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ORIGINAL ARTICLE

Activities of daily living and patient satisfaction after long fusion for adult spinal deformity: a retrospective study

Yoshinori Ishikawa[1] · Naohisa Miyakoshi[1] · Takashi Kobayashi[2] · Toshiki Abe[2] · Hiroaki Kijima[1] · Eiji Abe[2] · Yoichi Shimada[1]

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Abstract

Purpose Spinal instrumented arthrodesis improves health-related quality of life (HRQOL), although mobility is impaired. This study evaluates activities of daily livings after thoracolumbosacroiliac arthrodesis for adult spinal deformity and patient satisfaction.

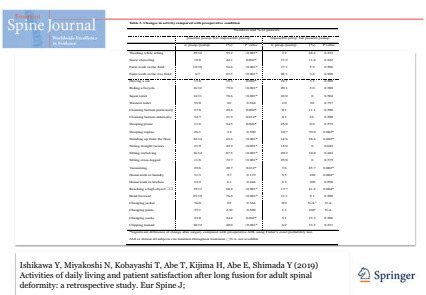
Methods Fifty patients who underwent surgery filled self-administered questionnaires (1-year preoperative and postoperative conditions), and 36 patients (3 men and 33 women; mean age 71.4 years) participated in the study. Twenty-five activities, including weeding, snow shoveling, toilet activities, and sleeping postures, were examined. Spinal alignment with Scoliosis Research Society (SRS)—Schwab classification, HRQOL with SRS-22, complications, and patient satisfaction were evaluated. Pre- and postoperative conditions were statistically compared.

Results Spinal alignment improved postoperatively. Comparison data revealed that strenuous activities, such as weeding and farm work, significantly deteriorated postoperatively in 42.1–87.5% patients. Other basic activities, excluding Western toilet usage, sleeping supine, laundry and kitchen chores, and changing jacket/pants, also significantly deteriorated in 21–88% patients. Only activities such as sleeping supine, standing upright, vacuuming, doing laundry, and reaching for objects placed at heights became possible with significant difference postoperatively among activities that could not be performed preoperatively. Light activities were continued, but strenuous activities were restricted. Nevertheless, the patient satisfaction rate was 70%. Six patients exhibited complications; however, none were dissatisfied with surgery outcomes. Instrumentation or proximal junctional failures were associated with at least one strenuous work activity.

Conclusions Thoracolumbosacroiliac arthrodesis does not always improve activities postoperatively. Therefore, surgical indication for patients who continue activities preoperatively should be carefully decided.

Level of Evidence Level 3.

Graphical abstract These slides can be retrieved under Electronic Supplementary Material.



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Keywords Adult spinal deformity · Thoracolumbosacroiliac arthrodesis · Spinal mobility · Quality of life · Activities of daily living

Introduction

The number of healthy elderly individuals is increasing among the aging society. Spondylosis or osteoporosis worsens with aging. As a result, incidences of spinal deformities derived from vertebral fractures and severe spondylosis are increasing in the elderly. Adult spinal deformities (ASDs) such as kyphoscoliosis impair health-related quality of life (HRQOL) [1–4]. Spinal deformity becomes rigid, and spinal mobilities are limited. Correction of these sagittal plane deformities significantly improves HRQOL [1–5]. Global malalignment is associated with postural instability, as measured by a stabilometer [6]. Poor spinal alignment is compensated in the lower extremities, but deformity beyond compensation is associated with a risk of severe postural instability [6, 7]. Difficulty in standing upright without using support is associated with impaired activities of daily livings (ADLs) and lower QOL.

