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Degeneration of Sacroiliac Joint After Instrumented Lumbar or Lumbosacral Fusion

A Prospective Cohort Study Over Five-Year Follow-up

Kee-Yong Ha, MD,* Jun-Seok Lee, MD,† and Ki-Won Kim, MD*

Study Design. A prospective cohort study.

Objective. To determine the cause-effect relationship between fusion and sacroiliac joint (SIJ) degeneration after instrumented posterolateral lumbar or lumbosacral fusion.

Summary of Background Data. Adjacent segment degeneration following spinal fusion has attracted considerable attention. However, little attention has been paid to the SIJ, which is one of the adjacent joints.

Methods. This study prospectively examined 37 patients, who underwent instrumented posterolateral lumbar/lumbosacral fusion from July 1997 to October 1998. Among them, 32 patients were included in this study and defined as the fusion group (male/female: 10/22, mean age: 64 years). The fusion group was divided into 2 subgroups according to the range of fusion. Group 1 had floating fusion (fusion to L5) and included 22 patients (male/female: 7/15, mean age: 65.6 years). Group 2 had fixed fusion (fusion to S1) and included 10 patients (male/female: 3/7, mean age: 60.5 years). Thirty-four age-matched normal individuals (male/female: 18/16, mean age: 64.5 years) were recruited as a control group. SIJ degeneration was assessed by confirming the absence of degeneration in the SIJ by computed tomography scans before surgery and 2 weeks after surgery. The SIJ was evaluated again by taking computed tomography scans at 1 year and 5 years after surgery. The incidence of SIJ degeneration was evaluated and compared (fusion group *vs.* control group; group 1 *vs.* group 2). The clinical outcomes were evaluated using the Visual Analog Scales (VAS) and Oswestry Disability Index (ODI) before surgery and at the final follow-up.

Results. The incidence of SIJ degeneration in the fusion group was 75% (24/32), which was significantly higher than that of the control Group 38.2% (13/34) ($P < 0.05$). The incidence of SIJ degeneration (bilateral and unilateral) and bilateral SIJ degeneration was higher in group 2 than in group 1 ($P = 0.028$ and 0.04, respectively). The incidence of SIJ degeneration was not associated with the number of fusion segments. At the 5-year follow-up, the patients in groups 1 and 2 reported significant improvements in the VAS and ODI scores compared with the preoperative scores. However, there was no significant difference in the decrease in VAS and ODI scores between the 2 groups ($P = 0.145$ and 0.278, respectively).

Conclusion. Instrumented posterolateral lumbar/lumbosacral fusion can be a cause of SIJ degeneration. SIJ degeneration develops more often in patients undergoing lumbosacral fusion regardless of the number of fusion segments.

Key words: sacroiliac joint, degeneration, adjacent segment disease, lumbosacral spine, fusion. **Spine 2008; 33:1192–1198**

Instrumented lumbar or lumbosacral fusion is often used to treat a variety of spinal disorders. However, there are many clinical studies on the degeneration or disease adjacent to the instrumented fusion segments.[1] Multiple factors have been implicated, including the type of surgical procedure, the number of levels fused, the health of the adjacent segment, and sagittal curvature of the lumbar spine. After instrumented spinal fusion, compensatory mechanics occur at the adjacent segments, resulting from stress concentration, change in the contact site of the facet joints, and alterations in the motion biomechanics.[1–4] The incidence of adjacent segmental disease has been reported to range from 5.2% to 49%.[1] Previous studies[2,3] have reported that a radiologic instability in the adjacent segments develops 25 months after instrumentation, and that symptomatic changes in the adjacent segment develops 27 months after fusion in 5.2% to 18.5% of patients.[1,4–10] However, most of these biomechanical and clinical studies focused on the proximal segments adjacent to the instrumented lumbar/lumbosacral fusion.

The sacroiliac joint (SIJ) forms the lowest segment of the spine axis, and distributes the force delivered from the upper body.[11] This joint is approximately 6 times more resistant to the lateral force than the lumbar spine, but has approximately 1/12 and 1/2 of the resistance to axial direction forces and rotation forces than the lumbar spine, respectively.[12] The force delivered to the SIJ is a shear force, and can reaches up to 4800 N. The rotation movement of the SIJ is very small, approximately less than 4°, and the translation is also small, approximately 1.6 mm but it does move.[13] Such movement occurring in the SIJ plays an important role in distributing the force, and is influenced by the movement of the lumbosacral spine.[13] According to recent studies,[14,15] among the patients who reported lower back pain, approximately 15%, it was demonstrated that the lower back and buttock pain resulted from SIJ arthralgia.

