Long fusions to the sacrum in elderly patients with spinal deformity

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Abstract

Purpose Long spinal deformity fusions in elderly patients continue to be controversial. However, there is a growing population of elderly patients with spinal deformities that may be optimally treated by reconstructive surgery requiring a long fusion to the sacrum. This study evaluated clinical outcomes in elderly (>65) adult deformity patients who underwent posterior instrumented reconstruction consisting of fusion from the thoracic spine to the sacrum with iliac fixation.

Methods Patients in a prospective database for adult spinal deformity who had a posterior reconstruction with an instrumented fusion from the thoracic spine to the sacrum that included iliac fixation with minimum 2-year follow-up were identified. Two cohorts were compared: patients 65 years and older and patients 55 years and younger. Student's *t* test for independent groups was used to determine any significant differences between continuous variables. Chi-square was used to compare categorical demographic variables between the two groups.

Results The 65 and older group consisted of 15 patients with an average age of 71 years (range 65–78 years). The 55 and younger group consisted of 25 patients with an average age of 45 years (range 30–55 years). The older group had a worse mean co-morbidity score (4.6 vs. 2.1). Baseline SRS scores were similar between groups.

Baseline SF-12 data showed worse PCS (22.1 vs. 32.0, $p = 0.009$) yet better MCS (63.6 vs. 48.4, $p < 0.0001$) in the older group. Although major curve magnitude was similar (47.1° vs. 42.6°), the older group had more positive sagittal imbalance at baseline (115.7 vs. 54.2 mm, $p = 0.02$). Number of levels fused, operative time, blood loss, and incidence of complications were similar between groups. Two-year improvements in SRS subscores, SF-12 PCS, and MCS were not significantly different between groups.

Conclusions Properly selected patients 65 years of age and older who have substantial sagittal imbalance, a considerable disease burden, and a lesser degree of mental distress can obtain as much clinical benefit as their younger counterparts (≤ 55 years of age) 2 years following spinal deformity surgery that requires fusion from the thoracic spine to the sacrum with segmental instrumentation and iliac fixation.

Keywords Adult spinal deformity · Pelvic fixation · SRS-22

Introduction

Although there is growing evidence that adult spinal deformity surgery can significantly improve quality of life by decreasing pain and disability, major spinal reconstructions have been associated with significant complications that are reported to be more common in older patients and in those undergoing fusion to the sacrum. Because of problems associated with maintaining secure fixation and obtaining a fusion to the sacrum in long constructs, iliac fixation and anterior interbody support are often recommended for patients requiring fusion to the sacrum. Additionally, many patients require instrumentation and fusion

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into the thoracic spine for control of the coronal and sagittal plane deformities. The resulting magnitude of these surgeries has led some surgeons to conclude that the benefit to risk ratio is not favorable for older patients [2].

Previous studies have examined the results of adult deformity surgery in older patients, but the inclusion criteria, surgical techniques, and outcome assessments have varied [9, 14]. The purpose of our study was to examine the results of major spinal reconstruction surgery (fusion from the thoracic spine to the sacrum with iliac fixation) in patients older than 65 years of age by comparing them to a matched group of younger patients undergoing the same surgery.

Methods

Patients in a multicenter, prospective database for adult spinal deformity who had a posterior reconstruction with an instrumented fusion from the thoracic spine to the sacrum that included iliac fixation with minimum 2-year follow-up were identified. Surgeries were performed at four centers that contributed patients to the database from 2003 to 2007. Standard demographic data including age, gender, smoking status, and Charlson CoMorbidity Index [11] were collected. Surgical parameters collected included the number of levels fused, need for anterior interbody support at L5–S1, operative time, and blood loss. Anterior interbody support was used at the discretion of the treating surgeon. Radiographic data included curve magnitude and sagittal balance.

The Short Form 12 (SF-12) [16] and the Scoliosis Research Society 22 (SRS-22) [3, 4] were administered prior to surgery and at 1 and 2 years after surgery. The SF-12 is a generic measure of health-related quality of life with eight domains and two summary scores: a Physical Composite Summary Score (PCS) and a Mental Composite Summary Score (MCS). The PCS is a measure of disease burden while the MCS is a measure of mental health [16]. The SRS-22 is a scoliosis-specific measure with five domains: Appearance, Activity, Pain, Mental health, and Satisfaction as well as Total Score. It has been found to be valid and reliable in patients with adult spinal deformity [7, 8]. An SRS-22 subscore was also calculated [6]. This is calculated using only the Appearance, Activity, Pain, and Mental health domains.

Two cohorts were compared: patients 65 years and older and patients 55 years and younger. Student's *t* test for independent groups was used to determine any significant differences between continuous variables. Chi-square was used to compare categorical demographic variables between the two groups. All data analysis was carried out using SAS 9.2 (Cary, NC).

