

Original Article

Whole segmental pedicle screw fixation combined with posterior lumbar fusion for treating lumbar spinal stenosis associated with degenerative scoliosis in elderly patients

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Abstract: Objective: To investigate the effects of whole segment pedicle screw fixation and fusion on low back, lower limb function and the incidences of postoperative complications in elderly patients with lumbar spinal stenosis associated with degenerative scoliosis (SSS). Methods: One hundred and thirty elderly patients who were diagnosed with SSS and prepared for surgical treatment in our hospital from November 2013 to November 2014 were recruited. All these patients all had multiple segments affected and Cobb angles were all over 20°. The patients either received whole segmental fixation combined with posterior lumbar fusion (WSF, n=70) or short-segment fixation combined with posterior lumbar fusion (SSF, n=60) in a random way. The treatment effects of surgery including changes of lumbar pain, lower extremity functions and Cobb angles and postoperative complications were evaluated and compared during the 2-year follow-up. Results: All the patients showed no abnormalities in the correction of the Cobb angles or the height of the intervertebral space during the follow-up. In WSF group, the number of fused segments was 11.2±2.8, while in SSF group, the number was 5.6±1.4, with an average fusion period of 3.5 months. The mean postoperative Cobb angles were 7.4° and 12.2° in the WSF and SSF group respectively with significant intergroup difference. The Japanese Orthopedic Association scores before operation and two years after operation were 11.32±2.32 and 12.89±2.11 respectively in WSF group and 11.43±1.94 and 11.98±2.19 respectively in SSF group with significant intergroup difference in the postoperative phase. The pain relief rates were 93% and 88% for WSF and SSF patients respectively which were similar between groups. There was no intergroup difference in the incidence of postoperative complications. Besides, the patients in WSF group demonstrated greater improvement in regards to ODI than those in SSF group (P<0.001). Conclusion: Whole segmental fixation can achieve better effects than short-segment fixation method when treating senile SSS.

Keywords: Degenerative lumbar scoliosis, whole segmental pedicle screw fixation and fusion, lower extremity function

Introduction

China has been gradually turning into an aging society. Some of the senior citizens have been suffering from bone diseases and the incidence of senile lumbar spinal stenosis with scoliosis (SSS) has been rising significantly each year [1]. The disease can seriously affect older people's quality of life, as it could cause them to experience different levels of pain in the low back and limitations in lower-extremity functions [2]. Since elderly patients were at higher risks of postoperative complications compared with adults, physicians tend to choose conservative

treatment instead of surgical methods when treating SSS. Although conservative treatment is relatively safer, it often cannot achieve the desired effects [3]. Therefore, many elderly patients still need to undergo surgeries to remove pains and restore motor functions [4].

At present, the common surgical methods for treating SSS include short-segment and long-segment fixation after decompression, and for the latter one, the whole segmental fixation method is often applied [5, 6]. In the short-segment fixation combined with posterior lumbar fusion, the pedicle screw fixation and bone

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graft fusion are performed for the unstable segments affected by scoliosis and the unstable segments caused by decompression. This method can allow more motion segments to be preserved, however, its effect of correction is usually not quite satisfactory and correction loss could take place. On the contrary, in the whole segmental fixation with fusion, the fixation and fusion are performed for all the lumbar vertebrae. This can achieve better correction, while it would cause patients to lose more motion segments. However, considering that the elderly patients won't require too much movement in the spine, the whole segmental fixation might be a more suitable option for treating senile SSS [7, 8].

The main aim of this study was to investigate the effects of whole segmental pedicle screw fixation and lumbar fusion treatment on low back pain, lower extremity functions and the incidences of postoperative complications in treating elderly patients with SSS.

Materials and methods

General information

This study was approved by local Ethical Committees and informed consent was got from every eligible patient. A total of 130 patients who were diagnosed with SSS and prepared for surgical treatment from November 2013 to November 2014 were included in this study.