From the *Department of Orthopedic Surgery, College of Medicine, The Catholic University of Korea, and †Department of Orthopedic Surgery, Dongshin General Hospital, Seoul, Korea.
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Address correspondence and reprint requests to Kee-Yong Ha, MD, Department of Orthopedic Surgery, Kang-Nam St. Mary's Hospital College of Medicine, The Catholic University of Korea, 505 Banpo-dong, Seocho-ku, 137-040, Seoul, Korea; E-mail: kyh@catholic.ac.kr

However, there has not been any study specifically addressing the incidence of SIJ degeneration after instrumented lumbar or lumbosacral fusion, even though SIJs are the mobile and adjacent segments to fusion. Therefore, this study examined the cause-effect relationship between the fusion and SIJ degeneration after instrumented posterolateral lumbar or lumbosacral fusion.

■ Materials and Methods

Study Design

From July 1997 to October 1998, 39 consecutive patients, who underwent decompression and instrumented posterolateral lumbar/lumbosacral fusion using an autogenous iliac bone graft at our institution, were recruited before surgery and evaluated prospectively over a 5-year period. The exclusion criteria consisted of pre-existing SIJ disease, a disease history affecting the SIJ, prior surgery about the SIJ, and an injury involving the SIJ. During the follow-up period, patients who had nonunion at the fusion site in the computed tomography (CT) scans were also excluded. Seven patients dropped out [4 patients were lost to follow-up and 3 patients underwent revision surgery (2 for nonunion at the fusion site and one for proximal segment stenosis)]. Thirty-two patients (10 males and 22 females) were finally included in the study and were defined as the fusion group. The mean age at the time of surgery was 64 years (range, 53–78 years) and the mean follow-up period was 87.6 months (range, 77–94 months). The preoperative diagnoses of the patients were spinal stenosis in 22, spondylolisthesis in 9 (7 isthmic/2 degenerative), and recurrent HNP in one patient. The same instrumentation system (TSRH; Medtronic Sofamor Danek, Memphis, TN) was used in all patients. Twenty-six patients underwent posterolateral lumbar fusion (PLF), and 6 patients underwent posterior lumbar interbody fusion using titanium threaded cages packed with an iliac bone graft combined with instrumented PLF. An autologous bone graft was harvested from the posterior superior iliac spine of the left side through a separate incision. The same surgeon performed all the procedures without injuring the SIJ. After surgery, the patients were managed by bed rest for 3 or 5 days. All patients used lumbosacral orthosis for 3 months.

The fusion group was divided into 2 subgroups according to the range of fusion. Group 1 was the floating fusion group (fusion to L5) and included 22 patients [male/female: 7/15, mean age: 65.6 years (range, 56–78 years)]. Group 2 was the fixed fusion group (fusion to S1) and included 10 patients [male/female: 3/7, mean age: 60.5 years (range, 53–68 years)] (Table 1). As a control group, among the patients who underwent a pelvic CT for a gynecologic or medical examination, 34 age-matched normal individuals without a history of spine surgery or disease affecting the SIJ were enrolled in this study

