There are remarkable advances in robotic surgery [6]. Also, laparoscopic procedures are used as a minimally invasive method for the lesions in the presacral region [4, 14]. In the light of overall surgical experiences and technological advances, particularly two parameters play an important role in choosing the surgical approach: the size and location of the tumor [1, 2, 13]. The sacrum, which is the main anatomic landmark that forms a compact barrier for both parameters, is the basic anatomical point for the definition of each of the three surgical approaches.

In this paper, we defined a new anatomical landmark associated with the structure of the sacrum for the optimum surgical approach. This landmark, defined as the sacrococcygeal sinus angle (SSA), is the angle formed by the tangent line passing through the anterior surface of the first sacral vertebra (S1) and the line extending from the promontorium to the distal end of the coccyx (Fig. 1).

We discussed the degree of SSA in different age groups, as well as its role in choosing the surgical approach.

Materials and methods

For the measurement of SSA, three groups were designated: (group 1) early childhood, (group 2) late childhood and (group 3) adulthood. Early childhood was defined as the period of life between 0 and 3 years of age, late childhood as the period between 3 and 16 years of age and adulthood as the period between 16 and 70 years of age. All subjects were randomly selected from the electronic archives of the radiology unit among patients undergoing lumbosacral magnetic resonance imagination (MRI) for any reason. Each group consisted of ten subjects and whether the groups were homogeneously distributed according to gender and age was disregarded. SSAs were measured and recorded using an angle measurement program at the working station (Advantage Windows, software version 4.2, GE Medical Systems), in which MRI scans were evaluated using a 1.5 Tesla MRI device (Signa Excite, GE Healthcare, Milwaukee, WI, USA). The groups

Fig. 1 T2-weighted mid-sagittal lumbosacral magnetic resonance imaging. *a* The line tangent to the anterior margin of the first sacral vertebra. *b* The line which starts from the promontorium and ends at the tip of the coccyx. *Alpha* refers to the sacrococcygeal angle between these two lines, *L5* fifth lumbar vertebra, *S1* first sacral vertebra

were compared using a one-way ANOVA analysis of variance, followed by Tukey's post hoc analysis. *p* value <0.05 was considered to be statistically significant.

Results

The Shapiro–Wilk test showed that the data were normally distributed ($p = 0.075$). The mean SSA was 53.9 ± 11.4 , 77.8 ± 11.2 and $74.5 \pm 12.5^\circ$ in groups 1, 2 and 3, respectively. The degree of SSA of each subject is shown in Table 1.

Intergroup comparisons revealed a significant difference between group 1 and the other two groups ($p = 0.0005$). It was found that the SSA was 20° less in the 0- to 3-year age group as compared to the other age groups. The SSAs of group 2 and group 3 were comparable.

Discussion

Surgical interventions used for the treatment of presacral masses include anterior approach (abdominal), posterior

Table 1 Age, gender and sacrococcygeal angle measurements of cases in each group

Case	Group 1			Group 2			Group 3		
	Age	Gender	Angle	Age	Gender	Angle	Age	Gender	Angle
1	0	M	61.2	16	F	82.2	49	M	62.6
2	1	M	57.7	15	F	73.6	50	M	70.2
3	1	M	39.6	6	F	64.9	42	M	96.4
4	3	F	52.8	15	F	58.4	58	M	67.0
5	1	F	46.8	8	F	84.7	55	F	90.0
6	2	F	64.5	14	F	82.2	26	M	81.9
7	3	M	65.6	14	F	88.0	51	M	70.2
8	1	M	49.6	15	F	67.7	24	F	70.4
9	2	M	68.0	10	F	82.8	71	M	56.0
10	0	M	34.0	14	F	94.2	32	F	80.7

Fig. 2 The area of a triangle increases when the degree of the angle increases and thus comprises larger part of the sacrum. Alpha refers to the sacrococcygeal angle. **a** The illustration of the more narrow angle, **b** the illustration of the wider angle

approach (transsacral) and a combination (abdominal + transsacral) of these two approaches [8, 10, 11, 15]. The main factors that determine the type of surgical approach include malignancy because of invasion, size of the tumor and location of the tumor with reference to the sacrum [1, 13]. Basically, anterior or combined approaches are preferred for masses above the level of the third sacral vertebra (S3) and for large and malignant masses, whereas the posterior approach is used for relatively smaller and benign masses located at the inferior sacral region (below the level of S3). Detachment of the tumor from its anterior attachment is recommended especially to prevent large vessel injury in the presence of large, invasive tumors extending to the upper levels of the sacrum [5, 10, 13]. Moreover, the sacrum, as a compact barrier, limits the surgical exposure when using the posterior approach for tumors located particularly at the upper levels and causes a blind zone for the surgeon. Therefore, depending on the

size and level of the tumor, partial resection of the sacrum might be required while using the posterior approach. Although, resection of the coccyx alone is sometimes adequate, larger sacral resection is required in some cases. For masses involving the sacrum, the amount of resection is consistent with the sacral level involved and is predictable. However, for presacral masses without sacral involvement, sacral resection is performed to maximize the exposure in the presacral region and to minimize the blind zone. To minimize the blind zone and widen the field of view while using the posterior approach is of great importance for total resection of the tumor and for reducing the complications.

If the SSA described by us forms a triangle via a parallel line starting from the inferior tip of the sacrum and running parallel to the ground, the area of the triangle also covers the field of view of the presacral region. Also, the sacral region needed to be resected for maximum view is also within this

area. The area of the triangle is calculated using the sinus area formula. According to this formula, the area of a triangle increases when the degree of the angle increases and thus comprises larger part of the sacrum (Fig. 2).

This indicates that larger sacral resection is required to provide maximum field of view in the presacral region. The present study showed that the SSA was significantly smaller in the 0- to 3-year age group as compared to the other age groups. There was no significant difference between the other two groups. We are of the opinion that this anatomical feature provides an advantage for using the posterior approach for the treatment of presacral masses in patients ≤ 3 years of age. Thus, a large field of surgical view can be achieved with less extensive sacral resection, even with coccygeal resection alone. Since the SSA is small in this age group, even masses extending above the level of the first sacral vertebra can be safely resected via the posterior approach [7]. Pelvic width and depth as well are less in early childhood. Therefore, the posterior approach should be considered in the first place as a more minimally invasive approach for the treatment of presacral tumors of early childhood, though the tumor is substantially large.

In conclusion, we are of the opinion that the SSA defined by us is an ancillary anatomical landmark while choosing the surgical approach for the treatment of presacral masses. In the posterior approach, as the SSA decreases, the extent of resection that must be performed to obtain a maximum field of view for presacral masses decreases. Since a narrow SSA will provide a wider viewing angle of presacral area in the posterior approach, it may be advantageous in malignant and large tumors with invasion to the surrounding tissues. Compared with the other age groups, the SSA was significantly smaller during early childhood. This feature provides an anatomical superiority in this age group for the posterior approach in the surgical treatment of presacral masses. Also, a larger scale with a larger cohort of study patients is required to validate this perspective as a fundamental part of an operating strategy against presacral tumors.

Conflict of interest None.

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