Inclusion criteria: 1) Patients must meet the diagnostic criteria for SSS [9] and the diagnosis had to be confirmed by attending physicians; 2) Age range: no less than 65 years old; 3) Patients had no other types of diseases that could affect the outcome of the study, such as cardiovascular disease, hepatorenal disorder, and urinary system disease, etc.; 4) Patients had multiple segments affected, and their Cobb angles were all above 20°. Then, patients (72 males, 58 females) were randomized into two groups: whole segmental fixation group (WSF group, n=70) and short-segment fixation group (SSF group, n=60). All participants had completed the Oswestey Low Back Pain Disability Questionnaire.

Surgical methods

Patients received general anesthesia. A midline incision was made over the lower back. The

paraspinal muscles was stripped from the subperiosteum to fully reveal the segments for decompression, and the decompression was conducted based on patient's clinical symptoms and imaging examination.

Short-segment fixation: The neural decompression was carried out for the affected segments, and the concave side was dilated to a certain degree. Then a bent bar, with a suitable size that matched the patient, was used for lumbar lordosis fixation [10]. Bone graft was performed for lumbar spinal fusion, which was operated at the posterolateral side of the surgical site and the area of the articular process [11].

Whole segmental fixation: The neural decompression was conducted, and the fixation and fusion were carried out for the whole segments, during which the pedicle screws were implanted into each lumbar vertebral body for fixation, and bone graft for lumbar spinal fusion was performed at the posterolateral side of the surgical site and the area of the articular process [12].

Outcome measures

Outcome measures were as follows: 1) Japanese Orthopedic Association (JOA) score for the assessment of lumbar function 12 h before operation and 2 years after operation (JOA score is a Japanese Orthopedic Association standard rating system for assessing the treatment, with its score ranging from 0-29; a lower score indicates a greater disability; the questionnaire consists of the following parts: a. subjective symptoms 9 points (lower back pain, leg pain or leg numbness and tingling, and gait); b. clinical signs and symptoms 6 points (straight leg raising test, sensory function, and motor function); c. activities of daily living 14 points (lying and turning over, standing, cleaning oneself, anteflexion, sitting, lifting heavy things, walking); d. bladder function (-6-0 points); 2) Height of the anterior and posterior margin of the intervertebral space, and height of the anterior margin of the vertebral body in the decompressed segments were evaluated 24 h after operation; 3) Variation in Cobb angles 24 h before and after operation (to determine Cobb angle, the upper and lower vertebrae which are tilted most severely toward the concavity of the curve in scoliosis are located, then a line is drawn at the top edge of the upper vertebra, and at the bottom edge of the lower ver-

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Table 1. Patients' characteristics in two groups

	Sex (M/F)	Age (Y)	BMI	Preoperative Cobb angle	Number of affected segments
WSF (n=70)	42/28	73.22±7.56	24.39±3.43	25.49±2.19	3.12±0.19
SSF (n=60)	30/30	74.19±7.50	24.30±4.19	26.43±2.31	3.04±0.24
χ^2/t	1.307	1.483	0.944	0.493	0.953
P	0.290	0.193	0.381	0.231	0.316

Note: WSF, whole segmental fixation; SSF, short-segment fixation.

sidered statistically significant.

Results

Patients' characteristics

There was no difference in age, sex, preoperative Cobb angle, or BMI between two groups (all $P > 0.05$, **Table 1**).

Table 2. Lumbar fusion in two groups

	Number of fused segments	Average fusion time (month)
WSF (n=70)	11.2±2.8	3.5±1.2
SSF (n=60)	5.6±1.4	3.5±0.9
t	9.331	1.483
P	0.021	0.312

Note: WSF, whole segmental fixation; SSF, short-segment fixation.

Lumbar fusion in two groups

As is shown in **Table 2**, the number of the fused segments in WSF group was more than that in SSF group ($P < 0.05$) with similar fusion time across groups ($P > 0.05$).

