

A hybrid therapeutic approach for decreasing postoperative complications in patients with adult lumbar degenerative scoliosis

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Abstract

To decrease postoperative complications in patients with adult lumbar degenerative scoliosis (ALDS), short-segment fusion surgery was used in this study. However, the incidence of adjacent segment disease was found to be remarkable. Therefore, we applied the hybrid treatment (short-segment fusion for responsibility levels plus nonfusion stabilization of lumbar segments, which was called the Wallis system, for the proximal level) to patients enrolled into this study. The purpose of this study was to investigate the feasibility of a novel hybrid therapeutic approach for treating patients with ALDS.

From January 2011 to January 2017, a retrospective study was conducted consisting of 16 patients with ALDS who were treated with hybrid treatment. All patients were treated with short-segment decompression and fusion for responsibility levels and nonfusion stabilization of lumbar segments for the proximal levels. The imaging outcomes were evaluated preoperatively and at the time of follow-up.

The mean visual analog score for back pain decreased from 6.1 ± 2.0 preoperatively to 2.1 ± 0.7 at 2-year follow-up ($P < .05$), and the mean visual analog score for leg pain reduced from 8.1 ± 0.6 preoperatively to 1.3 ± 0.8 at 2-year follow-up ($P < .05$). The Oswestry disability index scores improved from $65.4 \pm 16.3\%$ preoperatively to $18.3 \pm 5.6\%$ at 2-year follow-up ($P < .05$). The mean Cobb angle was $22.1 \pm 6.2^\circ$ preoperatively, and $13.8 \pm 6.8^\circ$ at 2-year follow-up ($P < .05$). The lumbar lordosis changed from $-40.4 \pm 14.8^\circ$ to $-43.5 \pm 11.2^\circ$ at 2-year follow-up ($P < .05$). Solid fusion was achieved in all the patients, and no incidence of adjacent segment disease was noted as well.

The proposed hybrid treatment for patients with ALDS can achieve favorable clinical outcomes and a lower incidence of ALDS. However, the correction of deformity is still limited that highlights the necessity of further study.

Abbreviations: ALDS = adult lumbar degenerative scoliosis, LL = lumbar lordosis, ODI = Oswestry disability index, VAS = visual analog score.

Keywords: adult lumbar degenerative scoliosis, Cobb angle, hybrid treatment, Oswestry disability index, visual analog scale

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This retrospective study was approved by the Institutional Review Board of 301 hospital and Peking University People's hospitals. All patients involved in the study consent to participate in the study and the written consent has been obtained from all the patients.

All individual's data consent to publish. Please contact author for data requests.

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All data generated or analyzed during this study are included in this published article [and its supplementary information files].

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1. Introduction

The adult lumbar degenerative scoliosis (ALDS), described as “de novo” scoliosis, was defined as a curve $>10^\circ$ due to degeneration of the facets and discs.^[1] The prevalence of ALDS widely ranges from 8.3% to 68%,^[2,3] accompanied by a higher incidence in older patients. Patients suffering from ALDS are mainly complicated by advanced age, osteoporosis, cardiopulmonary insufficiency, and other medical comorbidities, contributing to a high incidence of postoperative complications. When conservative treatment fails to treat symptomatic patients, surgical intervention can be alternatively an appropriate option; however, surgery has been associated with a major complication incidence of as high as 28% to 86%,^[4,5] and the risk of morbidity has notably increased with an age-elevation pattern.^[6]

Several surgical strategies have been taken to address the deformity in patients with ALDS. Surgical procedures commonly include: decompression alone, decompression and short-segment fusion, and decompression and long-segment fusion with correction of deformity.^[7,8] However, the most effective therapeutic strategy for ALDS has still remained controversial. Although long-segment fusion has achieved satisfactory deformity correction, the risk of complications, for example, bleeding and complications related to internal fixation, has noticeably increased.^[9,10] The short-segment decompression and fusion can reduce the incidence of complications, whereas accompanied by a

higher risk of ALDS. The adjacent segment disease (ASD) was harmful for the patients which need a revision surgery. Many surgeries were performed to reduce the incidence of this complication. Therefore, in the present study, a hybrid treatment strategy (short-segment decompression and fusion for responsibility levels and nonfusion stabilization of lumbar segments, which was called the Wallis system, for the proximal level) was applied to patients with ALDS. The purpose of this study was to explore the efficacy and feasibility of the proposed hybrid treatment for reducing the postoperative complications in patients with ALDS.

