Eur J Orthop Surg Traumatol (2018) 28:177–181
https://doi.org/10.1007/s00590-017-2027-4

ORIGINAL ARTICLE • SPINE - SCOLIOSIS

Midlife changes of health-related quality of life in adolescent idiopathic scoliosis patients who underwent spinal fusion during adolescence

Tsutomu Akazawa[1,2] · Toshiaki Kotani[2] · Tsuyoshi Sakuma[2] · Shohei Minami[2] · Yoshiaki Torii[1] · Sumihisa Orita[3] · Kazuhide Inage[3] · Kazuki Fujimoto[3] · Yasuhiro Shiga[3] · Gen Inoue[4] · Masayuki Miyagi[4] · Wataru Saito[4] · Seiji Ohtori[3] · Hisateru Niki[1]

Received: 29 May 2017 / Accepted: 5 August 2017 / Published online: 10 August 2017

Abstract
Purpose Our previous study reported a good health-related quality of life (HRQOL) in adolescent idiopathic scoliosis (AIS) patients 21 years or more after surgery. The purpose of this study is to investigate midlife changes in HRQOL among AIS patients who passed further 5 years from the previous survey.
Methods Subjects were 252 individuals who underwent spinal fusion for AIS between 1968 and 1988. The survey was administered twice—in 2009 and in 2014 using Scoliosis Research Society Patient Questionnaire (SRS-22). We analysed survey responses from 42 individuals (39 females, 3 males) who responded to both surveys.
Results The average scores for each respective domain of the SRS-22 in 2009 and 2014, respectively, were: function, 4.3 and 4.2; pain, 4.3 and 4.3; self-image, 3.0 and 2.9; mental, 3.9 and 3.8; satisfaction, 3.6 and 3.5. There were no significant differences in any domain of the SRS-22 between 2009 and 2014. Comparing non-fused segments of the lumbar spine of patients with fewer than four discs remaining with patients with four discs or more remaining, SRS-22 satisfaction score decreased more in patients with fewer than four discs (change in patients with four discs or more: −0.02; change in patients with fewer than four discs: −0.38; $P = 0.05$).
Conclusion Each SRS-22 subscore was similar between 2009 and 2014 surveys. Those scoliosis patients who underwent spinal fusion during adolescence had good HRQOL scores in midlife. Even after five years passed, good conditions were maintained.

Keywords Adolescent idiopathic scoliosis · Long-term clinical outcome · Health-related quality of life · Patient-reported outcome

Introduction

Surgeries for adolescent idiopathic scoliosis (AIS) are performed on patients in the second decade of life. Long-term health is therefore an important consideration. Recently, health-related quality of life (HRQOL) has been reported using patient-reported outcomes in order to characterize long-term health after surgery. In a study of post-operative AIS patients 11 years after surgery (mean age 32.3) using SF-36, Gotze et al. found physical functioning equivalent to the German population mean [1]. In a study of AIS patients 20 years after surgery (mean age 38.8), Mariconda et al. reported each domain of the SRS-24 equivalent to healthy individuals [2]. Additionally, in a study of AIS patients 20 years after surgery (mean age 39.7), Danielsson et al. found no significant difference in SF-36 compared with national means [3]. Indeed, there are many reports of long-term health status equivalent to healthy subjects among post-operative AIS patients in their 30 s.

Nevertheless, there are few reports on post-operative AIS patients in their 40 s. It is a serious concern whether

✉ Tsutomu Akazawa
cds00350@par.odn.ne.jp

[1] Present Address: Department of Orthopaedic Surgery, St. Marianna University School of Medicine, 2-16-1 Sugao, Miyamae-ku, Kawasaki, Kanagawa 216-8511, Japan

[2] Department of Orthopedic Surgery, Seirei Sakura Citizen Hospital, Sakura, Japan

[3] Department of Orthopaedic Surgery, Graduate School of Medicine, Chiba University, Chiba, Japan

[4] Department of Orthopaedic Surgery, Kitasato University School of Medicine, Sagamihara, Japan

post-operative AIS patients can maintain health status in middle age. We investigated HRQOL in a group of AIS patients 21–41 years after surgery (mean age 46) [4]. We reported that function and self-image domains of SRS-22 were significantly lower compared with healthy subjects. It is concerning that this may represent the beginning of a decline in health status of AIS patients as they reach middle age, compared with healthy subjects. Therefore, knowing the HRQOL changes that occur in middle age may be valuable for predicting what kind of health status patients will have later in life. Nevertheless, there are no reports investigating the natural history of such HRQOL changes in post-operative AIS patients.