Correction of Cobb angles

According to **Table 3**, the average Cobb angle in WSF and SSF group was 25.49° ($12-37^\circ$) and 26.43° ($13-42^\circ$) respectively before operation. No significant difference was observed between the two groups ($P = 0.231$). The average Cobb angle in WSF group and SSF group after operation was 7.4° and 12.2° respectively, and the difference showed statistical significance ($P < 0.001$).

JOA scores between two groups

The JOA score two years after operation (**Table 4**) in WSF group was higher than that in SSF group ($P = 0.017$). The pain relief rates were 93% and 88% respectively, which indicated similarity between the two groups ($P = 0.374$).

ODI between two groups

It can be seen from **Table 5** that greater improvement in the WSF group was demonstrated in patients in regards to ODI than those in SSF group. The difference was statistically significant for postoperative comparisons ($P < 0.001$).

Postoperative complications between two groups

Complications occurred in the two groups included: fluctuating blood pressure, electrolyte disturbance, focal cerebral infarction, stress ulcer, laryngeal pain and expectoration, and skin redness in sacrococcygeal region.

tebra; next, lines are drawn perpendicular to each of these two lines, and the angle measurement where they intersect is the Cobb angle); 4) Oswestry Disability Index (ODI) 24 h before and after operation (ODI is commonly referred to in international orthopedics journals to quantify disability for low back pain; it comprises of 10 questions, with each on a 0-5 points scale; the index calculation is as follows: the summed score/50 (which is the total possible score) *100%, if there is an unanswered question, then the calculation will be: the summed score/45 (which is the total possible score) *100%; a higher score indicates a greater disability); 5) Postoperative complications: abnormal blood pressure, electrolyte disturbance, focal cerebral infarction, stress ulcer, laryngeal pain, expectoration, skin redness in sacrococcygeal region, etc.

Statistical methods

SPSS17.0 software was applied for statistical analysis in this study. The count data was expressed as n (%) and χ^2 test was used for comparison between groups. The measurement data was presented as mean \pm standard deviation, independent samples t-test was used for comparison between groups, and the within-group comparison across different time points (before and after surgery) was conducted by paired samples t-test. $P < 0.05$ was con-

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Table 3. Correction of Cobb angle in two groups

Cobb angle (°)	WSF (n=70)	SSF (n=60)	t	P
Before operation	25.49±2.19	26.43±2.31	0.493	0.231
After operation	7.4±2.1	12.2±1.6	-14.466	0.000

Note: WSF, whole segmental fixation; SSF, short-segment fixation.

Table 4. Comparison of JOA score in two groups

JOA score	WSF (n=70)	SSF (n=60)	t	P
Before operation	11.32±2.32	11.43±1.94	-0.290	0.771
After operation	12.89±2.11	11.98±2.19	2.409	0.017

Note: WSF, whole segmental fixation; SSF, short-segment fixation.

Table 5. Comparison of ODI in two groups

ODI	WSF (n=70)	SSF (n=60)	t	P
Before operation	74.5±19.2	69.5±12.4	1.731	0.086
After operation	35.3±11.5	44.3±16.4	-3.661	0.000

Note: WSF, whole segmental fixation; SSF, short-segment fixation.

There was no statistically significant difference in these complications between groups ($P > 0.05$, **Table 6**).

Discussion

The SSS is mainly caused by some degenerative pathological changes in intervertebral disk, zygapophyseal joint and vertebral body. Usually, the Cobb angle in patients with scoliosis is below 40 degrees [13]. When a pathological change occurs in the spine, the shape of the vertebral canal in the segment affected by scoliosis would be changed, the volume of the vertebral canal would decrease [14], and noticeable changes could be observed in the joint structure. Some patients could even suffer from osteoarthritis, with related clinical symptoms of nerve root compression [15]. Clinically, there are many surgical methods for treating SSS. In the method of whole segmental pedicle screw fixation, decompression and fusion technique, the screws are inserted into each pedicle of the vertebral body in the segments affected by scoliosis. This is for the screw to produce a relatively large force for fixation so that the deformity in concave and convex could be improved technically to some extent [16]. This article is to compare the long-term and short-term effect of the whole segmental and the short-segment fixation.