Results

The 65 and older group consisted of 15 patients with an average age of 71 years (range 65–78 years). The 55 and younger group consisted of 25 patients with an average age of 45.4 years (range 30–55 years). Female to male ratio was similar between groups: 13:2 and 21:4, respectively, (Table 1).

In the older group, 4 of the 15 patients had a prior fusion surgery. In the younger group, 13 of the 25 patients had a prior fusion surgery. This was not statistically different ($p = 0.187$).

The older group had a worse mean co-morbidity score (4.6 vs. 2.1, $p < 0.001$). Bone mineral density *t* scores were not statistically different, although they were not available for the majority of patients. Six of the 25 patients in the younger group had an average femoral neck *T* score of -1.28 (range -2.4 to -0.2). Eleven of the 15 older patients had an average femoral neck *T* score of -0.79 (range -2.0 to 1.1). There was no significant difference between groups ($p = 0.32$). The older group had worse baseline leg pain

Table 1 Demographics and baseline data

Variable	≥65	≤55	<i>p</i> value
Number	15	25	
Age (years)	67.62	45.39	
Gender (M:F)	2:13	4:21	1.000
Smokers	0	2	0.519
BMI (kg/m ²)	26.82	26.48	0.847
Revision surgery	4	13	0.187
CCMI	4.60	2.05	0.000
Baseline			
Back pain	7.00	5.58	0.114
Leg pain	6.17	4.00	0.045
SRS Pain	2.33	2.77	0.078
SRS Appearance	2.44	2.75	0.202
SRS Activity	2.57	3.10	0.032
SRS Mental	3.81	3.64	0.558
SRS Satisfaction	2.64	3.22	0.047
SRS Subscore	2.82	3.07	0.187
SRS Total	2.80	3.08	0.126
SF-12 PCS	22.12	32.04	0.009
SF-12 MCS	63.55	48.35	<0.0001
Curve magnitude	47.14	42.58	0.450
Sagittal balance	115.57	54.22	0.018
L5-S1 AIBF	5	15	0.103

BMI body mass index, *CCMI* Charlson comorbidity index, *SRS* Scoliosis Research Society, *SF-12* short form-12, *PCS* Physical Composite Score, *MCS* Mental Composite Score, *AIBF* anterior interbody fusion

scores (6.2 vs. 4.0, $p = 0.045$), while baseline back pain was not statistically different (7.0 vs. 5.6, $p = 0.114$).

Baseline SRS scores were similar between groups, except that the older group had worse baseline SRS activity scores. Baseline SF-12 data showed worse PCS (22.1 vs. 32.0, $p = 0.009$) yet better MCS (63.6 vs. 48.4, $p < 0.0001$) in the older group.

Although average major curve magnitude was similar (47.1, range 15°–81° vs. 42.6, range 22°–89°, $p = 0.450$), the older group had a greater average positive sagittal balance at baseline (115.7, range −10 to 270 vs. 54.2, range 0–172 mm, $p = 0.018$). Number of levels fused was similar between groups (15.5 vs. 14.2, $p = 0.852$). Five of the 15 (33 %) patients in the older group and 15 of the 25 (60 %) patients in the younger group underwent L5–S1 interbody fusion ($p = 0.103$). Operative time and blood loss were similar between groups.

Two-year improvements in back pain (4.8 vs. 3.6, $p = 0.466$) and leg pain (3.7 vs. 2.0, $p = 0.965$) were not statistically different between groups. Two-year improvements in SRS subscores (1.03 vs. 0.65, $p = 0.254$) or total scores (1.10 vs. 0.66, $p = 0.188$) were not statistically different between groups. Two-year improvements in SF-12 PCS (11.3 vs. 6.8, $p = 0.794$) and MCS were not significantly different between groups Table 2.

Complications were similar between groups. There was one case of pseudoarthrosis (rod breakage) noted by 2-year follow-up in each group. The patient in the <55 group had unilateral rod breakage on the right side at L5–S1 noted at 2-year follow-up, while the patient in the >65 group had unilateral rod breakage on the right at L4–L5 noted at 1-year follow-up that was stable at 2-year follow-up. One patient in the <55 group developed an intraoperative

coagulopathy resulting in excessive bleeding. One patient in the >65 group developed a deep venous thrombosis with pulmonary embolism the immediate postoperative period requiring an inferior vena cava filter. There was one deep infection in the >65 group requiring irrigation and debridement, and one proximal junctional fracture from a fall 7 weeks postoperatively resulting in an incomplete spinal cord deficit which improved following urgent decompression and proximal extension of the fusion from T3 to T6.