The purpose of this study is to investigate midlife changes in HRQOL among AIS patients who underwent spinal fusion during adolescence. Our hypothesis is that HRQOL may decline for AIS patients who have reached middle age.

Materials and methods

The institutional review board approved the present study. Subjects were 252 individuals who underwent spinal fusion for AIS between 1968 and 1988. Mean age at time of operation was 14.8; mean Cobb angle was 68.3 degrees preoperatively and 39.4 degrees 2 years post-operatively. Letters were sent to each such surgical patient. Those who consented were administered a questionnaire. For the questionnaire, we used the Japanese version of Scoliosis Research Society Patient Questionnaire (SRS-22) [5]. The survey was administered twice—in 2009 and in 2014. For the 2009 survey, we received responses from 66 individuals; there were 66 non-respondents, 112 unknowns, and 8 deaths. In 2014, responses were obtained from 48 individuals; there were 62 non-respondents, 134 unknowns, and 8 deaths. We analysed survey responses from 42 individuals (39 females, 3 males) who responded to both surveys. The mean age of these 42 individuals was 50.8 (40–60) at the time of investigation, with an average follow-up period of 36.4 (26–45) years. Thirty-seven patients underwent posterior spinal fusion (Harrington rod: 26 cases; Harrington rod with wiring: 8 cases; multiple hook: 3 cases). Five patients underwent anterior spinal fusion (Dwyer method: 2 cases; Zielke method: 3 cases). The lowest instrumented vertebrae were: T12—3 cases; L1—8 cases; L2—10 cases; L3—8 cases; L4—6 cases; L5—2 cases; unknown—5 cases. We analysed change in survey response from 2009 to 2014 for each questionnaire item.

Healthy volunteers were recruited in our institution by bulletin board posting in the following criteria: (1) healthy individuals, (2) age 40–60 years, (3) no history of scoliosis, (4) no history of spine surgery. A total of 38 healthy volunteers were asked to fill out SRS-22 questionnaire. Previously undiagnosed scoliosis was discovered in three individuals, while tumours were found in two individuals, and these five individuals were excluded from the study. The 33 individuals who matched the patients in age and gender demographics were enrolled as control group.

Statistical analyses were conducted using SPSS Statistics version 22.0 (International Business Machines Corporation, NY, USA). Paired *t* test was used to compare 2009 and 2014 survey responses. Unpaired *t* test was used for comparisons of worsened versus non-worsened cases for each score, number of non-fused segments, comparison of scoliosis group versus control group, and comparison of participants versus non-participants. *P* value less than 5% was regarded as a significant difference.

Results

The average scores for each respective domain of the SRS-22 in 2009 and 2014, respectively, were: function, 4.3 and 4.2; pain, 4.3 and 4.3; self-image, 3.0 and 2.9; mental, 3.9 and 3.8; satisfaction, 3.6 and 3.5. There were no significant differences in any domain of the SRS-22 between 2009 and 2014 (Table 1). Individuals with lower 2014 scores in each domain of the SRS-22 were, respectively: function, 16 individuals (38.1%); pain, 12 individuals (28.6%); self-image, 24 individuals (57.1%); mental, 15 individuals (35.7%); satisfaction, 18 individuals (42.9%) (Fig. 1).

We compared those whose SRS-22 scores worsened with individuals whose scores did not worsen, for each domain. There were no significant differences in present age, length of follow-up period from spinal fusion surgery, or body mass index for each domain (Table 2).

Comparing non-fused segments of the lumbar spine of patients with fewer than four discs remaining with patients with four discs or more remaining, SRS-22 satisfaction score decreased more in patients with fewer than four discs (change in patients with four discs or more −0.02; change in patients with fewer than four discs −0.38; $P = 0.05$). There was no significant difference in any other domain of the SRS-22 (Table 3).

Table 1 SRS-22 scores in 2009 and 2014

	2009	2014	*P*
Function	4.3 ± 0.7	4.2 ± 0.7	0.67
Pain	4.3 ± 0.7	4.3 ± 0.7	0.81
Self-image	3.0 ± 0.7	2.9 ± 0.8	0.13
Mental	3.9 ± 0.9	3.8 ± 0.9	0.83
Satisfaction	3.6 ± 0.7	3.5 ± 0.7	0.15

Values are mean (±standard division)