Table 1. Patient Demographics and CT Findings in the Fusion Group

				POD 1 yr SIJ Change						POD 5 yr SIJ Change						SIJ Degeneration	
Group	Fusion Level	Gender/Age	POD 2 wks SIJ Change	JSN	Scl	Ost	Ero	SC	IBF	JSN	Scl	Ost	Ero	SC	IBF	Rt	Lt
G1	L45	M/64	−	+	+	−	−	−	−	+	+	−	−	−	−	+	+
G1	L45	F/57	−	−	−	−	−	−	−	+	+	−	−	−	−	+	+
G1	L45	F/64	−	−	+	−	−	−	−	−	+	−	−	−	−	+	+
G1	L45	F/56	−	+	−	−	−	−	−	+	−	+	−	−	−	+	+
G1	L45	M/70	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
G1	L45	F/72	−	−	−	−	−	−	−	+	+	−	−	−	−	−	+
G1	L45	F/67	−	+	+	−	−	−	−	+	+	−	−	−	−	−	+
G1	L345	M/74	−	−	−	−	−	−	−	+	−	+	−	−	−	+	+
G1	L345	F/62	−	−	−	−	−	−	−	−	−	+	−	−	−	+	+
G1	L345	F/56	−	−	−	−	−	−	−	+	+	−	−	−	−	+	+
G1	L345	F/61	−	−	−	−	−	−	−	−	−	+	−	−	−	−	+
G1	L345	F/61	−	−	−	−	−	−	−	+	+	+	−	−	−	−	+
G1	L345	M/65	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
G1	L345	M/75	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
G1	L345	M/68	−	+	+	−	−	−	−	+	+	−	+	−	−	+	+
G1	L345	F/65	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
G1	L345	F/64	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
G1	L345	F/68	−	+	−	−	−	−	−	+	+	+	−	−	−	−	+
G1	L345	F/67	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
G1	L345	M/78	−	−	−	−	−	−	−	−	+	−	−	−	−	+	+
G1	L345	F/62	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
G1	L345	F/67	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
G2	L5S1	M/68	−	−	+	−	−	−	−	+	+	−	−	+	−	−	+
G2	L5S1	M/64	−	+	−	−	−	−	−	+	+	+	+	−	−	+	+
G2	L5S1	F/55	−	−	−	−	−	−	−	+	−	−	−	−	−	+	+
G2	L5S1	F/53	−	+	+	−	−	−	−	+	+	+	−	−	−	+	+
G2	L45S1	M/62	−	−	+	−	−	−	−	−	+	−	−	−	−	+	+
G2	L45S1	F/58	−	+	+	−	−	−	−	+	+	+	−	+	−	+	+
G2	L45S1	F/62	−	−	−	−	−	−	−	+	+	−	+	−	+	+	+
G2	L45S1	F/58	−	+	−	−	−	−	−	+	−	+	−	−	−	+	+
G2	L45S1	F/67	−	−	−	−	−	−	−	+	+	−	−	+	−	+	+
G2	L45S1	F/58	−	+	−	−	−	−	−	+	+	+	+	−	−	−	+

G1: group 1 (fusion to L5), G2: group 2 (fusion to S1).
POD indicates postoperative day; SIJ, sacroiliac joint; JSN, joint space narrowing; Scl, sclerosis; Ost, osteophyte; Ero, erosion; SC, subchondral cyst; IBF, intraarticular bone fragment.

Table 2. Individual Demographics and CT Findings in the Control Group

		SIJ Change						SIJ Degeneration	
No.	Gender/Age	JSN	Scl	Ost	Ero	SC	IBF	Rt	Lt
1	F/66	+	−	−	−	−	−	+	−
2	F/69	−	−	−	−	−	−	−	−
3	F/66	−	+	−	−	−	−	−	+
4	F/69	−	−	−	−	−	−	−	−
5	M/63	−	−	+	−	+	−	−	+
6	F/66	−	−	−	−	−	−	−	−
7	M/62	+	−	+	+	−	−	+	−
8	M/62	−	+	−	−	−	−	−	+
9	F/67	−	−	−	−	−	−	−	−
10	M/68	−	−	−	−	−	−	−	−
11	M/63	−	−	−	−	−	−	−	−
12	F/66	−	−	−	−	−	−	−	−
13	M/62	−	−	−	−	−	−	−	−
14	M/62	+	+	−	−	−	−	+	+
15	F/67	+	−	+	−	−	−	+	−
16	M/68	−	−	−	−	−	−	−	−
17	F/66	−	−	−	−	−	−	−	−
18	M/64	+	+	−	−	−	−	+	+
19	M/62	−	−	−	−	−	−	−	−
20	M/65	−	+	−	−	−	−	−	+
21	F/68	−	−	−	−	−	−	−	−
22	F/67	−	−	−	−	−	−	−	−
23	M/64	−	+	−	−	−	−	−	+
24	M/61	+	−	−	−	−	−	+	−
25	F/61	−	−	−	−	−	−	−	−
26	M/63	−	−	−	−	−	−	−	−
27	F/60	+	−	+	−	−	−	−	+
28	M/65	−	−	−	−	−	−	−	−
29	M/64	−	−	−	−	−	−	−	−
30	F/64	−	−	−	−	−	−	−	−
31	F/62	+	+	−	+	−	−	+	−
32	M/68	−	−	−	−	−	−	−	−
33	F/63	−	−	−	−	−	−	−	−
34	M/60	−	−	−	−	−	−	−	−

SIJ indicates sacroiliac joint; JSN, joint space narrowing; Scl, sclerosis; Ost, osteophyte; Ero, erosion; SC, subchondral cyst; IBF, intraarticular bone fragment.

