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กระดูกกระเบนเหน็บติดกับกระดูกเอวชิ้นที่ 5 ในคนไทย

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Sacralization of the 5th Lumbar Vertebra in Thais

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หลักการและเหตุผล: กระดูกกระเบนเหน็บโดยทั่วไปประกอบด้วยกระดูกย่อย 5 ชิ้น เชื่อมติดกันเป็นชิ้นเดียว ได้มีรายงานภาวะกระดูกกระเบนเหน็บติดกับกระดูกเอวชิ้นที่ 5 (sacralization) ในหลายเชื้อชาติ แต่ยังไม่มีการศึกษาในประชากรไทย

วัตถุประสงค์: เพื่อศึกษาอุบัติการณ์ของภาวะกระดูกกระเบนเหน็บติดกับกระดูกเอวชิ้นที่ 5 (sacralization) ในประชากรไทย

รูปแบบการศึกษา: การศึกษาเชิงพรรณนา

สถานที่ทำการศึกษา: คลังกระดูกภาควิชากายวิภาคศาสตร์ คณะแพทยศาสตร์ มหาวิทยาลัยขอนแก่น

กลุ่มตัวอย่าง: กระดูกกระเบนเหน็บจากโครงกระดูกคนไทยที่อยู่ในคลังกระดูกของภาควิชากายวิภาคศาสตร์ คณะแพทยศาสตร์ มหาวิทยาลัยขอนแก่นจำนวน ทั้งสิ้น 206 โครง ทั้งเพศชายและเพศหญิง (จากเพศชาย 114 โครง และจากเพศหญิง 92 โครง) อายุเมื่อเสียชีวิตอยู่ระหว่าง 26-90 ปี

วิธีการศึกษา: สำรวจหากระดูกกระเบนเหน็บชิ้นที่ประกอบด้วยกระดูกย่อย 6 ชิ้น เลือกเฉพาะกระดูกกระเบนเหน็บที่มีกระดูกย่อย 6 ชิ้นที่เกิดจากการมีกระดูกเอวชิ้นที่ 5 เชื่อมติดกับชิ้นแรกของกระดูกกระเบนเหน็บ นับจำนวนชิ้นของกระดูกเอวของโครงกระดูกชุดเดียวกัน เพื่อยืนยันว่ากระดูกกระเบนเหน็บชิ้นที่เกินมาเป็นกระดูกเอวชิ้นที่ 5 บันทึกและนำข้อมูลที่ได้มาคำนวนหาอุบัติการณ์ของภาวะแปรผันดังกล่าว

ผลการวิจัย: พบอุบัติการณ์ภาวะ sacralization ในกลุ่มตัวอย่างประชากรไทย 9 ราย (4.4 %) โดยพบในเพศชาย 7 ราย (6.1 %) และในเพศหญิงเพียง 2 ราย (2.2 %) เท่านั้น ในเพศชายทั้ง 7 ราย พบ 4 ราย มีการเชื่อมติดกันของกระดูกเอวชิ้นที่ 5 กับกระดูกกระเบนเหน็บแบบสมบูรณ์ (complete sacralization) ส่วนที่เหลืออีก 3 ราย และในเพศหญิงทั้ง 2 ราย

Background: The sacrum generally is composed of five vertebrae fused to form a triangular bony mass. Numerous anatomical variations of the sacrum have been reported including many reports of sacralization of the fifth lumbar in different race. There has never been reported among Thais.

Objective: To determine the incidence of sacralization of the fifth lumbar vertebra among Thais

Design: Descriptive study based on numerical survey.

Setting: Bone Collection Unit, Department of Anatomy, Faculty of Medicine, Khon Kaen University, Thailand

Subjects: Included were 206 sacra from Thai skeletons, 114 males and 92 females between 26 and 90 years of age at death.

