

ความชุกของภาวะความผิดปกติทางกายภาพของกระดูกสันหลังส่วนกระเบนเหน็บของผู้ป่วยในโรงพยาบาลราชวิถี: การศึกษาย้อนหลัง

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Prevalence of Sacral Dysmorphia of Patients in Rajavithi Hospital, A Retrospective Study

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Abstract

Background: Sacral dysmorphia entails abnormal anatomy of the upper sacrum. Dysmorphic sacra have narrow and angled upper osseous corridors, increasing the risk of cortical perforation during iliosacral screw and transacral screw insertion. To date, no statistical data regarding this condition exist in Thailand. We aimed to collect statistical data for this patient group in Thailand. **Objective:** To determine the prevalence of sacral dysmorphia among patients at Rajavithi Hospital. **Methods:** Data were collected from Rajavithi Hospital's database for the past 5 years, from January 1, 2016, to December 31, 2020, and analyzed to determine the prevalence of sacral dysmorphia and safe corridors for percutaneous screw fixation at the sacrum. **Results:** A total of 594 patient records were collected. Sacral dysmorphia was found in 136 cases, accounting for 23%. Gender was found to have no effect on disease prevalence but did affect sacral size, with males being significantly larger. The sacral dysmorphia group had 94.1% unable to insert a transacral screw at position S1, with an average width and height of 15.46 and 17.00 mm, respectively. At position S2, both iliosacral and transacral screws of all sizes (6.5, 7.0, and 7.3 mm) could be inserted, with average width and height of 13.98 and 17.84 mm, respectively. **Conclusion:** We recommend using the S2 position instead of the S1 position for percutaneous screw fixation in individuals with sacral dysmorphia due to advantages including safety, low complication rates, ease of surgery, and strength.

Keywords: Sacral dysmorphia, Thailand population, Percutaneous screw fixation

บทคัดย่อ

ภูมิหลัง: ความผิดปกติของกระดูกเชิงกราน มีกายวิภาคผิดปกติของ sacrum ตอนบน dysmorphic sacra มีทางเดินกระดูกส่วนบนที่แคบและเป็นมุมซึ่งเพิ่มความเสี่ยงของการเจาะเยื่อหุ้มสมองในระหว่างการใส่สกรู iliosacral และสกรู transacral จากการรับรู้ไม่มีข้อมูลสถิติของโรคนี้ในประเทศไทย ผู้วิจัยต้องการรวบรวมข้อมูลทางสถิติสำหรับผู้ป่วยกลุ่มนี้ในประเทศไทย **วัตถุประสงค์:** เพื่อศึกษาความชุกของภาวะผิดปกติของเชิงกรานของผู้ป่วยในโรงพยาบาลราชวิถี **วิธีการ:** เก็บข้อมูลจากฐานข้อมูลของโรงพยาบาล

ราชวิถีในรอบ 5 ปีที่ผ่านมา ตั้งแต่วันที่ 1 มกราคม 2016 - 31 ธันวาคม 2020 ได้รับการวิเคราะห์เพื่อหาความชุกของ sacral dysmorphia และทางเดินที่ปลอดภัยของการยึดสกรูผ่านผิวหนังที่ sacrum **ผล:** รวบรวมข้อมูลผู้ป่วยทั้งหมด 594 ราย ความผิดปกติของกระดูกเชิงกราน พบใน 136 ราย คิดเป็น 23% พบว่าเพศไม่ส่งผลต่อความชุกของโรค แต่ส่งผลต่อขนาดของเชิงกราน โดยเพศชายจะมีขนาดใหญ่กว่าอย่างเห็นได้ชัด group sacral dysmorphia มี 94.1% ไม่สามารถใส่สกรู transacral ที่ตำแหน่ง S1 ได้ โดยมีความกว้างและความสูงเฉลี่ย 15.46, 17.00 มม. ตามลำดับ ส่วนที่ตำแหน่ง