[male/female: 18/16, mean age: 64.5 years (range, 60–69 years)] (Table 2). The incidence of SIJ degeneration was evaluated and compared (fusion group *vs.* control group; group 1 *vs.* group 2). The incidence of SIJ degeneration in the fusion group (group 1 *vs.* group 2) according to the number of fusion segments was also compared.

Assessment of Sacroiliac Joint

CT scans were performed before surgery and 2 weeks after surgery to first confirm the absence of an abnormality in the SIJ or an injury to the SIJ during surgery. The SIJ was evaluated again by taking CT scans at 1 year and 5 years after surgery.

On the CT scans, the changes in the SIJ, such as sclerotic changes, erosion, osteophyte formation, intraarticular gas formation, joint space narrowing, intraarticular bone fragments, and subchondral cysts, were evaluated. However, as reported in other studies,[16,17] intraarticular gas formation, local sclerosis, and mild or moderate osteophyte formation, which were considered to be part of the normal aging process and were not specificity related to SIJ degeneration, were excluded from the evaluation.[17–20] A diagnosis of SIJ degeneration was based on the presence of one or more of the following CT findings: sclerosis, erosion, osteophyte, joint space narrowing, intraarticular bone fragment, and subchondral cyst (Figure 1). All the findings of SIJ degeneration were assessed according to the definition described previously.[16–20]

A sclerotic lesion was defined as sclerosis throughout the entire joint area. Partial sclerotic lesions or sclerotic lesions that developed locally in the iliac bone were excluded. The widest area of the subchondral sclerotic lesion below the articular surface was measured using a computer measurement system (Marosis PACS system; Marotech). Sclerosis measuring >5 mm in the iliac bone area and >3 mm in the sacral bone area was considered positive. Osteophyte formation was defined on the CT scan by extraarticular osteophytes forming a bridge passing beyond the SIJ space or extraarticular osteophyte without forming a bridge but passing beyond the SIJ space. In regard to the joint space narrowing, a space measuring <2 mm was considered positive. The assessment of SIJ degeneration was performed at 1 week intervals, and was performed twice.

The CT images were obtained using Somatom Volume Zoom Scanner (Siemens, Berlin, Germany), and at the time of measuring, the variables were a 250 mm field of view, 140 KV(p) [kilovolt (peak)], 3 seconds cycle time, and 49.32 mGy CTBIw (CT dose index). 0.5 seconds and a current from 200 to 250 mA were used per picture, and the slice thickness was 2.5 mm using a high resolution protocol (2000 window, 200 level setting).

Clinical and Functional Outcomes

The clinical outcome was assessed using a pain score based on a 10-point Visual Analog Scale (VAS; range, 1–10). A VAS score of 1 was defined as no pain and a score of 10 was

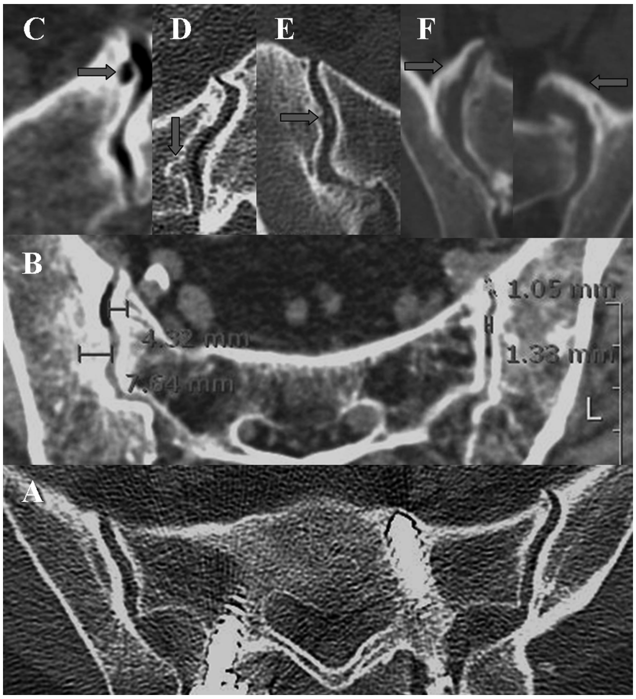

Figure 1. CT scans of the degenerative change of sacroiliac joint (SIJ) obtained at 5 years after instrumented posterolateral lumbar/lumbosacral fusion. **A**, Normal SIJ of the fusion group. **B**, Sclerosis at the left SIJ and joint space narrowing at the right SIJ. **C**, Subchondral cyst. **D**, Erosion. **E**, Intraarticular bone fragment. **F**, Osteophyte formation.