In this study, we found that the Cobb angle was corrected by an average of 68% in WSF group

and 41% in SSF group. The correction of Cobb angle in WSF group was significantly better than that in SSF group, and the postoperative JOA score in WSF group was also higher. Besides, the patients in WSF group demonstrated greater improvement in regards to ODI than those in SSF group. Thus, it could be suggested that the most distinct advantage in WSF group was that it could help patients have a better postoperative recovery in the long run.

The whole segmental fixation may cause iatrogenic spinal instability if the fixation is not conducted properly, and the instability could lead to compensated scoliosis especially when the patients have experienced the excision of two or more vertebral plates [17] with wide excision planes. This kind of scoliosis often occurs outside the internal fixation parts [18].

For the short-segment fixation, patients would have complications of compensated kyphosis if there is a lack of control of kyphoscoliosis crankshaft or if there is an occurrence of physiological bone resorption as time goes by [19]. Theoretically, the whole segmental fixation has more advantages in respect of long-term recovery effect [20].

The elderly patients are more likely to suffer from complications. Hence, it would be unnecessary for doctors to put too much emphasis on three-dimensional correction during the surgery. Instead, they could focus on eliminating patients' clinical symptoms and restore the balance and stability of the spine physiologically [21]. Therefore, in the operation, the intervertebral space on the concave side could be dilated moderately, so that the intervertebral foramen could be expanded to a certain extent [22]. By doing this, the pressure on the spine could be indirectly relieved, which would be conducive to the recovery of the vertebral body in sagittal plane to some degree, and other means for repositioning would then be unnecessary [23]. There are some scholars believing that the whole segmental fixation may result in the occurrence of pseudoarthrosis. However, it didn't happen in this study [19]. On the contrary, if the segments for fixation are short, the spinal stability would be decreased and the load on fixed areas would be increased, which could cause fatigue and fracture in patients more easily [24].

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Table 6. Comparison of complication incidence in two groups

	WSF (n=70)	SSF (n=60)	X ²	P
Abnormal blood pressure	6 (8.57)	6 (10.00)	0.079	0.779
Electrolyte disturbance	5 (7.14)	4 (6.67)	0.011	0.915
Focal cerebral infarction	1 (1.42)	0 (0.00)	0.864	0.353
Stress ulcer	1 (1.42)	0 (0.00)	0.864	0.353
Laryngeal pain and expectoration	11 (15.70)	12 (20.00)	0.407	0.523
Skin redness in sacrococcygeal region	3 (4.28)	2 (3.33)	0.079	0.778
Total	27 (38.58)	24 (40.00)	0.028	0.868

Note: WSF, whole segmental fixation; SSFG, short segmental fixation.

Since the patients included in this study were quite old, systemic osteoporosis could probably occur if patients were confined to beds after operation, and this could act as one of the major factors affecting stress distribution. Although the whole segmental fixation achieved a better correction effect than short-segment fixation, it also decreased patients' bone density in vertebral body. However, the whole segmental fixation also increased the stiffness of bone graft fusion, which countered the influence of the low bone density. Thus, the lowering of the bone density in vertebral body after surgery wouldn't cause any severe adverse effect on patients. Besides, in SSF group, the fact that part of the patients had osteoporosis, along with other factors including the impact of bone density and stress, the loosening at the screw-bone interface after pedicle fixation, and the decrease of bone density, all affected the strength of the pedicle fixation severely. The strength of short-segment fixation appeared to be not enough for treating long segmental scoliosis, and as a result, the complication incidence in SSF group was higher than that in WSF group.

To sum up, the whole segmental fixation method for treating senile SSS can achieve a better result in regards to effect and safety compared with short-segment fixation, which makes it suitable for clinical application.

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Disclosure of conflict of interest

None.

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