S2 สามารถใส่ได้ทั้งสกรู iliosacral และ transacral ทุกขนาด (6.5, 7.0 และ 7.3 มม.) โดยมีควมกว้างและความสูงโดยเฉลี่ย 13.98, 17.84 มม. ตามลำดับ **สรุป:** ผู้วิจัยแนะนำให้ใช้ตำแหน่ง S2 แทนตำแหน่ง S1 ในการยึดสกรูผ่านผิวหนังในผู้ที่เป็นโรคความผิดปกติของกระดูกเชิงกราน โดยมีข้อดี คือ ปลอดภัย ภาวะแทรกซ้อนต่ำ ผ่าตัดง่าย แข็งแรง

คำสำคัญ: ความผิดปกติของกระดูกเชิงกราน, ประชากรไทย, การยึดสกรูผ่านผิวหนัง

บทนำ (Introduction)

Percutaneous screw fixation is a commonly used surgical method for patients with complete sacral fractures and sacroiliac joint disruptions¹. Surgery causes screw placement in 10-15% of cases². This is mainly due to abnormal pelvic anatomy, termed “sacral dysmorphia,” which alters the corridor for SI screw fixation compared to normal anatomy. The sacral anatomy in sacral dysmorphia differs from that of normal individuals, and there are currently no criteria to clearly define this condition². First described in 1996 by Routt ML Jr, the incidence rate was reported as 30-40%³. Since then, more studies have been conducted, showing varying prevalence rates ranging from 14.5-44%^{2, 4, 6-8}, likely due to different diagnostic criteria used in each study^{2, 4, 5, 6-7}. Sacral dysmorphia has been found to be related to gender and race, with qualitative and quantitative characteristics differing among populations^{2,9}. However, most research has been conducted on Caucasians, with only a small number of studies on other continents¹⁰. These studies have shown different values than those in Caucasians but are often flawed, making them unreliable. This research is the first to study the Thai population,

aiming to determine the prevalence of sacral dysmorphia and safe distances for percutaneous screw surgery in Thailand, located in Southeast Asia.

วัตถุและวิธีการ (Materials and Methods)

This study was a retrospective study. Data were collected from patients treated at Rajavithi Hospital from January 1, 2016, to December 31, 2020, meeting inclusion criteria (age over 18 years, radiographs, and CT scans of the pelvis) and exclusion criteria (prior sacral surgery, sacral abnormalities due to cancer, sacrum immaturity, bone infections, bilateral sacral fractures, or images with interpretation difficulties). Basic patient information including gender, age, race, accidents, weight, and height was recorded. Sacral dysmorphia was diagnosed using criteria based on Hasenboehler EA’s research, involving altered sacral anatomy with increased alar slope, obliquity of the residual transverse process, anomaly of the first sacral anterior neural foramina anatomy, and sacralized L5 or lumbarized S1 vertebrae. Width and height measurements of sacrum segments at positions 1 and 2 were recorded from CT scan images by a single orthopedic resident.

S1 segment (Figure 1): Width was measured in the axial view. The perpendicular distance from the antero-lateral corner of the sacral canal to the anterior cortex of the S1 segment was measured using a cut CT scan, with this corridor being the narrowest. Height was measured in the coronal view, the perpendicular distance from the highest edge of the first neural foramen to the superior cortex of the S1 segment was measured using the cut CT scan with the narrowest corridor.