Methods: An anatomical study was done on the sacrum. The sacra consisting of six vertebrae, by incorporation of the fifth lumbar, were selected. To confirm the lack of a fifth lumbar vertebra, we re-counted the lumbar vertebrae belonging to the same skeleton of the selected sacrum. The specimens were then carefully examined and recorded.

Results: We found 9 (4.4%) specimens with the 5th lumbar vertebra fused to the first segment of the sacrum, representing sacralization; the incidence of which was 7 (6.1%) in males and 2 (2.2 %) in females. The degree of sacralization varied: complete in four out of seven of the males and incomplete in the remaining three out of seven males and in the two females.

Conclusions: The present study shows that the incidence of sacralization of the 5th lumbar vertebra among Thai is about 4.4 %. The knowledge of this anatomical variation

พบมีการเชื่อมติดกันแบบไม่สมบูรณ์ (incomplete sacralization)
สรุป: ข้อมูลที่ได้จากการศึกษาครั้งนี้ ทำให้ทราบอุบัติการณ์ของภาวะกระดูกกระเบนเหน็บติดกับกระดูกเอวชิ้นที่ 5 ซึ่งพบได้ 4.4 % ในประชากรไทย ภาวะความแปรผันดังกล่าวอาจเป็นประโยชน์สำหรับแพทย์ที่ควรคำนึงถึงในการประกอบการวินิจฉัยเบื้องต้น สำหรับผู้ป่วยที่มีปัญหาเกี่ยวกับบริเวณหลังส่วนล่าง

Keywords: Anatomic variation, Sacral foramina, Sacrum

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INTRODUCTION

The sacrum is a large, triangular, wedge-shaped bone located between the two innominate bones to form the posterior wall of the pelvic cavity.[1-2] Generally, the sacrum comprises five rudimentary fused vertebrae, but numerous anatomical variations have been reported[1-4]. The most common anomaly is additional elements yielding a six-segment sacrum, whereas reduction of sacral constituents is less common[4]. Such additional elements may due to fusion of the fifth lumbar or first coccygeal vertebrae[2,4]. In the current study, it is the fusion of the fifth lumbar vertebra to first sacral segment (sacralization)[5], which is of interest because there has been no published reports about sacralization in Thais. Our aim was, therefore, to establish the incidence of sacralization of the fifth lumbar vertebra among Thais.

MATERIALS AND METHODS

This study was approved by Ethics Committee on Human Specimens Research of Faculty of Medicine, Khon Kaen University, Thailand.

We examined 206 six sacra from Thai skeletons from the Bone Collection Unit, Department of Anatomy, Faculty of Medicine, Khon Kaen University. The subjects (114 males and 92 females) were between 26 and 90 years of age at death. Any increases in the number of elements of the sacrum were investigated and the identification of the six-segmented sacrum with five sacral foramina was performed.

The sacra consisting of six vertebrae, by incorporation of the fifth lumbar, were selected. Those with fusion of the first coccygeal vertebra were excluded. The lumbar vertebrae corresponding to the same skeleton of the selected sacra was re-counted to confirm the lack of a fifth lumbar. The specimens with sacralization of the fifth lumbar vertebra were carefully examined and evaluated for the degree of sacralization and recorded.

We used a two-fold subdivision of sacralization: 1) selected specimens which had a residual joint line between the transverse processes of the additional sacral elements constituted incomplete sacralization; while, 2) those with complete bony union between the transverse processes and the sacra constituted complete sacralization. The data were then analyzed using descriptive statistics and Gross anatomy observation.

RESULTS

Examination of 206 subjects revealed that 4.4% (9 cases) had their 5th lumbar vertebrae fused to the first segment of the sacrum, fulfilling the definition for sacralization. The incidence of sacralization was 6.1% (7 cases) in males and 2.2% (2 cases) in females (Table 1). Overall, the degree of sacralization was 4 out of 9 % complete vs. 5 out of 9 % Incomplete (Table 2). Complete sacralization was not observed among the female specimens. Complete sacralization occurred in 4 out of 7 cases of male (Figure 1), while incomplete sacralization (Figure 2) occurred in the remaining 3 males and both females (5 out of 9 of both sexes) (Table 2). The incidence of sacralization in our study was lower than the previous report[2,6-8], except the report of Moore and Illinois[9] (Table 3).