2. Patients and methods

2.1. Patients

This study was approved by the institutional review boards of the authors' affiliated institutions, and all patients gave informed consent to participate in the study. From January 2011 to January 2017, 16 patients with ALDS who underwent hybrid surgery in our hospital were retrospectively analyzed. The clinical presentations of such patients were back pain, intractable radicular pain, and intermittent claudication. Inclusion criteria: Cobb angle above 10°; posterior-only procedure for ALDS correction; short fusion: limited to 1 to 2 segments; (4) availability of imaging examinations and clinical data (inpatient medical records and questionnaires); participation in nonoperative therapies, including bracing, resting, physiotherapy, and analgesics, without adequate relief of patients' symptoms. Exclusion criteria: idiopathic curves; prior lumbar fusion surgery; other comorbidities, such as neoplasm, trauma, and infection. Here, 16 (45.7%) patients were matched with the inclusion criteria, including 4 men and 12 women (mean age, 61.3 ± 5.7 years; mean follow-up time, 28.4 ± 1.1 months). All patients signed the written informed consent forms prior to participation in the study.

2.2. Surgical procedures

The proposed hybrid treatment included short-segment fusion for responsibility levels and nonfusion stabilization of lumbar segments (the Wallis system) for the proximal level (next to the fusion level).

Before surgery, all patients were treated with nerve root block to confirm the level where the pain originated. Under general anesthesia, the patient was placed in a prone position on the operating table. The incision was in the midline. The pedicle screw was inserted bilaterally. The isthmus, the posterior arch of the vertebrae, the inferior joint facet, and the ligamentum flavum were resected. These local bones were kept for autograft during the interbody fusion. The nerve root was identified, and the canal of nerve root was clearly decompressed. Then, discectomy and endplate preparation were performed, and the disc space was packed with the autograft bones. A cage interbody graft was then inserted and commonly placed relatively to the concave side to restore lumbar lordosis (LL) and decrease lumbar curve. Then, we placed the Wallis system in the proximal level (Fig. 1).

2.3. Data collection

Data were collected through review of inpatient medical records and questionnaires. The primary data of the present research were blood loss, duration of surgery, time to ambulation,

postoperative length of hospital stay, visual analog score (VAS), Oswestry disability index (ODI), and complications. The complications were categorized into early (within 3 months after surgery) and late postoperative complications.^[3]

2.4. Imaging examinations

Imaging examinations were performed preoperatively, postoperatively, and at the time of each follow-up. The data were collected and evaluated preoperatively and at the time of follow-up. The Cobb angle of the lumbar curve was measured using the standard Cobb's method on an anteroposterior radiograph, and the lumbar and pelvic parameters were measured on a lateral radiograph, including LL, sacrum slope, and pelvic tilt. The radiologic films taken at 2-year follow-up were utilized to assess fusion. The fusion criteria were based on Bridwell et al interbody fusion grading system: I: Fused with remodeling and trabeculae present. II: Graft intact, not fully remodeled and incorporated, while without abnormal lucency. III: Graft intact, potential lucency present at top and bottom of graft. IV: Fusion absent with collapse/resorption of graft. The assessments were performed by 2 independent assessors blinded to the study.

2.5. Statistical analysis

Data were expressed as mean ± standard deviation. Preoperative and postoperative differences were compared using paired sample *t* test, and statistical significance was set at $P < .05$. All analyses were carried out using SPSS 17 software (IBM, Armonk, NY).

3. Results

3.1. Surgical outcomes

The median time required to perform a surgical procedure was 151.3 ± 27.3 minutes (range, 105–220 minutes) with a mean intraoperative blood loss of 168.8 ± 84.9 mL (range, 100–325 mL). The mean length of hospital stay was 5.3 ± 0.9 days (range, 4–7 days). The time to ambulation was 2.6 ± 0.9 days (range, 1–4 days) postoperatively (Table 1).