defined as the worst pain imagined by the patient. The patients assessed the pain outcome subjectively. The VAS score was measured before surgery and 5 years after surgery. The functional outcome was assessed using the Oswestry Disability Index (ODI) score. The ODI score was measured at the same time points as the clinical outcome assessments. The clinical and functional outcomes, the change in the mean VAS and the ODI scores (decrease from the baseline VAS and ODI scores), were compared.

Statistical Analysis

The data were analyzed using SPSS software (version 10.0; SPSS, Chicago, IL), and statistical analysis was performed. The dichotomous variables were compared using the Fisher exact and χ^2 tests. The P values were based on the Student t test for independent variables. The threshold for statistical significance was established at $P < 0.05$.

■ Results

SIJ Degeneration in the Fusion Group and the Control Group

The incidence of SIJ degeneration in the fusion group was 75%, which was significantly higher than in the control group (38.2%) ($P < 0.05$, Table 3).

SIJ Degeneration According to the Range of Fusion

The incidence of SIJ degeneration (bilateral and unilateral) was higher in group 2 than in group 1 ($P = 0.028$) (Figure 2). The incidence of bilateral SIJ degeneration was also higher in group 2 than in group 1 ($P = 0.04$). However, the incidence of unilateral SIJ degeneration was similar in both groups (Table 4).

Table 3. The Incidence of Sacroiliac Joint Degeneration Between the Groups

	Control Group (n = 34)	Fusion Group (n = 32)
SIJ degeneration (%)	13 (38.2)	24 (75)*
Joint space narrowing	8 (23.5)	19 (59.3)
Sclerosis	7 (20.6)	18 (56.2)
Osteophyte	4 (11.8)	11 (34.4)
Erosion	2 (5.9)	4 (12.5)
Subchondral cyst	1 (2.9)	3 (9.4)
Intraarticular bone fragment	0 (0)	1 (3.1)

All values inside parentheses indicate percentages.
*Significant differences between the groups, Pearson χ^2 test, $P < 0.05$.

SIJ Degeneration According to the Number of Fusion Segments

One segment fusion was performed in 11 patients. Among them, 10 (91%) developed SIJ degeneration. Two segments fusion was performed in 21 patients, and SIJ degeneration developed in 14 (67%). However, the incidence of SIJ degeneration was not found to be associated with the number of fusion segments.

In group 1, one segment fusion was performed in 7 patients. Among them, 6 (86%) developed SIJ degeneration. Two segments fusion was performed in 15 patients, with SIJ degeneration developing in 8 (53%). In group 2, 1 and 2 segment fusion was performed in 4 and 6 patients, respectively. SIJ degeneration developed in all patients. However, the incidence of SIJ degeneration according to the number of fusion segments was similar in both groups and within each group (Table 1).

Clinical and Functional Outcomes

At the 5-year follow-up, the patients in each group demonstrated significant improvement in the VAS and ODI scores compared with the preoperative scores. In group 1, the mean VAS scores was 8.7 ± 1.3 before surgery, and 3.7 ± 1.2 at 5 years after surgery, showing 57.5% improvement. The mean ODI scores was 60.3 ± 11.4

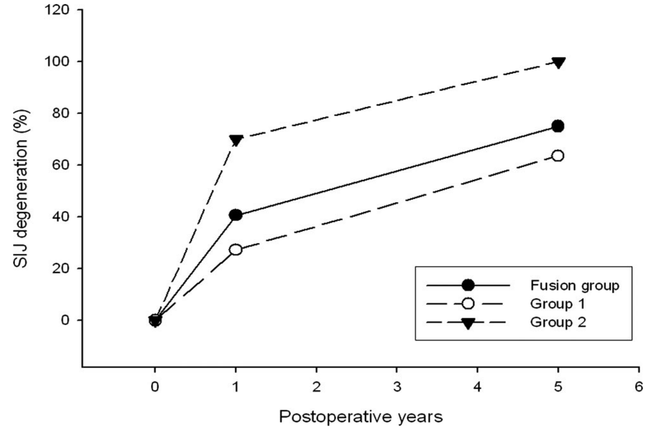

Figure 2. The incidence of sacroiliac joint (SIJ) degeneration after instrumented posterolateral lumbar/lumbosacral fusion.