Specimens with complete sacralization presented true bony union between the transverse process of the 5th lumbar and the sacrum vertebrae on both sides, such that the contour of the 5th lumbar vertebra in these specimens could not be recognized since it appeared contiguous with

Table 1. Frequency distribution of sacralization of the 5th lumbar vertebrae

	Males [no. (%)]	Females [no. (%)]	Total [no. (%)]
Subjects	114	92	206
Sacralization	7 (6.1 %)	2 (2.2 %)	9 (4.4 %)

Table 2. Frequency distribution of degree of sacralization

	Males [no.]	Females [no.]	Total [no.]
Subjects	7	2	9
Sacralization:			
Complete	4 out of 7	0 out of 2	4 out of 9
Incomplete	3 out of 7	2	5 out of 9

Table 3. Incidence of sacralization from previous study compared with our study

Race	Incidence	References
Australian aboriginals	18 %	Mitchell, 1936
Indians	16 %	Bustami, 1989
Arabs	10 %	Bustami, 1989
Natives of Britain	8.1 %	Brailsford, 1928
Americans	3.6 %	Moore & Illinois, 1925
not mention	5 %	Moore & Dally, 1985
Thais	4.4 %	Our study

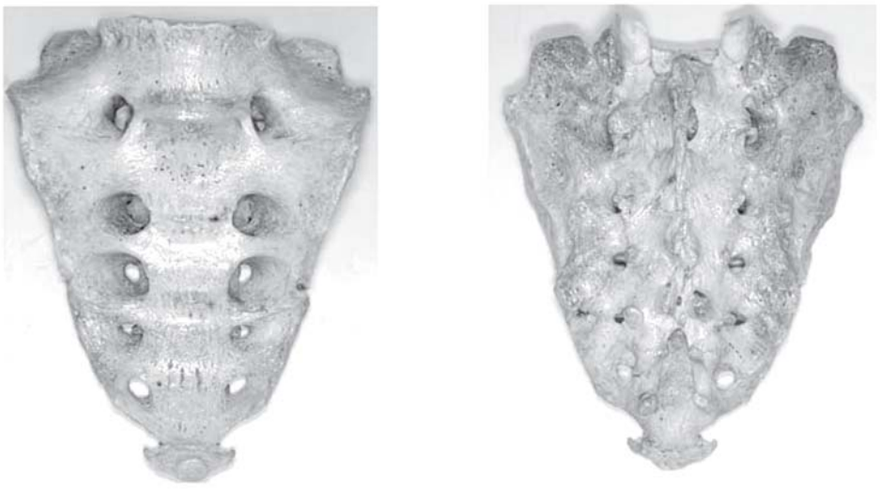
the sacrum. By contrast, when incomplete sacralization presented, the bony union between the transverse process of the 5th lumbar and the sacrum vertebrae was observed only on the right side of specimens and a definite joining line—between the transverse processes of the lumbar and the sacrum was noticed on the left side (*i.e.* instead of the true bony union). In addition, a cleft was observed between the 5th lumbar and the 1st sacral vertebral bodies (Figure 2) in all of these cases.

DISCUSSIONS

The present study shows that the incidence of sacralization of the 5th lumbar vertebra among Thais is 4.4 %. Based on the literature, sacralization varied by race and the incidence in our study was close to the 3.4% reported by Moore and Illinois[9] and the 5% commonly found among normal person as stated in Moore and Dalley[2], a textbook of Anatomy. Notwithstanding, the incidence in our study was much lower than that the 18, 16 and 10 percent found among Australian aboriginals, subcontinent Indians and Arabs, respectively (Table 3).