3.1.1. Clinical results. The mean VAS for back pain decreased from 6.1 ± 2.0 preoperatively to 2.1 ± 0.7 at 2-year follow-up ($P < .05$), and the mean VAS for leg pain reduced from 8.1 ± 0.6 preoperatively to 1.3 ± 0.8 at 2-year follow-up ($P < .05$). The ODI score improved from 65.4 ± 16.3% preoperatively to 18.3 ± 5.6% at 2-year follow-up ($P < .05$). All patients were satisfied with the surgical results (Table 2).

3.2. Imaging findings

It was unveiled that 5 (31.2%) patients received 1-level fusion, and 11 (68.8%) patients received 2-level fusion. The mean Cobb angle decreased from 22.1 ± 6.2° preoperatively to 13.8 ± 6.8° at 2-year follow-up, with a mean correction of 9° ($P < .05$). The LL changed from -40.4 ± 14.8° preoperatively to -43.5 ± 11.2° at 2-year follow-up ($P < .05$). The pelvic tilt varied from 19.4 ± 5.1° preoperatively to 14.4 ± 5.5° at 2-year follow-up ($P < .05$). The sacrum slope changed from 28.3 ± 9.1° preoperatively to 33.0 ± 4.7° at 2-year follow-up ($P < .05$). All patients achieved grade I fusion at the final follow-up according to imaging findings, and no obvious loss of correction was observed (Table 2).



Figure 1. A 55-year-old female patient suffered from adult lumbar degenerative scoliosis operated with short-segment and hybrid treatment. (A, B) Preoperative X-ray showed the Cobb angle was 23°. (C, D) Preoperative computed tomography and magnetic resonance imaging showed the L4/5 disc herniation. (E, F) Postoperative X-ray showed the Cobb angle was 11°. (G, H) The X-ray 2-year follow-up showed the Cobb angle was 16° and achieved grade 1 fusion.

3.3. Complications

3.3.1. Early complications. There was one dura tear with cerebrospinal fluid leakage, which was repaired during surgery without other special treatment. One patient suffered from pneumonia, and he/she was recovered after antibiotic treatment. One patient suffered from fat liquefaction of incision, and he/she was recovered after debridement.

3.3.2. Late complications. No patients suffered from ASD. There was no complication of neurologic injury and nonunion. Besides, no breakage or failure of any screw or rod was noted.

4. Discussion

The ALDS is a complex spinal disorder, resulting from degeneration of the spine. The clinical presentations in patients with ALDS are complicated, including simple radiculopathy and leg pain, lumbar stenosis, chronic mechanical low back pain, and loss of sagittal and coronal balance. Several surgical strategies have been taken to treat the deformity in patients with ALDS. Those methods aimed to decompress the lumbar stenosis and fusion, reestablish regional and global spinal balance, and prevent progression of deformity. However, the treatment of the ALDS is still in an ongoing debate.^[11,12]

Variables	Data
Age, yrs	61.3
Sex	
Male	4
Female	12
Level	
One	11
Two	5
Surgery time, min	151.3±27.3
Blood loss, mL	168.8±84.9
Time to ambulation, d	2.6±0.9
Hospital stay, d	5.3±0.9
Follow-up time	28.4±1.1