Table 4. The Incidence of Sacroiliac Joint Degeneration According to the Range of Fusion

	No. Patients	SIJ Degeneration Patients (%)
Fusion group	32	24 (75)
Group 1 (fusion to L5)	22	14 (64)*
Bilateral		9 (41)
Unilateral (Rt./Lt.)		5 (0/5) (23)†
Group 2 (fusion to S1)	10	10 (100)
Bilateral		8 (80)
Unilateral (Rt./Lt.)		2 (0/2) (20)

*†Significant differences between the groups, Pearson χ^2 test, *$P = 0.028$, †$P = 0.04$.

before surgery, and 26.5 ± 10.2 at 5 years after surgery, showing 56.1% improvement. In group 2, the mean VAS scores was 8.7 ± 1.6 before surgery, and 2.9 ± 2.1 at 5 years after surgery, showing 66.7% improvement. The mean ODI scores was 60.2 ± 21.7 before surgery, and 18.8 ± 8.8 at 5 years after surgery, showing 68.8% improvement. However, there was no significant difference in the decrease in the VAS and ODI scores between the groups (group 1 *vs.* group 2).

Discussion

Movement occurring in the SIJ plays an important role in distributing the force delivered from the upper body, and is influenced by the movement of the lumbosacral vertebrae.[11–13] However, its movement is quite small. Therefore, an evaluation of the SIJ by a physical examination is quite difficult, and in addition, it is also difficult to detect an abnormality in the SIJ by simple radiography.[21–24] Excluding the diseases that can mediate the effect on the SIJ, only the presence or absence of abnormal rotation of the SIJ could be detected in simple radiography. Therefore, for patients who are clinically suspected to have a pathologic lesion in the SIJ but the simple radiography are normal, CT is the most rational and an excellent method for detecting a lesion in the SIJ early.[18,21,23–26]

Vogler *et al*[17] examined the CT findings of 45 asymptomatic normal individuals and suggested joint space narrowing, sclerotic changes in the sacroiliac area, erosion, and intraarticular osteophyte formation as abnormal findings of the SIJ. However, in their study, the number of elderly patients (5 cases) was too small to evaluate the precise incidence of SIJ degeneration in asymptomatic normal individuals more than 60 years of age. Shibata *et al*[27] examined the CT findings of 95 normal asymptomatic individuals. They reported the development of degenerative changes in 60%, 94%, and 100% of subjects in their 20s, 40s, and 50s, respectively. However, without any preset standard, they included local sclerotic changes and minimal osteophyte formation as degenerative changes. Hence, the criteria for determining SIJ degeneration are unclear. In this study, SIJ degeneration developed in 38.2% of the control group. According to the strict criteria diagnosing SIJ degeneration, those with intraarticular gas formation, local sclerosis, and mild or moderate osteophyte formation were excluded. Thus, SIJ degeneration was assessed strictly. In addition, the CT scans of 34 age-matched normal individuals without a history of spine surgery or a disease affecting the SIJ were examined. This allowed for a more accurate assessment of the degenerative changes in the SIJ in the control group. In contrast, SIJ degeneration developed in 75% of patients who underwent instrumented lumbar/lumbosacral fusion. This incidence is approximately double that of the control group (38.2%). Although degeneration of the SIJ can be considered part of the normal aging process, this result showed that instrumented lumbar/lumbosacral fusion mediated the effect on the SIJ, and accelerated the degenerative changes.