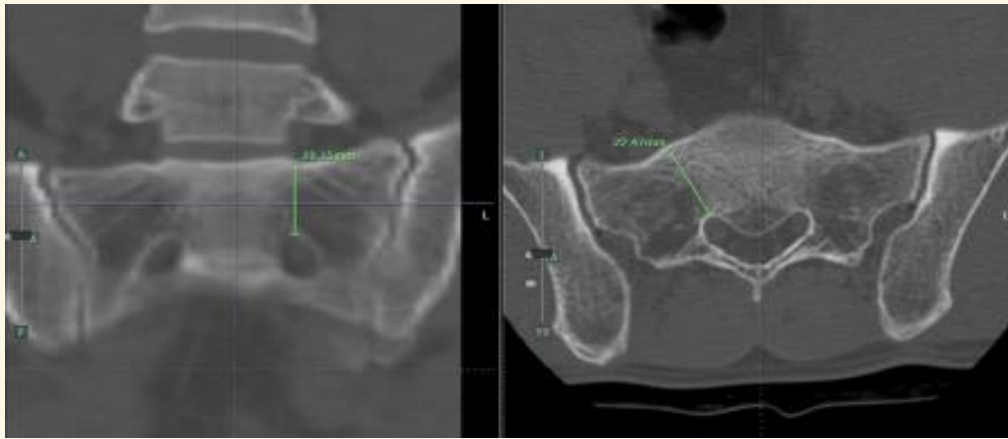


Figure 1: S1 segment

The S2 segment (Figure 2): Width is measured in the axial view as the perpendicular distance from the antero-lateral corner of the sacral canal to the anterior cortex of the S2 segment using a cut CT scan with the narrowest corridor. Height is measured in the coronal view as the perpendicular distance from the highest edge of the first neural foramen to the superior cortex of the S2 segment using a cut CT scan with this corridor being the narrowest.



Figure 2 : S2 segment

The ability to insert iliosacral screws and transacral screws at sacrum segments 1 and 2, as well as the maximum size that can be inserted, was considered. A distance of 2 mm between the screw and the edge of the cortex of the sacrum was maintained for safety and strength of the system.

Data analysis was performed using SPSS (Statistics Package for the Social Sciences, version 23.0; SPSS, Inc., Chicago, IL, USA). The sample calculation was based on the study by Hasenboehler EA², using the formula by Wayne WD¹¹. The calculated sample size was 567.

Demographic Analysis

General basic data, which are categorical, are reported with numbers and percentages. Continuous data are reported with the average and standard deviation if the data has a normal distribution.

Inferential Statistics

Comparison of continuous data in two unrelated populations was conducted. For normally distributed data, the student t-test was utilized. The statistical significance level was set at p-value < .05.

Results

From the database over a 5-year period, there were a total of 596 cases, with 2 cases excluded due to unreadable CT scans. The total data remaining was 594 cases, comprising 276 males (46.5%) and 318 females (53.5%).

Baseline characteristics were illustrated in table 1. The normal sacrum group consisted of 458 cases, accounting for 77%, with 210 males (45.9%) and 248 females (54.1%). Males had greater width and height of S1 (MD: 0.84, 0.88) and safe corridors for both iliosacral screw and transacral screw at S1 and S2, being significantly wider than females. The prevalence of sacral dysmorphism was 23%.

The sacral dysmorphism group exhibited a smaller and shorter safe corridor of the iliosacral in S1 (MD: 2.4, 4.5), but S2 had a wider and longer corridor (MD: 2.3, 2.5) compared to the normal group. Almost all safe corridors of transacral screws at S1 could not be measured. Only 12 individuals had a sacrum angle allowing for transverse measurements (MD: 13.6, 100.5). The S2 part was wider and longer (MD: 5.4, 5.4) compared to the normal group.

The prevalence of Sacral Dysmorphism was 23%, with 66 males (48.5%) and 70 females (51.5%), showing no statistical difference. Only the width of the iliosacral screw corridor showed statistical significance, being wider for males than females (MD: 1.9).

Table 1. Baseline data

Group	Cases	Gender	Mean Age (years) \pm SD	Race
Normal sacrum	458	Male: 210 (45.9%) Female: 248 (54.1%)	46.7 \pm 15.7	Thai (100%)
Sacral dysmorphism	136	Male: 66 (48.5%) Female: 70 (51.5%)	52.1 \pm 13.5	Thai (100%)

Table 2. Compare males and females in all data.