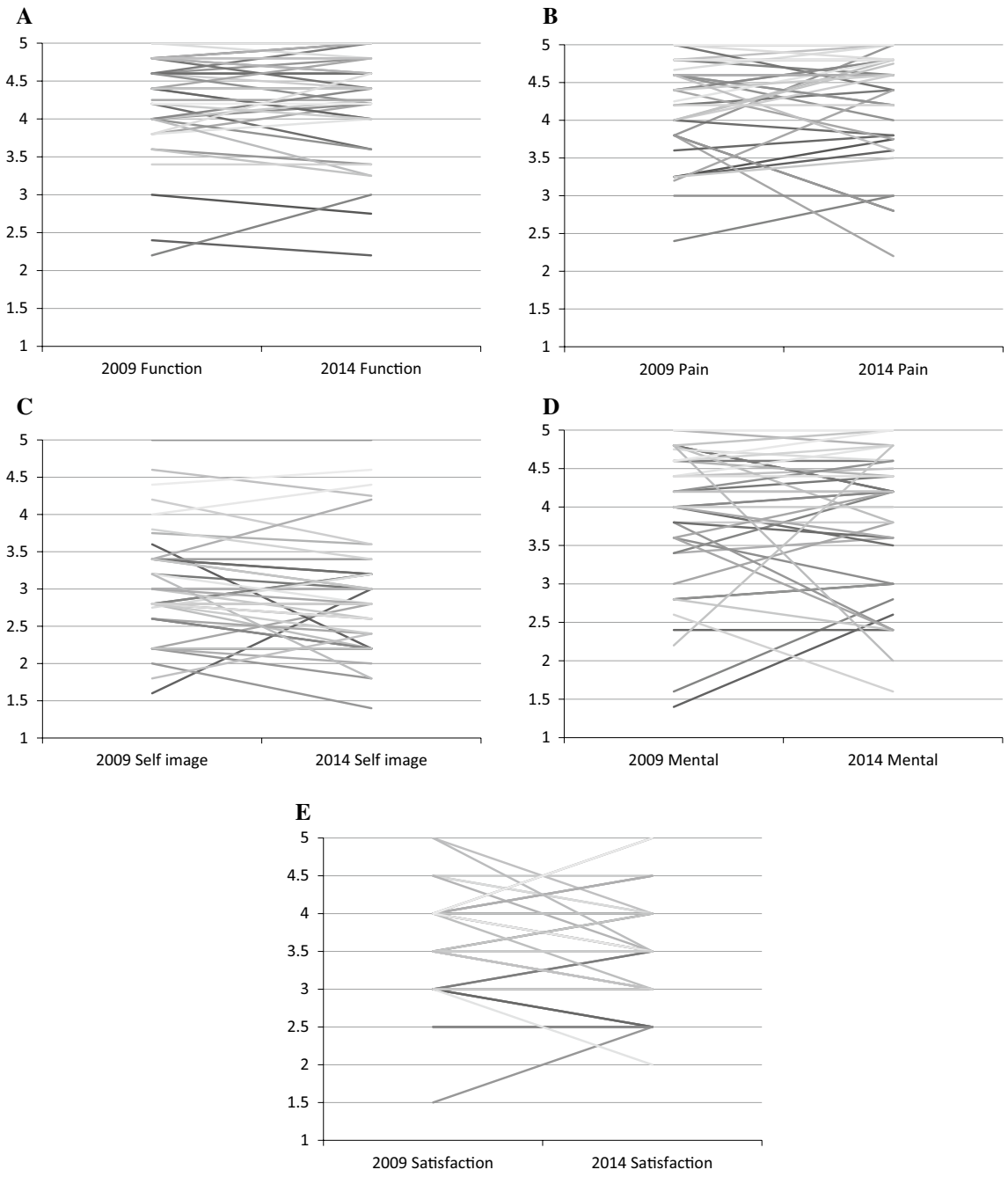

Fig. 1 Changes of SRS-22 scores from 2009 survey to 2014 survey. **a** Function domain. **b** Pain domain. **c** Self-image domain. **d** Mental domain. **e** Satisfaction domain

Scoliosis group and control group comparisons

The 42 patients in the scoliosis group were compared to the 33 individuals without scoliosis in the control group. There were no significant differences between groups in age (scoliosis group 50.3 ± 5.6 years, control group 48.8 ± 5.6 years, $P = 0.251$) and percentage of females (scoliosis group 92.9%, control group 90.9%, $P = 0.758$).

SRS-22 scores for function (scoliosis group 4.2 ± 0.7, control group 4.8 ± 0.5, $P < 0.001$) and self-image (scoliosis group 2.9 ± 0.8, control group 3.9 ± 0.7, $P < 0.001$) were significantly lower in the scoliosis group. There were no significant differences between the two groups in pain (scoliosis group 4.3 ± 0.7, control group 4.4 ± 0.5, $P = 0.373$) or mental health (scoliosis group 3.8 ± 0.9, control group 4.1 ± 0.8, $P = 0.199$) scores on the SRS-22.