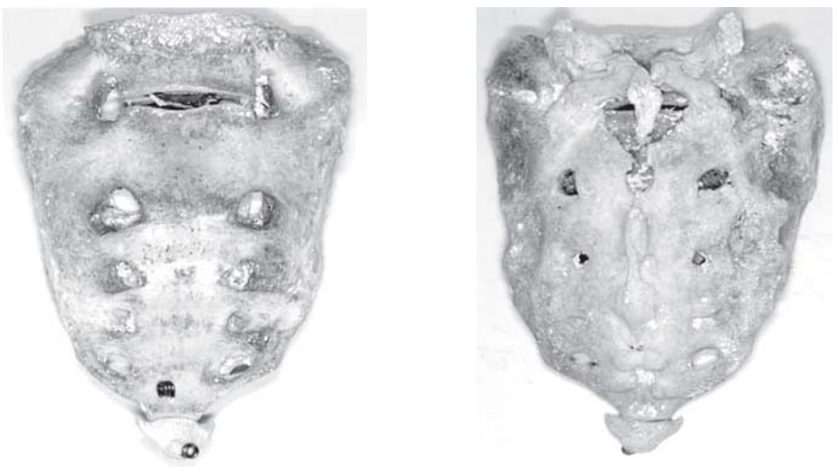
During the $4^{1}/_{2}^{th}$ week of human embryo, the vertebral column developes from ventromedial portion of the somite known as sclerotome. Each segment of sclerotome migrates from both sides to surround the neural tube and the notocord at the mid-line of the body plane. During the 5th week, each segment of sclerotome is divided into cranial and caudal portions. The cranial area further develops to form the vertebral body, whereas the caudal part develops to form the interventing disc [10,11]

These processes are considered to be regulated by the respective homeobox and paired-box genes, *Pax 1*



Ventral surface Dorsal surface

Figure 1. A complete sacralization in male



Ventral surface Dorsal surface

Figure 2. An complete sacralization in male

and Pax 9 in the control of cell poriferation during early sclerotome development[12,13]. As revealed in mice that were deficient for one functional copy of *Pax 1*, heterozygosity and homozygosity of the *Pax 9* mutation result in vertebral malformations in the lumbar region, such as fused and split vertebrae, as well as ossified fusions between vertebrae and neural arches[13]. Thus, the intervertebral disk cartilage between L5 and S1 vertebrae calcified to become a sacralization of the fifth lumbar vertebra, may be caused by some genetic determinants of these morphological changes from the somite to vertebrae. This hypothesis was supported by a previous study of Tini[14] as increased incidences of lumbrosacral transitional vertebrae were observed occurring within families.

Although, sacralization is not a serious anomaly, perhaps no more than an anatomical variant, the fusion of

the lumbrosacral joint may cause greater difficulty during labor as the pelvis is less mobile[15] and it may be the cause of low back pain problem.

In 1917, Bertolotti[16] described the relationship between low back pain and sacralization of the 5th lumbar vertebra. Others proposed that sacralization may cause symptoms such as herniated discs[17], spinal pain, radicular pain, or lumbar scoliosis[18]. But their pathophysiology or machanics is still unknown. Disc protrusion or extrusion herniation frequently occurs at the level above the lumbrosacral transitional vertebra rather than at the level of the transitional vertebra in patients with low back pain[19-21]. Some evidence suggests that low back pain may be more severe when associate with sacralization[22].

The sacralized transverse process may form a pseudarthrosis with the ilium and degenerative sclerosis may appear around the false joint. This may be a site of low back pain[23]. The lumbar nerve roots may be altered when a lumbrosacral transitional vertebra is present and this probably could be a risk factor of low back pain[24]. The clinical importance of such variation associated with or without low back disorders is still debated[25-27].

This first report of sacralization of the fifth lumbar vertebra in Thais could be useful in basic osteology and may be clinically relevant to the preliminary consideration in patients with low back problems. Further studies are needed to test whether the clinical symptoms are related to this anatomical variation.

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