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Risk of rectal puncture due to needle entry into the presacral space

Importance of measuring the distance between the rectum and sacrococcyx, and the thickness of the sacrococcyx

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Abstract

During ganglion impar block, the needle may approach the presacral space and the sacrum may be penetrated during caudal anesthesia. Because the rectum is in front of the sacrococcyx and is thus at risk for puncture, it is important to determine the distance between the sacrococcyx and rectum, as well as the thickness of the sacrococcyx.

Computed tomography was used to measure the distance between the rectum and sacrococcyx, as well as the thickness of the sacrococcyx. The distances between the coccyx and rectum, sacrococcygeal joint and rectum, sacral level 5 ('sacrum 5') and rectum, and 'sacrum 4 to 5 junction' and rectum were measured. The results were compared based on the presence or absence of stools in the rectum. The thickness of the sacrococcyx was measured at the sacrum 4 to 5 junction and sacrococcygeal joint.

In total, 1264 patients were included in this study. All distances were less than 1 mm in both males and females, with the exception of the distance between the coccyx and rectum in males. In both males and females, there was no significant difference in distance between the sacrococcyx and rectum according to the presence or absence of feces in the rectum, but there was a difference in the distance between sacrum 5 and the rectum in males ($P = .048$). Several male and female patients showed thicknesses of less than 5 mm at the sacrococcygeal joint.

Some patients have a distance of less than 1 mm between the sacrum and rectum. Practitioners should exercise caution when applying a needle to the presacral space. If the sacrum is accidentally penetrated during caudal block, rectum puncture cannot be ruled out. Excretion of feces does not influence the distance between the sacrococcyx and rectum in females.

Abbreviation: CT = computed tomography.

Keywords: caudal anesthesia, ganglion impar block, presacral space, rectum, sacrococcyx

1. Introduction

The presacral space inside the pelvis is located behind the rectum and in front of the sacrococcyx. Many procedures to reduce pain target the sacrum; in particular, ganglion impar block must cross the sacrum and enter the presacral space. There are many methods for blocking the ganglion impar,[1–5] and most can be performed safely and easily using fluoroscopy or ultrasonography. However, there is a risk of rectum puncture because the rectum is situated in front of the presacral space.[6] The presence of gas or stools in the rectum makes it difficult to distinguish the sacrococcygeal joint, thus complicating blockade of the ganglion impar during anteroposterior fluoroscopy.[7] Notably, ultrasound has difficulty penetrating bone,[8] and it is therefore difficult to identify the rectum in front of the sacrum. Ganglion impar block can be performed relatively safely through the sacral hiatus, because of the presence of the sacral bone. However, the sacrum may be accidentally penetrated during caudal anesthesia, which can lead to rectal puncture.[9–11]

While previous studies have measured the depth of the presacral space (between the sacrum and rectum), they only assessed the narrowest part, or a single site, in contexts other than anesthesia and pain management.[12–14] In this study, we measured the distance between the sacrococcyx and rectum, as well as the thickness of the sacrococcyx, at the main site associated with anesthesia and pain management procedures. We also investigated the effects of sex and rectal fecundity on the distance between the sacrococcyx and rectum.

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2. Materials and methods

2.1. Patients

This retrospective study was conducted with approval from the Institutional Review Board of Chuncheon Sacred Heart Hospital. All patients over 20 years of age, who underwent abdominopelvic computed tomography (CT) at Chuncheon Sacred Heart Hospital from January to December 2017, were included. However, we excluded patients with ulcerative colitis, lymphogranuloma venereum, post-irradiation changes, granulomatous colitis, inferior vena cava thrombosis, and tuberculous proctitis, all of which widen the presacral space.[12,15,16] Patients who had undergone hysterectomy or colorectal surgery were excluded.