Variable	Male = 276 (Mean \pm SD)	Female = 318 (Mean \pm SD)	Mean Difference	95%CI	p-value
S1AW	17.71 \pm 2.67	16.66 \pm 2.87	1.05	0.837, 1.263	<.01*
S2AW	13.35 \pm 9.40	11.95 \pm 2.04	1.4	1.218, 1.582	.01*
S1CHT	21.37 \pm 3.20	20.07 \pm 3.60	1.3	1.093, 1.507	<.01*
S2CHT	16.47 \pm 2.16	16.32 \pm 8.15	0.15	-0.022, 0.194	.76
S1ISCW	17.58 \pm 2.71	16.52 \pm 2.85	1.06	0.839, 1.281	<.01*
S1ISCL	55.62 \pm 5.43	55.87 \pm 5.57	-0.25	-0.275, 0.005	.57
S2ISCW	12.55 \pm 1.83	11.97 \pm 2.10	0.58	0.424, 0.736	<.01*
S2ISCL	47.55 \pm 5.34	49.93 \pm 5.49	-2.38	-2.579, -2.181	<.01*
S1TSCW	11.75 \pm 6.51	11.42 \pm 6.29	0.33	0.207, 0.453	<.01*
S1TSCL	86.44 \pm 45.17	87.09 \pm 45.14	-0.65	-0.774, -0.526	<.01*
S2TSCW	12.52 \pm 1.77	11.89 \pm 1.93	0.63	0.479, 0.781	<.01*
S2TSCL	90.14 \pm 7.71	93.85 \pm 8.01	-3.71	-3.871, -3.549	<.01*

Using student t-test, * significant < .05

S1ISCW/S2ISCW=S1/S2 Iliosacral screw corridor width

S1ISCL/S2ISCL=S1/S2 Iliosacral screw corridor length

S1TSCW/S2TSCW=S1/S2 Transacral screw corridor width

Table 3. Compare males and females in the normal sacrum group.

Variable	Male = 210 (Mean±SD)	Female =248 (Mean±SD)	Mean Difference	95%CI	p-value
S1AW	18.11±2.61	17.26±2.67	0.85	0.704, 0.996	<.01*
S2AW	13.18±10.68	11.36±1.62	1.82	1.697, 1.943	<.01*
S1CHT	22.24±2.67	21.36±2.64	0.88	0.805, 0.955	<.01*
S2CHT	15.97±1.75	15.95±9.11	0.02	-0.052, 0.092	.97
S1ISCW	18.03±2.59	17.17±2.61	0.86	0.714, 1.006	<.01*
S1ISCL	56.39±5.22	57.14±4.99	-0.75	-0.899, -0.601	.011*
S2ISCW	12.14±1.35	11.36±1.62	0.78	0.705, 0.855	<.01*
S2ISCL	46.95±4.72	49.34±5.55	-2.39	-2.465, -2.315	<.01*
S1TSCW	14.89±2.61	14.53±2.44	0.36	0.285, 0.435	.012*
S1TSCL	109.62±7.55	109.96±7.55	-0.34	-0.415, -0.265	<.01*
S2TSCW	12.13±1.35	11.36±1.62	0.77	0.700, 0.840	<.01*
S2TSCL	88.78±7.31	92.69±8.08	-3.91	-3.988, -3.832	<.01*

using student t-test, * significant < .05

S1AW/S2AW=S1/S2 Axial width

S1CHT/S2CHT=S1/S2 Coronal height

S1ISCW/S2ISCW=S1/S2 Iliosacral screw corridor width

S1ISCL/S2ISCL=S1/S2 Iliosacral screw corridor length

S1TSCW/S2TSCW=S1/S2 Transacral screw corridor width

S1TSCL/S2TSCL=S1/S2 Transacral screw corridor length

Table 4. Compare males and females in the sacral dysmorphia group.

Variable	Male = 66 (Mean±SD)	Female = 70 (Mean±SD)	Mean difference	95%CI	p-value
S1AW	16.47±2.47	14.52±2.55	1.95	1.587, 2.313	<.01*
S2AW	13.88±2.50	14.07±1.96	-0.19	-0.559, 0.179	.62
S1CHT	18.60±3.20	15.51±2.73	3.09	2.718, 3.462	<.01*
S2CHT	18.05±2.59	17.64±2.38	0.41	0.044, 0.776	.034*
S1ISCW	16.13±2.57	14.25±2.49	1.88	1.517, 2.243	<.01*
S1ISCL	53.17±5.40	51.37±5.21	1.80	1.437, 2.163	<.01*
S2ISCW	13.86±2.46	14.13±2.21	-0.27	-0.635, 0.095	.51
S2ISCL	49.48±6.66	52.00±4.75	-2.52	-2.854, -2.186	.01*
S1TSCW	1.74±4.85	0.43±1.76	1.31	0.944, 1.676	.04*
S1TSCL	108.11±51.6	108.46±52.61	-0.35	-0.684, -0.016	.020*
S2TSCW	13.78±2.29	13.77±1.76	-3.51	-3.844, -3.176	<.01*
S2TSCL	94.46±7.39	97.97±6.23	-3.51	-3.844, -3.176	<.01*