The correction of severe rigid spinal deformity requires long instrumentation, such as thoracolumbosacroiliac arthrodesis, which simultaneously impairs spinal mobility. However, few studies have discussed the actual restriction of ADLs. For instance, Kimura et al. [8] reported the effects of lumbar stiffness after lumbar fusion surgery on ADLs. Patients who received a 3- or 4-level fusion exhibited more ADL limitations compared with those who received 1- or 2-level fusions [8]. However, a 5-level fusion or more has not yet been discussed. Hart et al. [9] compared pre- and postoperative ADLs with longer fusion for 1, 2, 3, 4, and 5 levels or more groups with lumbar stiffness disability index (LSDI). LSDI showed a significant difference only for 1-level fusion, whereas the changes in LSDI score increased with the number of levels fused. Elderly people prefer farm works particularly especially in rural area, and strenuous activities deteriorate ASD. Although patients who underwent ASD surgery were prohibited from performing strenuous activities, it was questionable whether patients followed the instructions. Moreover, various activities, such as sitting on the floor, require larger spinal mobility, and the change in activity following ASD surgery may be different from those observed in previous studies reported by Hart et al. [9].

We thus hypothesized that with long spinal instrumentation, spinal mobility is restricted, thus potentially decreasing the activity and satisfaction. Moreover, patients with complications may be dissatisfied, and instrumentation failure might relate to high strenuous activity after surgery. Recognizing these data is helpful for considering surgical indication, preoperative patients' explanation, or patients' education. The present study aimed to investigate the difference between pre- and postoperative activities in patients with ASD treated using thoracolumbosacroiliac arthrodesis with satisfaction and complication.

Materials and methods

Fifty consecutive patients with ASD were included in this study. Surgeries were performed by an experienced surgeon between 2011 and 2014 at a single institute. All patients underwent multilevel posterior lumbar interbody fusion, and two patients underwent additional osteotomy for spinal alignment correction. Self-administered questionnaires were distributed to all patients. Thirty-six patients (3 men and 33 women) who responded to this questionnaire were retrospectively evaluated (mean age 71.4 years; age range 59–84 years). The mean follow-up period was 29 months (15.1–49.7 months). All patients were treated using thoracolumbosacroiliac arthrodesis. The caudal end was an S2 alar-iliac screw in all patients, and the cranial end was T4 in two patients, T5 in two patients, T7 in two patients, T9 in 29 patients, and T11 in one patient.

Pre- and postoperative pelvic tilt (PT), lumbar lordosis (LL), sagittal vertical axis (SVA), and pelvic incidence–LL (PI–LL) were evaluated using a standing lateral X-ray [5]. HRQOL information regarding function, mental health, pain, self-image, and satisfaction was evaluated using the Scoliosis Research Society (SRS)-22 questionnaire [10]. Strenuous or daily basic activities were assessed to evaluate the difference between pre- and postoperative ADLs (Table 1). Weeding while sitting, shoveling snow using a snow scoop, farm work in fields, and basic ADLs, such as driving a car, riding a bicycle, squatting when using a toilet, using a Western toilet, cleaning bottom posteriorly and anteriorly, sleeping prone and supine, standing upright, sitting straight (seiza), sitting curled-leg, sitting cross-legged, vacuuming, doing laundry and kitchen chores, reaching for an object placed at a height, bending forward, changing jacket/pants/socks, and clipping toenails, were evaluated using a simple check-box questionnaire (Table 1). Thus, the difference between pre- and postoperative conditions was evaluated with a possible or impossible response and compared. The differences in ADLs that the patients could and could not perform preoperatively and the differences in ADLs that patients could or could not perform postoperatively were examined and statistically analyzed. Data were obtained both at 1-year preoperative and at 1-year postoperative conditions. Moreover, satisfaction from the surgery was also assessed with five grades (i.e., very satisfied, satisfied, neither, dissatisfied, and very dissatisfied). Postoperative early and late complications, such as general conditions or instrumentation

failure, were assessed. Furthermore, the associations among activities, satisfaction, and complications were evaluated.

Statistical analysis

All statistical analyses were performed using EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria) [11]. EZR is a modified version of R commander designed to add statistical functions frequently used in biostatistics. To evaluate the factors affecting ADLs, the differences between pre- and postoperative ADLs with responses "possible" or "impossible" were analyzed using Fisher's exact probability test. The differences between pre- and postoperative spinal alignment and SRS-22 scores were analyzed using Student's paired *t* test. $P < 0.05$ were considered statistically significant.