2.2. Anatomy

The human sacrum is a large triangular bone comprising 5 fused vertebrae along with intervertebral discs.[17] The sacral hiatus is located at the caudal end of the sacrum, between 2 sacral cornua. The skin, subcutaneous adipose tissue and sacrococcygeal ligament cover the sacral hiatus. When a needle passes through the sacrococcygeal ligament, the sacral hiatus comes into direct contact with the epidural space. In 80% of people, the apex of the sacral hiatus is located at sacral level 4 or 5 (hereafter, sacrum 4 and 5, respectively).[18] The presacral space, which is located between the rectum and the sacrococcyx, contains fat, mesenchymal tissue lymph nodes, nerve plexuses and blood vessels. The superior boundary of the presacral space consists of peritoneal reflections, and the inferior boundary is composed of the levator ani and coccygeus muscles. The ureter iliac vessels are located on the lateral boundary.[19] The ganglion impar is located in front of the coccyx or around the sacrococcygeal joint; it represents the end point of the paravertebral sympathetic chain, and is responsible for nociception and sympathetic innervation of the perineal region.[20]

2.3. Measurements

A major advantage of CT is its ability to image bone, soft tissue and blood vessels simultaneously. Exclusionary diseases for this study could be identified through abdominopelvic CT, which was also used for all measurements and to determine the presence of stools in the rectum. After the mid-sagittal plane of the sacrococcyx had been identified, the anteroposterior diameter of the sacrococcyx and distance between the sacrococcyx and rectum were measured (Fig. 1). All distances were measured using the inbuilt tools of the PiViewStar Picture Archiving and Communication System (INFINITT Healthcare Co. Ltd., Seoul, Korea). All distances and thicknesses were measured on images under 2 × magnification. Distances less than 1 mm could not be measured, and were denoted as "< 1 mm." The distances between the distal end of the coccyx and the rectum, the sacrococcygeal joint and the rectum, sacrum 5 and the rectum, and the 'sacrum 4 to 5 junction' and the rectum were measured. Thickness measurements were performed at the narrowest points of the sacrococcygeal joint and sacrum 4 to 5 junction.

2.4. Statistical analysis

Continuous data are expressed as means and standard deviations, whereas categorical data are expressed as frequencies and percentages. The outcomes were analyzed according to sex and the presence or absence of feces. Age, height, weight, and body mass index were analyzed using Student's t-test. Distances and thicknesses were analyzed using the Chi-square test. SPSS software (version 22.0; IBM Corp., Armonk, NY) was used for the statistical analyses.

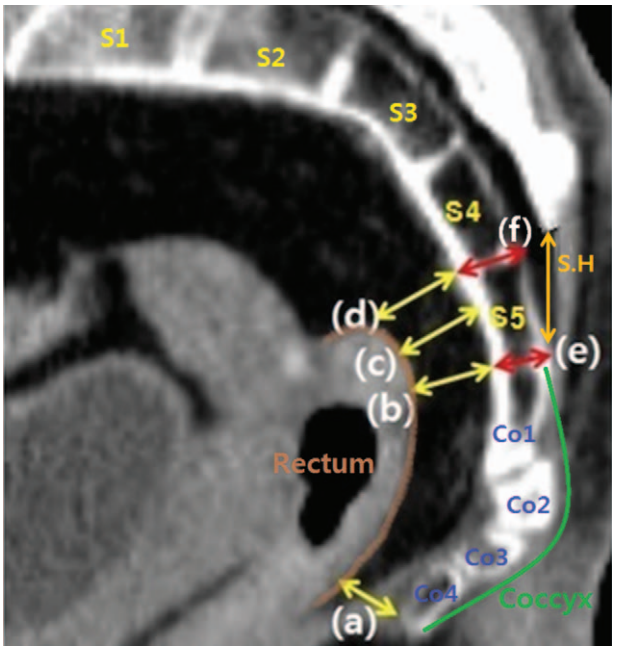

Figure 1. Various distance and thickness measurements in the mid-sagittal plane. S1, sacrum 1; S2, sacrum 2; S3, sacrum 3; S4, sacrum 4; S5, sacrum 5; S.H (orange arrow), sacral hiatus; Co1, coccyx 1; Co2, coccyx 2; Co3, coccyx 3; Co4, coccyx 4. (A) Distance between the distal end of the coccyx and the rectum; (B) Distance between the sacrococcygeal joint and the rectum; (C) Distance between the sacrum 4 to 5 junction and the rectum; (D) Distance between sacrum 5 and the rectum; (E) Thickness at the sacrococcygeal joint; (F) Thickness at the sacrum 4 to 5 junction.