using student t-test; * significant < .05

S1AW/S2AW=S1/S2 Axial width

S1CHT/S2CHT=S1/S2 Coronal height

S1ISCW/S2ISCW=S1/S2 Iliosacral screw corridor width

S1ISCL/S2ISCL=S1/S2 Iliosacral screw corridor length

S1TSCW/S2TSCW=S1/S2 Transacral screw corridor width

S1TSCL/S2TSCL=S1/S2 Transacral screw corridor length

Discussion

It is well known that the prevalence of sacral dysmorphia and bone size is related to race, but almost all studies about sacral dysmorphia and the safe corridor of sacral screws have been performed in Caucasians, who are primarily in Europe. From our research, we found that only a few studies have been conducted on Asians. From the research and understanding of the researcher, this research is the first to collect data in Thailand.

In the Caucasian group, sacral dysmorphia was found at rates of 14.5% to 44%. In the Asian group, there is a study in India that studies the safe corridor of sacral screws, but it only studies normal people and does not study sacral dysmorphia. Another study in Korea studies sacral dysmorphia and the corridor of sacral screws; they were found to have sacral dysmorphia up to 54%, which is very different from the European zone, but this research does not calculate sample according to statistical principles, making it less reliable. Our research found a prevalence of sacral dysmorphia of 23% and found that gender had no effect on this condition. This is consistent with the research of Hasenboehler EA et al². and Gardner MJ, et al⁵. But we found that gender affects the size of the sacrum, with males having a larger size than females, resulting in the corridor of the screw being larger. Also, our research confirms that the size of S2 in the Sacral group Dysmorphia is wider and higher than normal people (MD 1.79, 1.87 respectively) Compared to sacrum size between Caucasians and Asians, it was found that the axial width is not different but there is a difference in height. Caucasians have higher S1 and S2 compared to Asians. In the normal sacrum group, S1 and S2 had an average height difference of 25.17 mm and 15.57 mm, respectively. And for the Sacral dysmorphia group, the differences were 21.29 mm, 16.52 mm respectively. All normal sacral groups

can pass the smallest size of iliosacral and transacral screws (6.5 mm) in both S1 and S2. A different result from the research of Trikha V, et al⁹. and Gardner MJ, et al⁵., there were some people who were unable to insert a transacral screw in the normal sacral group because the corridor size is too small. As for the Sacral dysmorphia group, there were 5.9% (8/136) who could pass a transacral screw size of at least size 6.5 mm because sacral dysmorphia has a different severity of disease. The remaining 94.1% (128/136) could not be inserted because there was a too steep that made it impossible to insert a transacral screw. There were 4 out of 128 (4/128) who had less steep that could be passed but had there isn't enough space to fit the smallest 6.5 mm screw. As for the S2 position, both Iliosacral and Transacral screws of any size can be inserted.

The advantage of this research was that this was the first research in Thailand that has been collected data. The second was that there was a lot of sample. The third was to be able to confirm researches such as race affecting the prevalence of sacral dysmorphia and affected size of corridor of sacral screw and gender had no effect on the prevalence of sacral dysmorphia but it did have an effect on bone size. The main limitation of this research was the quality of the CT scan images. Images cut site and angle could not be adjusted to get true AP and true axial of the sacrum. This caused the measured values to be inaccurate. Another thing was that there was only one evaluator interpreting the results, which may result in bias.

Conclusion

The S2 segment should be used as an alternative to S1 for surgery with percutaneous sacral screw. Because of the advantages include more secure, reduce complication and more strength.

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