Table 2 Comparison between patients whose SRS-22 scores worsened and patients whose scores did not worsen, for each domain

	Patients whose function scores worsened	Patients whose function scores did not worsen	*P*
Present age, years	52.1 ± 5.6	50.3 ± 5.5	0.345
FU period from surgery, years	37.5 ± 5.6	36.1 ± 5.1	0.439
Body mass index, kg/m^2	20.3 ± 5.3	20.5 ± 2.5	0.897
	Patients whose pain scores worsened	Patients whose pain scores did not worsen	*P*
Present age, years	51.2 ± 4.0	51.0 ± 6.1	0.902
FU period from surgery, years	36.5 ± 5.2	36.6 ± 5.4	0.964
Body mass index, kg/m^2	20.8 ± 5.7	20.2 ± 2.7	0.751
	Patients whose self-image scores worsened	Patients whose self-image scores did not worsen	*P*
Present age, years	51.4 ± 5.4	50.5 ± 5.9	0.641
FU period from surgery, years	36.8 ± 5.0	36.3 ± 5.8	0.782
Body mass index, kg/m^2	20.3 ± 2.5	20.6 ± 5.3	0.869
	Patients whose mental scores worsened	Patients whose mental scores did not worsen	*P*
Present age, years	50.2 ± 5.1	51.4 ± 5.8	0.524
FU period from surgery, years	36.3 ± 4.6	36.8 ± 5.7	0.802
Body mass index, kg/m^2	20.8 ± 3.1	20.2 ± 4.0	0.647
	Patients whose satisfaction scores worsened	Patients whose satisfaction scores did not worsen	*P*
Present age, years	49.8 ± 4.6	52.0 ± 6.2	0.207
FU period from surgery, years	35.4 ± 4.6	37.6 ± 5.7	0.196
Body mass index, kg/m^2	20.5 ± 2.5	20.3 ± 4.5	0.859

Values are mean (±standard division)

FU follow-up

Table 3 Comparison between patients with patients with four discs or more remaining and fewer than four discs remaining

	Four discs or more	Fewer than four discs	*P*
Function	−0.02	−0.05	0.81
Pain	0.13	0.00	0.46
Self-image	−0.21	−0.05	0.33
Mental	0.05	0.06	0.69
Satisfaction	−0.02	−0.38	0.05

Comparison between participants and non-participants

Demographics of the 42 participants enrolled in both surveys (2009 and 2014) were compared to the 210 non-participants. No statistically significant differences were noted in patient age at surgery (participants 14.6 ± 2.0 years, non-participants: 14.8 ± 2.1 years, $P = 0.555$), preoperative Cobb angle (participants 70.0º ± 23.0º, non-participants 67.9º ± 19.5º, $P = 0.584$), and post-operative Cobb angle 2 years after surgery (participants 41.4 ± 2.8º, non-participants 38.9º ± 15.8º, $P = 0.416$). When the percentages of participants and non-participants were compared by sex, there was no significant difference between these groups in percentage of females (participants: 92.9%, non-participants: 90.0%, $P = 0.565$). Therefore, the patients who participated in this study can be considered representative of the entire 252 patients.

Discussion

In terms of SRS-22, middle-aged AIS patients did not undergo change in HRQOL during the 5-year period. We speculated that HRQOL would decline for middle-aged AIS patients, but that hypothesis was incorrect.

There are several reports on the minimal clinically important difference (MCID) of SRS-22 in post-operative AIS patients [6, 7]. In ROC analysis, Bago et al. report 0.6 MCID for the pain domain and 1.3 MCID for the self-image domain; in analysis using standard error, MCID for

the function domain was 0.8, and MCID for the mental domain was reported to be 0.4 [6]. Considering the function MCID 0.8, in the present study, 40 subjects had no change, 2 showed improvement, and 0 deteriorated. Similarly, taking into consideration the pain MCID 0.6, 31 subjects had no change, 5 improved, and 6 deteriorated. In terms of the self-image MCID 1.3, 39 subjects showed no change, 1 improved, and 2 deteriorated. In terms of the mental MCID 0.4, 22 subjects did not change, 9 improved, and 11 worsened. That is to say, even looking at MCID, HRQOL in middle-aged AIS patients remained in large part unchanged or improved, thereby indicating maintenance of health status.