3. Results

In total, 1351 patients were evaluated, of whom 87 were excluded (colorectal operation: 28; hysterectomy: 56; ulcerative colitis: 3). Therefore, a total of 1,264 patients were included in the final analysis. In total, 653 patients were male, of whom 396 had stools in the rectum; 611 patients were female, of whom 337 had stools in the rectum (Fig. 2). Among the males, those with stools in the rectum were older ($P = .011$), weighed less ($P = .013$), and had a lower body mass index ($P = .037$). There were no differences in age, height, weight, or body mass index between females with and without stools in the rectum (Table 1).

The distances between the sacrococcyx and rectum in males, based on the presence or absence of feces in the rectum, are summarized in Table 2. In all regions, except for between the distal end of the coccyx and the rectum in males, several patients had a distance of less than 1 mm between the sacrococcyx and rectum. No males had a distance between the distal end of the coccyx and the rectum of less than 1.0 mm. There was a statistically significant difference only in the distance between sacrum 5 and the rectum according to the presence or absence of stools in the rectum ($P = .048$). Distances between the sacrococcyx and rectum in females, according to the presence or absence of feces in the rectum, are summarized in Table 3. The

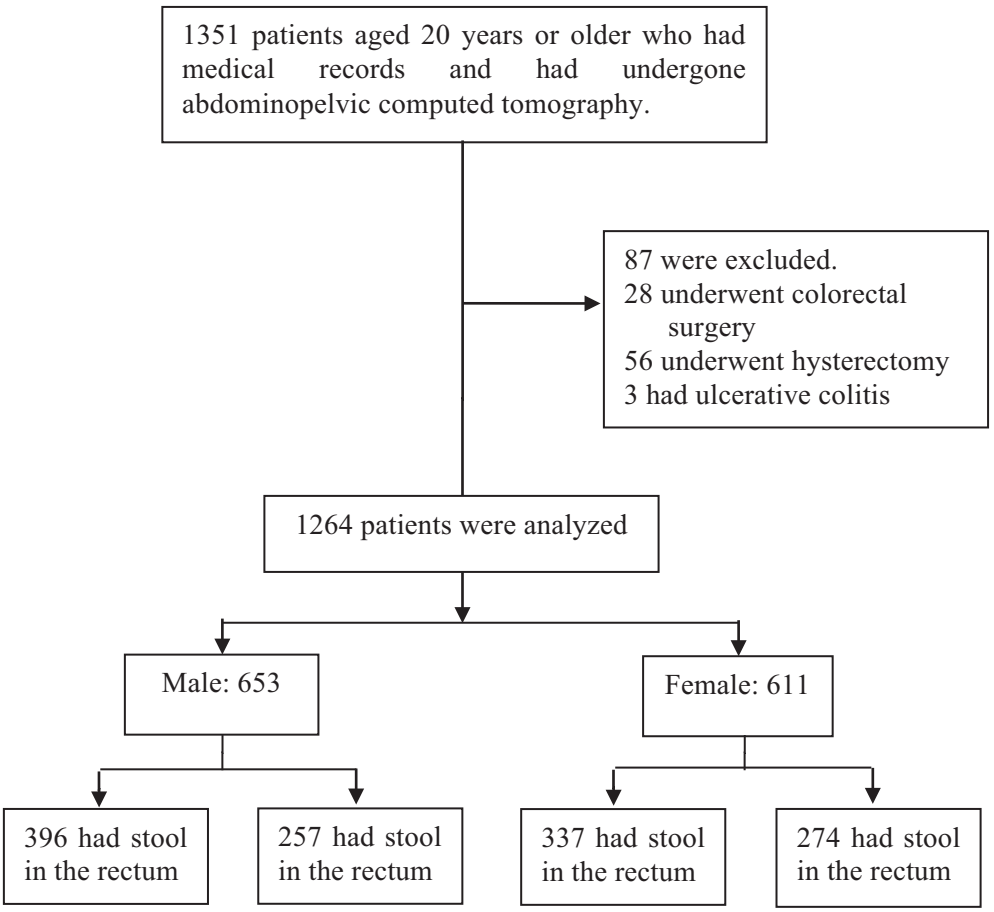

Figure 2. Patient flow diagram.

distances between the sacrococcyx and rectum in females were not significantly associated with the presence of stool in the rectum. In several females, all of the various distances between the sacrococcyx and rectum were less than 1 mm. Only 4 male patients in this study had rectal cancer and their data is in Table 4.