The main surgical strategy includes short-segment fusion and long-segment fusion. Short-segment fusion was defined as fusion to the responsibility level within the deformity. Long-segment fusion was defined as fusion that exceeds the deformity, and requires deformity correction. Although the long-segment fusion can accomplish satisfactory coronal and sagittal balance, the patients with ALDS are complicated by advanced age and medical comorbidities, increasing the incidence of complications and morbidity.^[13–15] A previous study reported that long-segment fusion surgery was found to be associated with a major complication incidence as high as 28% to 86%.^[16] To lower the incidence of the complications, several scholars^[17,18] advocated the short-segment fusion for the treatment of ALDS, and aimed to alleviate the symptoms rather than restore the alignment. The surgery should be as minor as possible to reduce the complications. The short-segment fusion can effectively deal with the majority of symptoms in patients with ALDS, whereas the ASD and deformity deterioration are emerging problems. Liu et al^[17] demonstrated that the treatment of patients with ALDS should be individualized according to the patient's age, the severity of the deformity, and medical comorbidities. Cho et al^[19] found that long-segment fusion provides a better scoliosis correction and coronal balance with a higher incidence of complications, whereas short-segment fusion is less effective in correcting deformity and decreasing the incidence of complications, while the incidence of ALDS is higher. Therefore, we, in the present research, used the hybrid treatment to lower the incidence of complications and ALDS.

The Wallis system was first described by Jacques Senegas in 1984,^[20] which was named dynamic interspinous fixation. That system can effectively restrict the over flexion-extension and

Variables	Preoperative	2-yr postoperative follow-up	P
Cobb	22.1±6.2°	13.8±6.8°	.000 < .05
LL	-40.4±14.8°	-43.5±11.2°	.014 < .05
SS	28.3±9.1°	33.0±4.8°	.006 < .05
PT	19.4±5.1°	14.4±5.5°	.019 < .05
VAS (back)	6.1±2.0	2.1±0.7	.000 < .05
VAS (leg)	8.1±0.6	1.3±0.8	.000 < .05
ODI, %	65.4±16.3	18.3±5.6	.000 < .05

LL = lumbar lordosis, ODI = Oswestry disability index, PT = pelvic tilt, SS = sacrum slope, VAS = visual analog score.

diminish the stress on interspinous process and facet joint. The Wallis system can not only restrict the abnormal activity in the diseased segment, but also guarantee that all the other segments are in a normal range of motion, and it finally reduces the occurrence of adjacent segment degeneration.^[21]

In the present study, the hybrid therapeutic strategy of short-segment decompression and fusion was conducted on patients with ALDS. The clinical outcomes showed that VAS and ODI scores were improved. Additionally, shorter operative time, less blood loss, and shorter length of hospital stay were found compared with previously reported outcomes. Besides, there were no patients suffering from ASD and no breakage or failure of any screw or rod. The clinical data suggested that the proposed hybrid treatment strategy can effectively relieve the symptoms of patients of ALDS, accompanied by lower complications, which may result in lower morbidity, less costs, and earlier rehabilitation.

Results of imaging examinations showed that the mean Cobb angle decreased from 22.1±6.2° to 13.8±6.8° with a mean correction of 9°, and the LL changed from -40.4±14.8° to -43.5±11.2°. During the surgery, we usually use a large cage placed relatively to the concave side to restore LL and decrease lumbar curve. In addition, the painful stimulus caused by disc herniation or stenosis is removed; the nerve root, muscle, and ligament are relaxed which are helpful for deformity correction. Besides, the Wallis system may play a significant role in the prevention of deformity progress. The radiographic data indicated that the hybrid treatment can achieve deformity correction without serious deterioration in patients with ALDS to a certain extent. However, the deformity in patients in the present study is still tangible, and the outcome of deformity correction is not satisfactory. Therefore, long-term assessment needs to be carried out in the future.

There are a number of limitations in this study. First, it was a retrospective study, which may generate a selection bias and loss to follow-up. Second, there were a variety of symptoms for patients with ALDS, and therefore, this technique was not appropriate for the patients enrolled into this study. Third, the full-length radiographs were not available; thus, we could only analyze local deformity. Fourth, the number of cases in our study was relatively limited, and the duration of follow-up was relatively short. Hence, a research with larger sample size should be carried out.

5. Conclusion

It was found that the proposed hybrid treatment strategy for the patient with ALDS was safe and effective. The short-segment decompression and fusion for responsibility levels could effectively improve the symptoms, with lower complications. The nonfusion stabilization of lumbar segments (the Wallis system) for the proximal level could reduce the incidence of ALDS. Although the proposed technique was not appropriate for all patients with ALDS, it may be applicable to a number of patients. However, the correction of deformity still requires further study.

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Author contributions

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