Table 1 Questionnaire about the effects of lumbar stiffness after surgery on activities of daily living

Check (✓☐) the statement that you could perform preoperatively and postoperatively

Activities		Preoperatively 1 year	Postoperatively 1 year
1	Weeding		
2	Snow shoveling		
3	Farm work in the field		
4	Farm work in the rice field		
5	Driving a car		
6	Riding a bicycle		
7	Squat toilet		
8	Western toilet		
9	Cleaning bottom posteriorly		
10	Cleaning bottom anteriorly		
11	Sleeping prone		
12	Sleeping supine		
13	Standing up from the floor		
14	Sitting straight (seiza)		
15	Sitting curled-leg		
16	Sitting cross-legged		
17	Vacuuming		
18	Housework in laundry		
19	Housework in kitchen		
20	Reaching a high object		
21	Bending forward		
22	Changing jacket		
23	Changing pants		
24	Changing socks		
25	Clipping toenail		

Results

The mean values for the pre- and postoperative PT, LL, SVA, and PI–LL are presented in Table 2. The mean preoperative spinal alignment was 40.4° in PT, − 5.4° in LL, 136.1 mm in SVA, and 54.1° in PI–LL, which was marked as deformity (SRS—Schwab classification/sagittal modifiers PT++; > 30°, SVA++; > 9.5 cm; PI–LL++; > 20°) [5]; however, these parameters significantly improved postoperatively to 19.9° in PT, 43.3° in LL, 24.7 mm in SVA, and 6.6° in PI–LL among nonpathologic criteria (SRS—Schwab classification/sagittal modifiers PT0; < 20°, SVA0; < 4 cm; PI–LL0; < 10°) [5] (Table 2). Moreover, preoperative HRQOL evaluated using a SRS-22 questionnaire with function, 2.4; mental health, 2.4; pain, 2.3; and self-image, 1.9 significantly improved to 3.0, 3.4, 3.6, and 3.4, respectively ($P < 0.05$) (Table 2). The mean postoperative SRS-22 satisfaction was 3.4 (Table 2).

Pre- and postoperative differences of ADL are presented in Table 3. These results included the number and percent change of ADLs that were possible preoperatively but impossible postoperatively and those that were impossible preoperatively but possible postoperatively (Table 3). Among ADLs that were possible preoperatively, all strenuous activities, such as weeding while sitting, shoveling snow, and farm work, in the fields deteriorated and became impossible postoperatively for 42.1–87.5% patients (Table 3). Farm work in rice fields exhibited the worst results among all strenuous activities. Eight patients could work in rice fields preoperatively, whereas seven patients (87.5%) could not (Table 3). All differences in strenuous activities were significant (Table 3). Other daily basic activities, such as driving a car, riding a bicycle, squatting on a toilet, cleaning bottom posteriorly and anteriorly, sleeping prone, standing upright, sitting straight (seiza), sitting curled-leg, sitting cross-legged, vacuuming, reaching for an object placed at a height, bending forward, changing socks, and clipping toenails, also deteriorated and became impossible for 20.7–87.5% patients with significant difference (Table 3). Sitting curled-leg exhibited the worst results among the basic activities. Sixteen patients could perform these activities preoperatively, whereas 14 patients (87.5%) could not do so postoperatively (Table 3). Using a Western toilet, sleeping supine, doing laundry and kitchen chores, and changing jacket and pants were impossible for only 0–9.7% patients, with no difference in significant deterioration between pre- and postoperative conditions (Table 3). In particular, using a Western toilet and changing jackets exhibited no deterioration after surgery. However, ADLs requiring relatively larger spinal mobilities became impossible postoperatively.

In contrast, among ADLs that were impossible preoperatively, weeding while sitting, shoveling snow, and

Table 2 Demographics and pre- and postoperative spinal alignment and HRQOL of patients

	Preoperative	Postoperative	*P* value*
Sagittal			
PT (°)	40.4 ± 13.2	19.9 ± 7.9	< 0.001
Modifiers			
LL (°)	− 5.4 ± 22.9	43.3 ± 12.1	< 0.001
SVA (mm)	136.1 ± 62.1	24.7 ± 42.5	< 0.001
PI–LL (°)	54.1 ± 24.2	6.6 ± 13.9	< 0.001
SRS-22			
Function	2.4 ± 0.5	3.0 ± 1.0	0.022
Mental health	2.4 ± 0.9	3.4 ± 1.0	0.011
Pain	2.3 ± 0.9	3.6 ± 1.2	< 0.001
Self-image	1.9 ± 0.5	3.4 ± 0.9	< 0.001
Satisfaction		3.4 ± 0.9	