Regarding sacrococcyx thickness, the sacrum 4 to 5 junction ($P < .0001$) and sacrococcygeal joint ($P < .0001$) differed significantly between males and females. (Table 5). The percentage of patients with a thickness > 10 mm was higher among males (sacrum 4–5 junction, male: female = 88.4%: 50.9%; sacrococcygeal joint, male: female = 85.1%: 56.3%). Both male and female patients had a thickness of less than 5 mm at the sacrococcygeal joint, while only 3 female patients had a thickness of less than 5 mm at the sacrum 4 to 5 junction.

4. Discussion

There were several patients with a distance of less than 1 mm between the sacrococcyx and rectum, although in males the distance between the distal end of the coccyx and the rectum always exceeded 1 mm. The distance between the sacrococcyx and rectum did not significantly differ according to the presence or absence of stools in the rectum, with the exception of the distance between sacrum 5 and the rectum in males. The thicknesses of the sacrum 4 to 5 junction and sacrococcygeal joint differed significantly between males and females. There were patients with thicknesses of less than 5 mm in all regions, except for the sacrum 4 to 5 junction in males.

Chrispin and colleagues reported that the average distance between the rectum and sacrum was 7.5 mm, and that a distance

Table 1

Demographic data of patients whose distance of presacral space was measured.

	Male (n = 653)			Female (n = 611)		
	Feces (n = 396)	No feces (n = 257)	*P*	Feces (n = 337)	No feces (n = 274)	*P*
Age (yr, Mean ± SD)	56.1 ± 17.2	52.6 ± 16.4	.011	56.5 ± 18.5	54.2 ± 17.8	.121
Height (cm, Mean ± SD)	168.2 ± 6.9	169.3 ± 7.0	.054	156.3 ± 7.2	156.9 ± 6.4	.238
Weight (kg, Mean ± SD)	67.7 ± 13.6	70.4 ± 13.2	.013	58.3 ± 11.9	59.4 ± 11.8	.292
BMI (Mean ± SD)	23.8 ± 4.0	24.5 ± 3.8	.037	23.8 ± 4.3	24.1 ± 4.4	.486

BMI = body mass index, SD = standard deviation.

Table 2

Comparison of distances between sacrococcyx and rectum in male according to presence or absence of feces in rectum.

	Feces (n = 396)		No feces (n = 257)		
Length (mm)	**Number (%)**	**Min-Med-IQR-Max (mm)**	**Number (%)**	**Min-Med-IQR-Max (mm)**	***P***
CR					
<1.0	0 (0)	Min: 1.9	0 (0)	Min: 2.8	
1.0≤ and <5.0	20 (5.1)	Med: 13.0	16 (6.2)	Med: 13.3	
5.0≤ and <20.0	316 (79.8)	IQR: 9.1–17.3	188 (73.2)	IQR:9.0–19.0	.247
20.0≤	60 (15.2)	Max: 34.8	53 (20.6)	Max: 34.8	
SCJR					
<1.0	12 (3.0)	Min: <1.0	5 (1.9)	Min: <1.0	
1.0≤ and <5.0	95 (24.0)	Med: 7.8	50 (19.5)	Med: 9.6	
5.0≤ and <20.0	265 (66.9)	IQR: 4.8–12.5	181 (70.4)	IQR: 5.4–13.7	.064
20.0≤	24 (6.1)	Max: 33.8	21 (8.2)	Max: 34.8	
S5R					
<1.0	1 (0.3)	Min: <1.0	1 (0.4)	Min: <1.0	
1.0≤ and <5.0	93 (23.5)	Med: 8.7	42 (16.3)	Med: 9.5	
5.0≤ and <20.0	279 (70.5)	IQR: 5.2–12.7	196 (76.3)	IQR: 6.0–14.1	.048
20.0≤	23 (5.8)	Max: 34.1	18 (7.0)	Max: 35.3	
S45JR					
<1.0	14 (3.5)	Min: <1.0	6 (2.3)	Min: <1.0	
1.0≤ and <5.0	114 (28.8)	Med: 7.0	67 (26.1)	Med: 8.0	
5.0≤ and <20.0	253 (63.9)	IQR: 4.1–11.2	171 (66.5)	IQR: 4.5–12.6	.181
20.0≤	15 (3.8)	Max: 35.5	13 (5.1)	Max: 32.7	

