Analysis of Clinical Effect of Interbody Fusion and Internal Fixation on Degenerative Scoliosis

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Objective: In this study, we analyzed the clinical effect of interbody fusion and internal fixation on degenerative scoliosis. Methods: After degenerative lumbar scoliosis (DLS) surgery, patients were retrospectively evaluated using VAS (Visual Analogue Scale) and ODI (Oswestry Disability Index) to evaluate clinical efficacy. All patients underwent posterior lumbar decompression laminectomy, pedicle screw internal fixation and posterolateral bone graft fusion.Imaging measurements include scoliosis Cobb angle, fusion Cobb angle, intervertebral angle (AIA), sagittal intervertebral angle (SIA), and lumbar lordosis angle. The relationship between these parameters was tested by binary Pearson analysis and linear regression analysis. Results: Before surgery, the Cobb angle of the scoliosis segment was 15.3°, and it dropped to 10.1° immediately after the operation (P <0.05). Compared with preoperative and postoperative values (2.4±2.7 and 2.1±2.3, respectively; P <0.05), AIA increased significantly (4.3±3.3) at the last follow-up. However, scoliosis Cobb angle and AIA were not related to VAS or ODI scores. At the final follow-up, no patients developed pseudoarthritis or internal device-related complications. Conclusion: Intervertebral bone fusion and internal fixation resulted in limited DLS correction, and the correction effect decreased over time. The AIA between the upper adjacent segment and the proximal fusion vertebrae continues to increase after surgery, but it does not worsen the clinical symptoms, which is reflected in the lower reoperation rate of the adjacent level of repair recurrence rate.

Key words: Interbody fusion; Internal fixation; Degenerative; Scoliosis
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Degenerative lumbar scoliosis is a three-dimensional spine deformity of mature skeletal adults [1]. From an epidemiological point of view, degenerative scoliosis mainly involves elderly patients aged 60 years, especially women [2]. Degenerative scoliosis is usually caused by asymmetric degeneration of intervertebral compounds (including intervertebral discs and facets). These changes cause asymmetric and progressive spondylolisthesis or rotation, and ultimately lead to scoliosis, loss of lumbar lordosis, translation of the vertebral or anterior vertebrae, and lateral rotation subluxation. Degenerative lumbar scoliosis often occurs simultaneously with lumbar spinal stenosis [3]. Patients often present with low back pain (LBP), with or without symptoms of nerve damage, such as radial radiation pain or muscle weakness intermittent claudication. These symptoms are similar to lumbar spinal stenosis, but may not be relieved by simple postural changes, such as flexion or sitting, usually requiring bed rest and surgical treatment [4]. When conservative treatment cannot treat symptomatic degenerative scoliosis, surgery is usually considered. Surgical treatment strategies include decompression alone and decompression combined with spinal fusion (with or without internal fixation). However, there is no consensus on which method. Patients with degenerative scoliosis who choose surgery are mainly due to the symptoms associated with lumbar spinal stenosis. The stenosis is usually shorter than the spine with scoliosis. Although longer spinal fusion is more stable, this method results in a reduction in the number of active

segments, a reduction in the range of spinal motion, and an increase in cost [5]. Because patients with degenerative scoliosis are a special population of elderly patients with multiple medical complications, prolonged fusion surgery may unnecessarily increase the risk of complications, for example, when considering the patient's general condition, bleeding and internal fixation are related complications[6]. Therefore, long segment fusion is not necessarily the best method. In general, patients can be relieved by decompression and fusion surgery that restricts the short segment of the upper and lower vertebral borders of the scoliosis region[7]. To our knowledge, several studies have analyzed the effect of different fusion methods on degenerative lumbar scoliosis, but there is no standard of care or published reports on the fusion of short-segment decompression and degenerative lumbar scoliosis[8]. Effectiveness analysis. Therefore, the purpose of this study was to evaluate the feasibility and effectiveness of short-segment decompression and degenerative lumbar scoliosis interbody fusion and internal fixation[9].