Values represent the mean ± SD

PT pelvic tilt, *LL* lumbar lordosis, *SVA* sagittal vertical axis, *PI–LL* pelvic incidence–lumbar lordosis

**t* test between pre- and postoperative measurements

farm work in the fields were possible for only 3.6–28.6% patients (Table 3). The best result among all strenuous activities was for weeding while sitting. Seven patients could not perform this activity preoperatively, whereas two patients were able to perform it postoperatively (Table 3). However, these differences were not significant. Driving a car, riding a bicycle, squatting while using a toilet, using a Western toilet, cleaning bottom posteriorly and anteriorly, sleeping prone, sitting straight (seiza), sitting curled-leg, sitting cross-legged, bending forward, changing jacket/pants/socks, and clipping toenails were impossible for 0–33.3% patients (Table 3). The best results were obtained for laundry and kitchen chores and changing pants. All patients (100%) exhibited improvement after surgery in this respect (Table 3). Almost all data did not show statistical significance between pre- and postoperative differences, whereas sleeping supine, standing upright, vacuuming, doing laundry and kitchen chores, and reaching for an object placed at a height were possible for 28.6–100% patients, and most of these differences were significant (Table 3).

ADLs associated with maintaining an upright posture for a long duration, such as while doing housework in the kitchen, became possible postoperatively. Light activities such as daily basic activities showed a possibility of being continued. Activities such as using a Western toilet, sleeping supine, doing laundry and kitchen chores, and changing jacket/pants were continued after thoracolumbosacroiliac arthrodesis. ADLs that require relatively larger spinal mobility, such as squatting while using a toilet, cleaning bottom posteriorly, standing upright, bending forward, changing socks, and clipping toenails, were restricted postoperatively. The patients displayed activity limitations, particularly with strenuous activities after surgery, whereas significant improvement was observed with SRS-22 assessment (Tables 2, 3). Moreover, 70% patients were satisfied with the surgery outcome (very satisfied and satisfied) (Fig. 1). A decreased capacity for activities was observed postoperatively; however, several patients were satisfied with the surgical outcome.

Six patients exhibited postoperative complications (16.7%): 1, transient motor weakness; 1, brain infarction; 1, surgical site infection; 3, instrumentation failures; and 1, proximal junctional failure (Table 4). All patients with failures were engaged in at least one strenuous activity postoperatively despite the prohibition. Although two patients underwent reoperation and a total of six patients exhibited complications, none of them were dissatisfied with the surgery outcome (Table 4). Two patients expressed "very satisfied" status and four expressed "satisfied" status with the surgery (Table 4).

Discussion

An increasing population of elderly subjects requires a healthy life span [12]. Accordingly, the number of spinal correction surgeries has increased in recent years. Women tend to have decreased bone mineral density with age and have a tendency to demonstrate kyphotic posture with vertebral fractures compared with men. The present study, therefore, predominantly included women.

Severe spinal kyphosis aggravates spinal inclination and SVA [6]. Positive SVA is reportedly associated with disability and unfavorable QOL scores [1–4, 13]. Key radiographic parameters deriving disability in patients with ASD are well recognized; their thresholds for severe disability were established based on prospective multicenter evaluation [14]. Schwab et al. [14] reported that PT, SVA, and PI–LL were important factors in estimating patients' disabilities and better QOL following ASD surgery. Their thresholds were 22° in PT, 47 mm in SVA, and 11° in PI–LL [14]. Moreover, the SRS—Schwab classification categorized PT < 20°, SVA < 40 mm, and PI–LL < 10° as nonpathological deformities [15, 16]. The patients in the present study demonstrated spinal malalignment preoperatively (40.4° in PT, 136.1 mm in SVA, and 54.1° in PI–LL); however, all these parameters significantly improved within the recommended threshold and the category of nonpathological deformity postoperatively (19.9° in PT, 24.7 mm in SVA, and 6.6° in PI–LL) (Table 2). Therefore, spinal malalignment could be reconstructed well, which implies that QOL was improved as well [16, 17]. Moreover, the SRS-22 score showed significant improvement of HRQOL in all domains