Many studies[28–31] have reported that a fracture of the pelvis develops because of the delivery of force to the pelvis after rigid posterior instrumented fusion. Furthermore, in the segments adjacent to the instrumented fusion, the bone mineral density was found to have decreased,[32,33] resulting in an adjacent vertebral fracture. Some studies[2,28–33] suggested that accelerated degeneration of 1 or 2 segments adjacent to the fusion might occur because of the increased force transmitted to these joints. Mathews *et al*[29] recommended fusion up to the fifth lumbar vertebra to reduce the delivery of force to the pelvis. However, in this study, a high rate (64%) of SIJ degeneration was observed in group 1. Almost ⅔ of the group of patients who had one intact disc below the fusion had a similar fate. This suggests that although the fusion stops to L5, the force that develops as a result of instrumented fusion is transmitted to the SIJ, and accelerates the degeneration. Therefore, regardless of whether the fusion includes the sacrum, the SIJ is influenced by the increased mechanical stress arising from instrumented lumbar/lumbosacral fusion.

The distal joint is the SIJ when the fusion extends to the sacrum. In this study, it was found that SIJ degeneration developed more frequently in cases of lumbar fusion to the sacrum. Although the mean age of Group 2 was younger than that of group 1, the incidence of SIJ degeneration in group 2 was higher (Figure 2). This suggests that in the case of lumbar fusion to the sacrum, the force delivered to the pelvis is higher, which has a larger effect on the adjacent SIJ.

Nagata *et al*[34] reported that more stress was transferred to adjacent segment as more levels were instrumented. Weinhoffer *et al*[35] also reported that 2-level instrumentation increased the adjacent disc pressure more than 1-level instrumentation. However, in the present study, there was no correlation between SIJ degeneration and the number of fusion segments. It is believed that SIJ degeneration might develop regardless of the number of fusion segments.

Other potential causes of SIJ degeneration after lumbosacral fusion include iatrogenic injury to the joint itself during graft harvest. Xu *et al*[36] reported a high incidence

of inner table disruption in patients with persistent SIJ pain after posterior iliac bone harvesting. They also found degenerative changes in the SIJ on CT scan. In the current study, the cancellous iliac bone for fusion was obtained from the posterior superior iliac spine of the left side in all patients, and all cases of unilateral SIJ degeneration developed on the left side. Interestingly, when the cancellous bone was obtained for a bone graft, although the damage to the SIJ was absent on the CT scan, the SIJ in the bone harvest side would develop degeneration more often than in the normal side at the end. This is in agreement with other reports showing that the harvest of cancellous bone for a bone graft also induced pelvic instability and had a negative effect on the SIJ.[37–39] Therefore, alternative methods to this technique (iliac crest grafting) should be considered in fusion surgery.

There were some limitations to this study. This study mainly focused on the radiologic changes in the SIJ after instrumented lumbar/lumbosacral fusion. The clinical outcome relating SIJ degeneration or SIJ pain was not assessed. On the CT scan, SIJ degeneration developed in 75% of patients who underwent instrumented lumbar/lumbosacral fusion. However, the clinical and the functional outcome were improved significantly in these patients because the SIJ pain was not assessed. It is believed that an improvement in the clinical and functional outcome resulted from the exclusion of patients who underwent revision surgery for nonunion at the fusion site and proximal segment stenosis on the CT scans during the follow-up. However, although the clinical outcome related to SIJ degeneration has not been addressed, it is important to clarify whether or not adjacent segmental changes in the SIJ develop after instrumented posterolateral lumbar/lumbosacral fusion. Although this prospective study examined a relatively small number of patients who underwent lumbosacral fusion, some important results could be made concerning SIJ degeneration. Furthermore, to the authors' knowledge, there have not been any prospective studies reporting the rate of SIJ degeneration after instrumented posterolateral lumbar/lumbosacral fusion during an observation period >5 years.

■ Conclusion

Instrumented posterolateral lumbar/lumbosacral fusion might be the cause of SIJ degeneration. SIJ degeneration develops more often in patients undergoing lumbosacral fusion regardless of the number of the fusion segments. Furthermore, iliac crest grafting also has a negative effect on the SIJ and induces SIJ degeneration, even though there was no damage to the SIJ during graft harvest. These results suggest that the SIJ is one of the segments adjacent to the fusion mass in the lumbosacral spine and is affected by fusion surgery. Therefore, it is recommended that surgeons consider SIJ degeneration before and after instrumented posterolateral lumbar/lumbosacral fusion.

■ Key Points

- SIJ is one of the segments adjacent to the fusion mass in the lumbosacral spine and is affected by fusion surgery.
- Instrumented posterolateral lumbar/lumbosacral fusion can be a cause of SIJ degeneration.
- SIJ degeneration develops more often in patients undergoing lumbosacral fusion regardless of the number of fusion segments.

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