Taking into consideration the long-term course of AIS patients who underwent spinal fusion, there are reports that it is better to preserve more non-fused segments. Danielsson et al. [8] examined AIS patients with fixation through L4 or L5 in detail with MRI and determined that there is intervertebral disc degeneration 25 years after surgery associated with low back pain. Likewise, Akazawa et al. found that in the long-term, those whose lowest instrumented vertebrae are L3 or higher and hence have more non-fused segments undergo less incidence of intervertebral disc degeneration [9]. In the present study, SRS-22 satisfaction scores were higher in patients with non-fused segments at four or more levels.

There are several limitations to the present research. Because of the very long-term follow-up, our response rate was low. Half the patients had relocated, and we were unable to pursue these cases because there is no national registration system in Japan. Also, 25% of patients unfortunately did not respond. This study had a rather long follow-up period, and it was impossible to enrol more patients. However, the response rate was low at 16.6%; there was no significant difference between the 42 participants and non-participants in patient age at surgery, preoperative Cobb angle, post-operative Cobb angle, and percentage of females. Therefore, the patients who participated in this study can be considered representative of the entire 252 patients. Going forward, we are considering new attempts to contact patients who did not respond to our initial solicitation. In the era when our study subjects underwent surgery, patient-reported outcome tools such as SRS-22 were not established. Since we did not survey subjects using SRS-22 in the short term before surgery or during the perioperative period, we cannot know the state of QOL before subjects reached middle age. In the future, we plan to accumulate SRS-22 data and use this for long-term investigation.

Conclusions

Each SRS-22 subscore was similar between 2009 and 2014 surveys. AIS patients who underwent spinal fusion during adolescence had good HRQOL scores in midlife. Even after five years passed, good conditions were maintained.

Acknowledgements The authors thank Mr. Hideo Ishikawa, Mr. Mitoshi Ishino, Ms. Mika Fujiwara, and Ms. Mayumi Ishii for assistance on data collection.

Compliance with ethical standards

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

References

1. Götze C, Liljenqvist UR, Slomka A, Götze HG, Steinbeck J (2002) Quality of life and back pain: outcome 16.7 years after Harrington instrumentation. Spine (Phila Pa 1976) 27:1456–1463
2. Mariconda M, Galasso O, Barca P, Milano C (2005) Minimum 20-year follow- up results of Harrington rod fusion for idiopathic scoliosis. Eur Spine J 14:854–861
3. Danielsson AJ, Wiklund I, Pehrsson K, Nachemson AL (2001) Health-related quality of life in patients with adolescent idiopathic scoliosis: a matched follow-up at least 20 years after treatment with brace or surgery. Eur Spine J 10:278–288
4. Akazawa T, Minami S, Kotani T, Nemoto T, Koshi T, Takahashi K (2012) Long-term clinical outcomes of surgery for adolescent idiopathic scoliosis 21–41 years later. Spine (Phila Pa 1976) 37:402–405
5. Hashimoto H, Sase T, Arai Y, Maruyama T, Isobe K, Shouno Y (2007) Validation of a Japanese version of the Scoliosis Research Society-22 Patient Questionnaire among idiopathic scoliosis patients in Japan. Spine (Phila Pa 1976) 32:E141–E146
6. Bagó J, Pérez-Grueso FJ, Les E, Hernández P, Pellisé F (2009) Minimal important differences of the SRS-22 patient questionnaire following surgical treatment of idiopathic scoliosis. Eur Spine J 18:1898–1904
7. Carreon LY, Sanders JO, Diab M, Sucato DJ, Sturm PF, Glassman SD, Spinal Deformity Study Group (2010) The minimum clinically important difference in Scoliosis Research Society-22 appearance, activity, and pain domains after surgical correction of adolescent idiopathic scoliosis. Spine (Phila Pa 1976) 35:2079–2083
8. Danielsson AJ, Cederlund CG, Ekholm S, Nachemson AL (2001) The prevalence of disc aging and back pain after fusion extending into the lower lumbar spine. A matched MR study twenty-five years after surgery for adolescent idiopathic scoliosis. Acta Radiol 42:187–197
9. Akazawa T, Kotani T, Sakuma T, Minami S, Orita S, Fujimoto K, Shiga Y, Takaso M, Inoue G, Miyagi M, Aoki Y, Niki H, Torii Y, Morioka S, Ohtori S, Takahashi K (2017) Spinal fusion on adolescent idiopathic scoliosis patients with the level of L4 or lower can increase lumbar disc degeneration with sagittal imbalance 35 years after the surgery. Spine Surg Relat Res 1:72–77