CR = distance between coccyx and rectum, IQR = interquartile range, Max = maximum, Med = median, Min = minimum, S45JR = Distance between sacrum 4-5 junction and rectum, S5R = distance between sacrum 5 and rectum, SCJR = distance between sacrococcygeal joint and rectum.

exceeding 20 mm was abnormal.[12] Eding and colleagues reported that the distance between the rectus and the rectum was 10 mm.[15] Kattan and colleagues reported that this distance was typically less than 15 mm, but was greater than 15 mm in some cases for unknown reasons.[13] Previous studies mainly explored these distances in terms of internal factors, and measured only the narrowest parts of sacrum 3 and sacrum 5.[12,13,15] Thus, it is difficult to apply their results to anesthesia and pain-management procedures performed in the sacral hiatus, sacrococcygeal joint, sacrum 4 to 5 junction, and coccyx. In addition, previous studies used plain X-rays during barium enemas;[12,13,15–15] whether measurements were obtained in the same midline in all subjects is difficult to determine. In our study, to ensure that the midline was the same in all patients, we measured the distances in the sagittal CT view, after identifying the midline in the transverse view.

Table 3

Comparison of distances between sacrococcyx and rectum in female according to presence or absence of feces in rectum.

	Feces (n = 337)		No feces (n = 274)		
Length (mm)	**Number (%)**	**Min-Med-IQR-Max (mm)**	**Number (%)**	**Min-Med-IQR-Max (mm)**	***P***
CR					
<1.0	1 (0.3)	Min: <1.0	3 (1.1)	Min: <1.0	
1.0≤ and <5.0	43 (12.8)	Med: 8.5	48 (17.5)	Med: 8.7	
5.0≤ and <20.0	278 (82.5)	IQR: 6.4–12.3	213 (77.7)	IQR:6.0–12.4	.05
20.0≤	15 (4.5)	Max: 34.8	10 (3.6)	Max: 34.8	
SCJR					
<1.0	22 (6.5)	Min: <1.0	19 (6.9)	Min: <1.0	
1.0≤ and <5.0	159 (47.2)	Med: 4.7	129 (47.1)	Med: 4.7	
5.0≤ and <20.0	152 (45.1)	IQR: 3.0–7.4	123 (44.9)	IQR: 3.1–8.0	.876
20.0≤	4 (1.2)	Max: 34.1	3 (1.1)	Max: 33.0	
S5R					
<1.0	19 (5.6)	Min: <1.0	13 (4.7)	Min: <1.0	
1.0≤ and <5.0	161 (47.8)	Med: 4.8	123 (44.9)	Med: 5.0	
5.0≤ and <20.0	154 (45.7)	IQR: 3.2–7.4	134 (48.9)	IQR: 3.1–8.1	.293
20.0≤	3 (0.9)	Max: 28.7	4 (1.5)	Max: 30.8	
S45JR					
<1.0	39 (11.6)	Min: <1.0	31 (11.3)	Min: <1.0	
1.0≤ and <5.0	179 (53.1)	Med: 3.7	134 (48.9)	Med: 4.1	
5.0≤ and <20.0	117 (34.7)	IQR: 2.3–6.5	106 (38.7)	IQR: 2.4–7.2	.333
20.0≤	2 (0.6)	Max: 28.7	3 (1.1)	Max: 27.7	

CR = distance between coccyx and rectum, IQR = interquartile range, Max = maximum, Med = median, Min = minimum, S45JR = Distance between sacrum 4-5 junction and rectum, S5R = distance between sacrum 5 and rectum, SCJR = distance between sacrococcygeal joint and rectum.

Table 4

Distance between sacrococcyx and rectum in rectal cancer patients.

Sex	Age	Ht	Wt	Coccyx to rectum	Sacrococcygeal junction to rectum	Sacrum 5 to rectum	Sacrum4-5 junction to rectum	Feces
Male	79.0	169.5	57.8	4.8	12.6	16.4	14.4	(–)
Male	55.0	175.0	63.0	7.1	3.3	3.4	3.4	(–)
Male	52.0	176.0	82.0	15.6	10.4	10.5	9.1	(–)
Male	45.0	180.0	80.0	7.1	5.2	10.1	5.2	(+)

Ht = height, Wt = weight.