MATERIALS AND METHODS

General Information

A review of 30 patients with degenerative scoliosis treated by the same surgeon between June 2017 and November 2019. Among the 30 patients, 6 were male and 24 were female. The study was approved by the ethics committee of our hospital. All patients obtained written consent. The average age of the patients was 60.6 years (range 45-80) (Table 1). Scoliosis involves 3 to 7 vertebrae, with an average of 5.0 vertebrae. The highest upper vertebra (UEV) is at T11 and the lowest is at L2. The highest lower vertebra (LEV) is L4 and the lowest is L5. Table 1 shows the positions of the vertices. Seven of the 30 cases were complicated by L4 spondylolisthesis.

Table 1.
Basic patient information

Sample number	Age	Sex	Vertex	UEV	LEV	PFV	DFV
1	73	Male	L2	T12	L5	L1	L5
2	47	Female	L2/3	L1	L5	L1	L5
3	53	Male	L2	T12	L5	L1	L5
4	60	Male	L4	L1	L5	L4	L5
5	72	Male	L1	T11	L5	L2	L5
6	64	Female	L4/5	L2	L5	L3	L5
7	55	Female	L2/3	L1	L5	L1	L5
8	67	Female	L3	L1	L5	L3	L5
9	55	Female	L2	T12	L5	L3	L5
10	66	Male	L3	T12	L5	L3	L5
11	53	Female	L3/4	L1	L5	L3	L5
12	70	Female	L2/3	L1	L5	L2	L5
13	65	Female	L3/4	L2	L5	L4	L5
14	64	Female	L3	L2	L5	L3	L5
15	80	Female	L2/3	L1	L5	L4	L5
16	52	Female	L2	L2	L5	L2	L5
17	61	Female	L2/3	L1	L4	L2	L4
18	70	Female	L3/4	T12	L4	L1	L4
19	70	Female	L3/4	T12	L5	L4	L5
20	56	Female	L3/4	L2	L5	L3	L5
21	54	Female	L4	L2	L5	L4	L5
22	50	Female	L3	L2	L5	L4	L5
23	51	Female	L3	T12	L5	L4	L5
24	73	Female	L2	L2	L5	L2	L5
25	70	Male	L3	T12	L5	L3	L5
26	57	Female	L2	T12	L5	L2	L5
27	58	Female	L3	L2	L4	L3	L4
28	45	Female	L2	T12	L5	L5	L5
29	57	Female	L3	L2	L5	L4	L5
30	57	Female	L2	T12	L5	L2	L5

Inclusion criteria

Inclusion criteria included scoliosis angle>10°; lumbar vertebrae degenerative changes (vertebral space stenosis, segmental ossification and/or hyperplasia) with lumbar stenosis claudication; lower limb radiation pain with intermittent claudication and lumbago

Exclusion criteria

Exclusion criteria include history of scoliosis (congenital or idiopathic scoliosis), history of lumbar spine surgery, congenital malformations of

the spine, pelvis or lower extremities, spinal masses, and spinal pathological fractures. In addition, patients who received adequate conservative treatment before receiving surgical intervention were also excluded.

Surgery

Thirty patients underwent posterior lumbar decompression pedicle screw fixation and posterolateral bone graft fusion under prone position under general anesthesia. According to the patient's osteoporosis, we did not perform compulsory corrections, but only made appropriate corrections. The surgical indications were radiation pain and intermittent claudication after at least 6 months of ineffective conservative treatment. All patients underwent stenosis decompression, including 1 case with L1-4 grade, 4 cases with L1-5 grade, 1 case with L2-4 grade, 6 cases with L2-5 grade, and 1 case with L3-4,9 cases were L3-5 grade,9 cases were L4-5 grade. The average fusion level is 3.2 (range 2-5). The proximal fusion level was 5 cases in L1, 7 cases in L2, 10 cases in L3, and 8 cases in L4. The distal fusion level was L4 in 3 cases and L5 in 28 cases (Table 1).