Table 3 Changes in activity compared with preoperative condition

	Numbers and % of patients					
	Possible pre-op but impossible post-op			Impossible pre-op but possible post-op		
	n; pre-op/post-op	(%)	*P* value	*n*; pre-op/post-op	(%)	*P* value
Weeding while sitting	29/16	55.2	< 0.001*	7/2	28.6	0.233
Snow shoveling	19/8	42.1	0.002*	17/2	11.8	0.242
Farm work in the field	19/10	52.6	< 0.001*	17/1	5.9	0.500
Farm work in the rice field	8/7	87.5	< 0.001*	28/1	3.6	0.500
Driving a car	17/6	35.3	0.009*	19/1	5.3	0.500
Riding a bicycle	16/12	75.0	< 0.001*	20/1	5.0	0.500
Squat toilet	14/11	78.6	< 0.001*	22/0	0	0.584
Western toilet	35/0	0[#]	0.568	1/0	0[#]	0.757
Cleaning bottom posteriorly	27/8	29.6	0.002*	9/1	11.1	0.500
Cleaning bottom anteriorly	32/7	21.9	0.012*	4/1	25.	0.500
Sleeping prone	11/6	54.5	0.006*	25/0	0.0	0.579
Sleeping supine	26/1	3.8	0.500	10/7	70.0	0.002*
Standing up from the floor	22/14	63.6	< 0.001*	14/4	28.6	0.049*
Sitting straight (seiza)	21/9	42.9	< 0.001*	15/0	0	0.602
Sitting curled-leg	16/14	87.5	< 0.001*	20/2	10.0	0.244
Sitting cross-legged	11/8	72.7	< 0.001*	25/0	0	0.579
Vacuuming	29/6	20.7	0.012*	7/6	85.7	0.002*
Housework in laundry	31/3	9.7	0.119	5/5	100	0.004*
Housework in kitchen	33/2	6.1	0.246	3/3	100	0.050
Reaching a high object	19/13	68.4	< 0.001*	17/7	41.2	0.004*
Bending forward	25/19	76.0	< 0.001*	11/1	9.1	0.500
Changing jacket	36/0	0[#]	0.566	0/0	N.A.[#]	N.A.
Changing pants	35/1	2.9[#]	0.500	1/1	100[#]	N.A.
Changing socks	33/8	24.2	0.002*	3/1	33.3	0.500
Clipping toenail	30/12	40.0	< 0.001*	6/2	33.3	0.231

*Significant difference of change after surgery compared with preoperative ADL using Fisher's exact probability test

[#]All or almost all subjects can maintain throughout treatment. *NA* not available

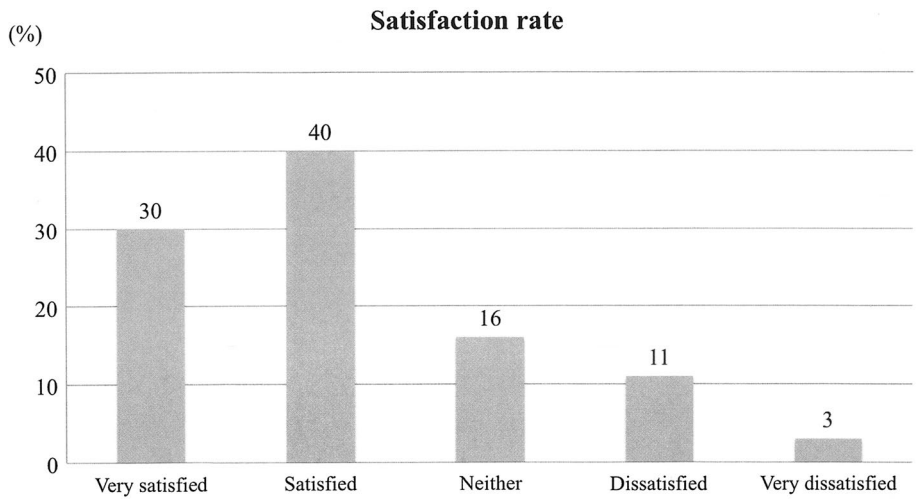

Fig. 1 Satisfaction rates after thoracolumbosacroiliac arthrodesis. The percentage of patients who were satisfied with the surgery (very satisfied plus satisfied) was 70%