Table 5

Comparison of the thickness of sacrum 4 to 5 junction and sacrococcygeal jo between male and female.

	Male (n = 653)		Female (n = 611)		
	Mean ± SD	Min-Max	Mean ± SD	Min-Max	*P*
SCJ (mm)	11.8 1.9	4.1 – 19.2	10.2 1.6	4.3 – 15.6	< .0001
S45J (mm)	12.0 1.8	6.6 – 21.7	10.0 1.7	4.8 – 16.0	< .0001

Max = maximum, Min = minimum, S45J = Sacrum 4-5 junction, SCJ = sacrococcygeal joint, SD = standard deviation.

Ganglion impar block through the sacrococcygeal joint is considered a relatively safe procedure.[1] However, the distance between the sacrococcygeal joint and rectum was less than 1 mm in 3% of our males with stools in the rectum, and in 6.9% of the females without stool in the rectum. A distance of less than 1 mm between the rectum and sacrococcyx was used as the shortest distance category in this study, including cases where the rectum and sacrococcyx appeared to be attached. The resolution of CT is 0.5–0.625 mm,[21] and the distance between the rectum and sacrococcyx may be less than 0.625 mm when the boundary between the rectum and sacrococcyx is difficult to distinguish.

The sacrococcygeal joint (where ganglion impar blockage is performed[1,3]) is composed of the intervertebral disc and ligaments,[22] while the sacrum 4 to 5 junction is located in front of the sacral hiatus.[23] We measured sacrococcyx thickness in the sacrococcygeal joint and sacrum 4 to 5 junction. Procedures through the sacral hiatus are relatively safe due to the presence of the sacral bone. However, in children aged 2 to 9 years, rectal puncture has been reported after penetration of the sacrum during caudal anesthesia,[9–11] and the average bone marrow density of a female aged 8 to 11 may be within the standard deviation of the average bone marrow density of a woman 80 years or older.[24]

There were some limitations to the present study. First, the subjects were drawn from a general patient population; they did not have specific diseases, and had not undergone CT scans for specific purposes. Because ganglion impar block is a nerve block that is also performed in cases of pelvic cancer or tumor pain,[25] we included patients with cancer or tumors in the pelvis. Tumors and cancers vary in size and can narrow the presacral space. There are a wide variety of tumor types, locations and sizes; we did not exclude any tumors. However, all tumors, including those from 4 patients with rectal cancer, did not occupy a presacral space in this study. Further studies are needed to measure the presacral space in patients with cancer, tumors or certain other diseases. Second, in general, during procedures involving caudal anesthesia and pain management, the patient is placed in a prone or lateral position, which differs from the position during CT scanning. We did not investigate changes in the presacral space according to patient position. However, the rectum is connected to the sigmoid colon at sacrum 3,[26] and is supported by the pelvic floor (which constitutes the levator ani muscles, Waldeyer's fascia, and the lateral ligament of the rectum).[27] The effect of gravity on organs in the pelvic cavity is negligible.[28]

In conclusion, several of our patients exhibited a distance between the sacrum and rectum of less than 1 mm. Practitioners should exercise caution when applying a needle to the presacral space, even when using methods that are commonly considered safe, and should be mindful of the possibility of rectal puncture if the sacrum is accidentally penetrated during caudal block. In the males in this study, there was a significant difference in the distance between sacrum 5 and the rectum according to the presence or absence of stool in the rectum. However, because there were differences in age, weight, and body mass index between these two groups of males, it is difficult to determine whether factors other than the presence of stools in the rectum contributed to this effect.

Author contributions

Young Suk Kwon contributed to this work as first authors.
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Acquisition of data: Narea Lee, Ho Seok Lee, Eun Ji Youn.
Analysis and interpretation of data: Soo Kyung Lee, Jae Jun Lee.
Drafting of the manuscript: Young Suk Kwon, Narea Lee.
Revising paper: all authors.
Study concept and design: Young Suk Kwon, Jae Jun Lee.
Study supervision: Soo Kyung Lee, Jae Jun Lee.

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