Because the patient mainly presents with lumbar spinal stenosis, interbody fusion and internal fixation is the preferred surgical treatment. Therefore, all patients underwent lumbar decompression (posterior approach), pedicle screw internal fixation, and posterolateral bone fusion. Bone graft materials are mainly derived from vertebral autotransplantation or joint hyperplasia. As mentioned earlier, the decompression fusion segment is positioned at the level affected by lumbar spinal stenosis. "Short segment fusion" means that the fusion range is limited to the length of the entire spine segment and does not exceed the upper and lower vertebral bodies (EV). Intervertebral space angle (IA) is defined as the angle formed by the proximal fusion vertebral body upper endplate and the upper adjacent vertebral body lower endplate. The pre-operative, post-operative and follow-up examinations included a set of anterior and posterior lateral x-rays taken while standing. scoliotic Cobb angle, Cobb angle fusion level, anterior and sagittal intervertebral angles between adjacent vertebrae and proximal fusion vertebrae and lumbar lordosis measurements. Complications were recorded, including the development of bone graft fusion, so the pedicle screws were loose or broken. Before surgery, all patients underwent computed tomography (CT), spinal cord CT scan (CTM), or magnetic resonance imaging (MRI) to assess the degree of lumbar spinal stenosis and help determine the fusion range. The average follow-up time was 48.3 months (25-97 months). Followed up for 3 years, clinical examination and imaging examination were carried out every 3 months, and every 6 months after 3 years. The final follow-up is the patient's last clinical examination and imaging examination[16].

Statistical methods

SPSS 23.0 software was used to perform statistical analysis on the comparison of the average radiological parameters of preoperative, postoperative and follow-up by paired t test. We also performed parametric relativistic analysis.

RESULTS

Radiometric data collected before operation, after operation and follow-up (3 months and last follow-up) were measured and statistically analyzed. The VAS (Visual Analog Scale) and ODI (Oswestry Disability Index) of low back pain and / or leg pain were recorded before surgery, 3 months after surgery and at the last follow-up. The scoliosis angle decreased from 15.4°±5.2 before surgery to 10.2°±5.2 after surgery (Table 2), the difference was statistically significant (P=0.003). The average correction rate was 33.8%. The average correction loss at the last follow-up was 4.4°. The difference between the immediate follow-up results and the last follow-up results was statistically significant (P=0.010). There was no significant difference in Cobb angle between scoliosis immediately after surgery and 3 months after surgery (P=0.204). In addition, the Cobb angle of scoliosis did not differ between preoperative and final follow-up results (P=0.646). There was a significant difference between the preoperative and immediate postoperative Cobb angle within the fusion level (P=0.018). There was also a significant difference in Cobb angle before and 3 months after surgery (P=0.032). At other time points, there was no significant difference in Cobb angle (P>0.05) within the fusion level (Table 2). There were statistically significant differences between the upper adjacent and proximal fusion vertebrae

before, after, and at the final follow-up angle (P=0.009, P=0.003, respectively) (Table 2). AIA with no obvious difference at other time points (P>0.05). In these comparisons, there was no difference in SIA between the upper adjacent vertebral body and the proximal fusion vertebral body (P>0.05) (Table 2). There was no statistically significant difference in lumbar lordosis angle at different time points (P>0.05) (Table 2).

Table 2.
Preoperative / postoperative imaging data (n = 30, x ± s)

	Preoperative	Postoperative	3 months after surgery	Last follow-up
Cobb angle	15.4˚±5.2	10.2˚±5.2	10.6˚±0.9	14.6˚±8.1
Fusion Cobb Angle	9.0˚±7.2	5.2˚±5.4	5.6˚±5.7	6.0˚±6.3
AIA	2.5˚±2.8	2.2˚±2.4	4.1˚±2.4	4.3˚±3.5
SIA	4.3˚±3.5	3.5˚±3.5	4.5˚±3.5	3.7˚±2.5
Lumbar lordosis	22.5˚±15.6	22.6˚±12.8	23,3˚±15.2	23.5˚±12.4
P value	0.01	0.05	0.204	0.01

The evaluation of back and leg pain proved to be important preoperative clinical differences based on blood vessels and ODI. At 3 months after surgery, there was no significant difference in the final follow-up scores (P=0.000, P=0.000, respectively) (Table 3). Vascular or ODI scores were found three months after surgery and the final follow-up evaluation (P>0.05).