Discussion

Previous studies have supported the efficacy of surgical treatment for adult deformity [9, 14]. Bridwell et al. [9] reported on 85 operatively treated patients (age 40–80 years) with adult symptomatic lumbar scoliosis who were compared with 75 patients treated non-operatively. The cranial extent of the fusion was the upper thoracic spine in approximately half of the patients and the thoracolumbar junction in the other half. The caudal extent of the fusion was the sacrum in 57.5 %, L5 in 20 %, and above L5 in 22.5 %. Although the follow-up was only 45 % in the nonoperative group, the operative group reported significant improvements in all quality of life measures while the nonoperative group reported no improvement. When the surgical patients were divided into younger (40–60 years) and older (60–80 years) groups, there were no differences in the incremental improvement although the older patients started with worse baseline scores. Although 15/85 patients experienced a major complication and 16/85 experienced a minor complication, there were no statistical differences between the complication groups with regard to ultimate outcome.

Similarly, Li et al. [14] reported on 34 operatively treated patients with adult scoliosis (all over 65 years of age) who were compared with 49 patients treated non-operatively. An average of 6.7 vertebral levels was fused, but other operative details were not reported. The nonoperative group had no significant improvements at 2-year follow-up, while the operative group reported significantly less pain, better health-related quality of life, self image, mental health, and greater satisfaction. The major complication rate was 17 % and the authors stated that a trend was observed for less positive outcomes with increasing age and complications.

Aebi has published a comprehensive review of adult scoliosis [1]. In addition to a classification system, the author discusses the complexity of the disease and various surgical treatment options that are available including isolated decompression, short fusions, and more extensive fusions [1]. It is important to note that the current study

Table 2 Two-year follow-up data

Two-year change	≥65	≤55	<i>p</i> value
Back pain	4.77	3.55	0.466
Leg pain	3.73	1.96	0.965
SRS Pain	1.48	1.02	0.456
SRS Appearance	1.52	0.93	0.117
SRS Activity	0.88	0.36	0.397
SRS Mental	0.29	0.27	0.716
SRS Satisfaction	1.96	0.82	0.026
SRS Subscore	1.03	0.65	0.254
SRS Total	1.10	0.66	0.188
SF-12 PCS	11.31	6.80	0.794
SF-12 MCS	−3.38	4.13	0.543
Curve change	4.00	19.60	0.099
Sagittal balance	71.83	29.61	0.670

SRS Scoliosis Research Society, SF-12 short form-12, PCS Physical Composite Score, MCS Mental Composite Score

only included patients who underwent a long instrumented fusion to the sacrum with iliac fixation. These patients will likely differ in radiographic and clinical presentation when compared with patients who undergo more limited procedures.

In line with intuitive reasoning, complications have been reported to increase with increasing age and surgical complexity (including fusion to the sacrum) [10, 15]. Less intuitive, and more controversial, is the effect of complications on final outcome. Some studies have shown that complications are not associated with ultimate outcome [5, 13]. This may reflect the fact that many of the reported complications are transient, treatable complications that are long forgotten by the patient at 2-year follow-up. Although it is not proven in the literature, the presence of catastrophic complications such as death, permanent paralysis, permanent blindness, and chronic infection undoubtedly affect the final outcome negatively regardless of the measures used.

The current study is supportive evidence that properly selected patients 65 years of age and older who have substantial sagittal imbalance are physically burdened by their disease and have a lesser degree of mental distress can obtain as much clinical benefit as their younger counterparts (≤ 55 years of age) 2 years following spinal deformity surgery that requires fusion from the thoracic spine to the sacrum with segmental instrumentation and iliac fixation.

Weaknesses of the current study include a relatively small sample size, as well as a likely difference in operative indications between groups. The older group had more positive sagittal imbalance which has been correlated with greater spinal disease burden [12]. The worse baseline positive sagittal balance in the older group may reflect age-related spinal changes including loss of lumbar lordosis, increasing thoracic kyphosis, and loss of compensatory mechanisms such as pelvic retroversion via muscle control. Although we attempted to match the groups from the existing database, it is apparent that patients in the database who are less than 55 years of age are having long fusions to the sacrum for different indications than those patients over 65 years of age. Younger patients were more likely to undergo extension of a previous fusion to the sacrum, while the older patients were more likely to have surgery for a “de novo” degenerative scoliosis. A substantial number of the cases were revision fusion cases. The intent of the study was to compare a group of carefully selected older patients undergoing major spinal reconstruction to a younger group of patients undergoing a similar surgery, to determine if older age was prohibitive for obtaining acceptable outcomes. The study was not intended to provide information regarding a specific indication for surgery (i.e. primary fusions vs. extension of previous fusions). Despite these

limitations, our study is the first to compare younger patients and older patients undergoing similar long fusions to the sacrum by similar surgeons with segmental instrumentation and iliac fixation using standard patient-based outcome measures.

It is probable that other factors (cardiopulmonary disease, osteoporosis, diabetes, obesity, psychosocial factors) are more important than age alone in predicting the “success” or “failure” of major spinal reconstruction surgery. Future studies may analyze these other factors and provide objective criteria that will place an individual patient in a favorable or an unfavorable risk:benefit category for major spinal reconstruction.

Conflict of interest None.

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