Table 4 Six patients with complications, strenuous activities relating instrumentation or proximal junctional failure, reoperation, and satisfaction

Patient	Complications	Strenuous activities	Reoperation	Satisfaction
1	Transient motor weakness		–	Satisfied
2	Brain infarction		–	Satisfied
3	Surgical site infection Instrumentation failure	Weeding, snow shoveling, farm work in the field	–	Satisfied
4	Instrumentation failure	Snow shoveling	–	Very satisfied
5	Instrumentation failure	Weeding, farm work in the field	+	Very satisfied
6	Proximal junctional failure	Weeding, snow shoveling	+	Satisfied

with function, mental health, pain, and self-image (Table 2; $P < 0.05$). There is no consensus on how to measure outcome in ASD surgery [18]. However, Faraj et al. [18] reported that the SRS-22 appears to have the highest level of clinimetric quality compared to the ODI, SF-12, and SF-36 and seems most suitable in the ASD population.

The loss of global balance impairs control of the center of gravity [6]. Corrective spinal instrumentation surgeries improve global balance and help regain impaired QOL [1–4, 16, 17, 19]. Miyakoshi et al. [19] compared the QOL of Japanese patients with osteoporosis between pre- and postoperative surgeries for ASD with a mean fused level of 6.6. Remarkably, the QOL activity domain did not show any significant recovery after ASD surgery compared with that reported for preoperative data [19]. QOL after surgery did not attain the control data obtained from normal patients who did not undergo spinal surgery, and activity subdomains did not recover significantly compared with those reported for preoperative data [19]. The present study explained the cause of poor recovery of activity domains [19]. Additionally, QOL is reportedly associated with spinal mobility [20]. Long instrumentation limits spinal mobility and therefore decreases patient activity. Some studies have reported the change of actual ADL after spinal arthrodesis for ASD [8, 9, 21–23]. Kimura et al. [8] reported the effects of lumbar stiffness after lumbar fusion surgery on ADL at approximately ≤4-level fusion. They concluded that patients who received a 3- or 4-level fusion, particularly a 4-level fusion, showed more ADL limitations because of postoperative lumbar stiffness. However, their evaluations only focused on basic ADLs. Therefore, the results of strenuous activities are not well known. Japan ranks first worldwide in population aging rate. The population aging rate of individuals aged ≥65 years in our prefecture is the highest in Japan, recently reaching 32.6%. Healthy life expectancy continues to increase, with elderly aged over 75–80 years working in rice fields or farms, particularly in rural areas. Other developed countries are expected to follow this trend in the near future. However, patients who did not perform those activities preoperatively were excluded if the activity was not a regular one for patients, after which the pre- and postoperative conditions were compared. Having a large number of elderly in a single population is a problem. In such a situation, the elderly have to perform all tasks by themselves, such as weeding or snow shoveling. Our data show that only 55% and 42% of patients discontinued weeding and snow shoveling, respectively (Table 3). Although strenuous activities are prohibited by surgeons, data show that the living environment requires strenuous activities. Therefore, the results of strenuous activities imply the following rate of surgeon's prohibition rather than the change of activity. Half the patients did not follow our instructions, which deteriorated the surgical outcome (Table 4). The patients with instrumentation failure or proximal junctional failure performed at least one strenuous activity despite the prohibition (Table 4).

Some basic ADLs, such as standing upright, vacuuming, or reaching for an object placed at a height, exhibited significant differences in both possible preoperative/impossible postoperative and impossible preoperative/possible postoperative change. These findings may indicate that changes in the ability/disability to perform these activities do not necessarily occur due to spinal stiffness after fusion. However, patients with ASD typically experience pain, and the pain may also be associated with these restrictions of activities.