Table 3.
VAS and ODI scores before and after surgery (n=30, x¯±s)

	Preoperative	3 months after surgery	Last follow-up
VAS score	8.5±1.2	2.7±3.0	3.3±3.6
ODI score	34.0±4,5	10.4±7.3	11.0±8.8
P value	0.00	0.204	0.05

Using a bivariate Pearson analysis, we observed that postoperative reduction in AIA degree was highly correlated with scoliosis correction (relative value r=0.743, P=0.000). In addition, SIA is directly related to changes in lumbar lordosis (r=0.624, P=0.000). Improvements in the visual analog scale and ODI were directly related to changes in lumbar lordosis (r=-0.458, P=0.048 and r=-0.326, P=0.044, respectively). Using linear regression and Pearson analysis of scoliosis Cobb angle, AIA, SIA, lumbar lordosis angle, and patient age, we observed a weak relationship between SIA postoperative changes and patient age (r=-0.329, P=0.031). Other parameters have nothing to do with the patient's age, see Table 4.

Table 4.
Bivariate Pearson analysis

	Postoperative AIA reduction	Postoperative SIA	Patient age
Correction of scoliosis height	0.624	-0.326	-0.329
Scoliosis Cobb angle	0.048	0.032	0.064
Lumbar lordosis	-0.458	0.053	0.025
P value	0.031	0.044	0.048

DISCUSSION

Unlike adolescent idiopathic scoliosis with obvious physical performance, patients with adult degenerative scoliosis seek surgical treatment to reduce pain rather than beautify[10]. There is still controversy about the best surgical method, and whether the fusion level of proximal scoliosis should exceed T10, and whether L5/S1 discs should be fused. Clinical studies have found that the incidence of pseudoarthritis is higher at the junction of the thoracolumbar spine (TL). Shufflebarger et al. Proposed that fusion at T10 or higher can prevent adjacent segmental disease (ASD) because the true ribs of T10 can enhance the susceptible TL junction. Cho also pointed out that a horizontal or neutral vertebra may help determine the level of proximal fusion of the coronal plane, and fusion with T10 is more stable than fusion with T11–L1[11]. However, shufflebarger et al. Pointed out that there is no effective evidence to support the efficacy of proximal fusion to T10 or above. It is believed that unnecessary fusion with T9 or T10 will increase the fusion level by 3 to 4 segments, resulting in increased bleeding and longer operation time, which in turn increases the incidence of complications and operation costs.

When selecting the level of distal fusion, Hamill et al evaluated whether the intervertebral space between L5/S1 was relatively normal without disc degeneration[12]. If the lumbar lordosis and sagittal position are well maintained, the extension of the distal fusion to L5 may be considered to maintain L5/S1 movement. The preservation of L5/S1 depends on the quality of the disc. Degenerative scoliosis often occurs in people over 45 years old, among which L5/S1 disc degeneration is very obvious[13]. Therefore, fusion with L5 may result in a high incidence of revision surgery. As a result, various surgeons recommended distal fusion to S1. S1 level in patients with L5/S1 disc degeneration. However, standards of care are still needed in this case. Theoretically, the incidence and degree of adjacent segmental degeneration may increase gradually with sufficient follow-up time in patients undergoing short-term fusion[14]. However, most cases of degenerative scoliosis are elderly patients with limited life expectancy, such as those in this study (mean age sixty point seven the oldest patient was 80 years old. Daily exercise usually decreases with age. Therefore, ASD is unlikely to cause serious clinical complications and require revision surgery in the remaining life of such patients. However, the validation of these findings requires longer follow-up in future studies[15].

CONCLUSION

In conclusion, interbody fusion and internal fixation leads to limited DLS correction, and the correction effect decreases with the passage of time. The AIA between the upper adjacent segment and the proximal fusion vertebrae continued to increase but did not worsen the clinical symptoms, which was reflected in the lower reoperation rate of the adjacent level.

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