Clipping toenails was impossible after surgery for 40% patients, whereas 60% patients could perform the activity (Table 3). Kimura et al. [8] reported that 30.8% patients were either unaffected or little affected after a 4-level fusion surgery on postoperative evaluation. Patients with ASD usually display poor mobility with rigid spine and may have restricted ADLs preoperatively. Moreover, preoperative restriction of activities increases postoperative major complications [24]. De la Garza Ramos et al. [24] reported that depending on others for ADLs before ASD surgery increase the risk of major perioperative complication by twofold compared to independent patients. To understand the effects of ASD surgery, we should evaluate the both pre- and postoperative ADLs.

Hart et al. [9] reported that American patients with longer fusion actually perceive increased limitations due to stiffness after lumbar arthrodesis. Their study compared pre- and postoperative states for 1, 2, 3, 4, and 5 levels or more fusion groups. ADL was evaluated with LSDI. LSDI shows significant difference only for 1-level fusion, although the

changes of LSDI score increased with the number of levels fused. Hongo et al. [25] reported the difference in spinal posture between American and Japanese subjects. He reported that American subjects displayed larger thoracic kyphosis and LL than Japanese subjects and that the ratio of lumbar to thoracic fractures was higher in Japanese subjects [25]. These differences could be attributed to a difference in lifestyle habits, such as sitting on the floor, which requires larger spinal mobility. The LSDI score comprised only ten basic ADLs. Other ADLs in different races needed assessment after ASD surgery. Various races from different countries living across the world from US to European countries make evaluation of different types of ADLs mandatory.

Fusion to the sacroiliac joint restricted the ability to stretch or bend, which led to limited daily activities 1 year postoperatively, although this effect may improve after another year [23]. Moreover, iliac instrumentation significantly improved radiographic and HRQOL parameters 2 years after surgery [21]. Our study included only those patients who underwent thoracolumbar to sacroiliac fixation; thus, the limitation of activities in our study assessed at 1 year after surgery may improve after another year. On the other hand, Sciubba et al. [22] evaluated the difference in ADLs at > 8 levels fusion and reported the difference of ADLs in the uppermost instrumented vertebra (UIV) within the upper thoracic (UT) versus the thoracolumbar (TL) region. The only domain for which UT exhibited greater impairment was in performing personal hygiene functions after visiting the toilet [22]. UIV in this study ranged from T4 to T11, and the most frequent UIV was T9 in 29 patients (80%). We speculate that UIV in UT has a larger limitation than that in TL because the thoracolumbar spine has a larger mobility than the thoracic spine. Thus, our study has some limitations. It was a retrospective study with a small number of cases with various UIV, female predominance, and lack of data after long-term follow-up. Complications and changing in functional disability may occur after 1 year. We evaluated the change of various types of activities for ASD surgery. Validated functional questionnaire is a better assessment of functional improvement; however, previous questionnaires included only a small number of questions relating to activities. Therefore, using a simple check-box questionnaire with different types of questions helped remind the participants of previous conditions easily and helped decrease potential recall bias.

Conclusions

Long spinal arthrodesis does not always increase ADLs. Light activities such as daily basic activities offer the possibility of being continued postoperatively. ADLs that require relatively larger spinal mobility as well as strenuous activities were restricted postoperatively. Nevertheless, patient satisfaction was high. Surgical failures may be associated with strenuous activities postoperatively. The indication of long spinal instrumentation among patients who continue performing activities preoperatively should be carefully decided. Moreover, postoperative patients' education is indispensable.

Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

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Affiliations

Yoshinori Ishikawa[1] · Naohisa Miyakoshi[1] · Takashi Kobayashi[2] · Toshiki Abe[2] · Hiroaki Kijima[1] · Eiji Abe[2] · Yoichi Shimada[1]

✉ Yoshinori Ishikawa
isikaway@doc.med.akita-u.ac.jp

[1] Department of Orthopedic Surgery, Akita University Graduate School of Medicine, 1-1-1 Hondo, Akita 010-8543, Japan

[2] Department of Orthopedic Surgery, Akita Kousei Medical Center, 1-1-1 Iijima-Nishifukuro, Akita 011-0948, Japan