

## Original Article

# Causes and managements of postoperative complications after degenerative scoliosis treatments with internal fixation

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**Abstract:** Objective: To investigate the causes and managements of early postoperative complications of degenerative scoliosis (DS) treated with internal pedicle screw fixation. Methods: From Jan 2000 to Apr 2013, 325 DS patients treated with internal pedicle screw fixation in our hospital were retrospectively involved. The categories, causes, managements and outcomes of early postoperative complications were statistically analyzed. Results: Early postoperative complications occurred in 10.76% of the patients including 16 cases of lower limb numb or pain, 6 cases of decreased lower limb sensitivity and motor functions, which accounted for 62.86% of all complications, followed by incision infections (4/35, 11.43%) and rare cases of cerebrospinal fluid leakage, cardiac and renal inadequacy, urinary system and pulmonary infections. The incidence of overall complications (19.79%,  $p = 0.001$ ) and nerve injuries (11.46%,  $p = 0.000$ ) were significantly higher in long-segment than in short-segment fixations. Improper screw implanting, over correction of scoliosis and insufficient blood supply of the spinal cord during operation were risk factors for early postoperative complications and most of them were cured by anti-infection medication, incision dressing change, nerve nourishment, adjusting the screws and anti-osteoporosis treatments within 6 months after surgery. Only three cases with severe nerve injury did not improve until the 6 months postoperative follow-up. Conclusions: Most of the postoperative complications in our DS patients disappeared within 6 months after surgery and more than half of complications were nerve injuries.

**Keywords:** Degenerative scoliosis, internal fixation, postoperative complications

## Introduction

Degenerative scoliosis (DS) is a kind of scoliosis occurring mainly in the lumbar spine and is caused by degenerative changes of intervertebral disc and facet joints after bone maturation and often combined with sagittal imbalance and poor rotation ability of the spine [1, 2]. The disease incidence is reported to be 6%-68% [3, 4] and the majority of affected patients are older than 50 years. Common symptoms are back and leg pain or intermittent claudication [5] and surgical interventions, such as decompression, fusion and internal fixation are often necessary for refractory or unsuccessful conservative treated back and leg pains [6]. These complicated surgery interventions frequently cause complications, such as nerve injury, incision infection, pulmonary embolism, pedicle

fracture, rupture of the anterior longitudinal ligament, cerebrospinal leakage as well as pseudoarthrosis formation [7-10]. In a retrospective study on complications after scoliosis surgery by Weiss et al., their incidence was noted to be up to 89% [11]. Cho et al. [12] investigated 47 degenerative lumbar scoliosis patients who received posterior fusion and fixation and reported 14 cases of early complications (< 3 months postoperatively) including nerve injury, superior infection, intestinal obstruction and urinary tract infections. In addition, they reported 18 cases of late complications like adjacent level degeneration and formation of pseudoarthrosis. The authors suggested that massive intraoperative blood loss was an independent risk factor of increasing complication rates and age, duration of surgery as well as medical disorders did not significant-

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**Table 1.** Basic characteristics of the patients

	Description	
Age (n, %)		62 (45-86)
Gender (n, %)	male	121 (37.23%)
	female	204 (62.77%)
Type of scoliosis (classified by location) (n, %)	Thoracic curve	219 (67.38%)
	Thoracic and lumbar curve	106 (32.62%)
Average operation time		2.84 hours
Average blood loss		675.02 ml
Average preoperative Cobb		22.11°
Chief complaint	Back and leg pain	33 (10.15%)
	Lower limb pain or intermittent claudication	10 (3.08%)
	Back pain with lower limb radiation pain or numbness	274 (84.31%)
Combined diseases	Visible scoliosis	8 (2.46%)
	Hypertension	90 (27.69%)
	Pulmonary disease	20 (6.15%)
	Diabetes	25 (7.69%)
	Coronary heart disease	4 (1.23%)
	Abnormal ECG	128 (39.38%)
	Thyroid disease	2 (0.62%)
	History of cerebral infarction	2 (0.62%)
	Osteoporosis	62 (19.08%)
Operation method	Hyperthyroidism	2 (0.62%)
	Long-segmental fixation and fusion	96 (29.50%)
	Short-segmental fixation and fusion	229 (70.50%)

ly correlate with the incidence of early complications. However, in a study of 98 degenerative lumbar spine patients, who underwent decompression and fusion by Carreon et al. [13], incision and urinary tract infections occurred in 78 patients and the incidence of complications increased with increasing age, operation time and fusion level. Regarding incision infections, some researchers found antibiotic medication combined with removal of internal fixations could eradicate the infection [14], while others noted that an infection could be controlled without internal fixation removal [15]. As major drawback of removing the internal fixation due to infections, 10-26 degree loss of correction was reported [16].

Taken together, a high incidence and various types of complications after DS surgery certainly weaken the benefits of these operations. However, research on the cause and management of early postoperative complications could still not reach a consensus. In our study, we retrospectively collected data of 325 DS patients, who received pedicle screw fixations and analyzed categories, causes and manage-

ments of postoperative complications in order to identify risk factors and to find methods to decrease the incidence of complications after spine surgery.

### Patients and methods

#### Patients

From Jan 2000 to Apr 2013, 325 DS patients treated with pedicle screw internal fixation in the PLA 117<sup>th</sup> hospital (Hangzhou, China) were involved. We retrospectively collected data of gender, age, chief complaints, combined diseases, type of scoliosis, cobb angle before and after the surgery, operation method, average operation time, average intraoperational blood loss, incidence of complications, treatment of complications and associated results. The study was approved by the ethical committee of the PLA 117<sup>th</sup> hospital and written informed consent was obtained from all participants.

#### Operation method

The operation method was selected according to symptoms, signs and radiological data. After

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**Table 2.** Category, causes, managements and treatment outcomes of postoperative complications

Category	Symptoms and signs	Number (%)	Managements	Results
Incision infection	Superficial infection	3 (0.92%)	Wound dressing,	Cured in 2w postoperatively
	Deep infection	1 (0.31)	Debridement, anti-infection drug	Cured in 5w postoperatively
Cerebrospinal leakage	Watery effusion through incision	3 (0.92)	In supine or lateral position, elevate head in bed, increased fluid infusion, dense suture of incision	Cured in 2w postoperatively
Renal inadequacy	Lower limbs swelling	1 (0.31)	Transferred to renal department	Cured
Cardiac inadequacy	Chest pain or discomfort, tachypnea	2 (0.62)	Consultation with cardiology, myocardium-nurturing, control fluid infusion	Cured in 2w postoperatively
Urinary system disease	1 case urinary hesitancy 1 case urinary tract infection	2 (0.62)	Transferred to urinary department	Cured
Pulmonary infection	Cough and expectoration, X-ray indicated pulmonary infection	1 (0.31)	Anti-inflammatory drug, phlegm, turn back and pat on the back	Cured
Nerve injury	Lower limb pain or numbness	16 (4.92)	Dehydration, nerve-nurturing and analgesia	The symptoms of lower limb numbness or pain reduced in 3 months and disappeared in 6 months postoperatively
	Decreased manifestly lower limb sensation and motor function	6 (1.85)	Dehydration, nerve-nurturing, steroid treatment and reoperation	Two cases improved and 4 cases had no sign of improvement in 3 months postoperatively 3 cases did not improve in 6 months postoperatively

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**Table 3.** Incidence and distribution of nerve injuries

Type of nerve injury		Slight nerve injury	Severe nerve injury
Number		16	6
Operation method	Long-segmental fixation	10	1
	Short-segmental fixation	6	5
Cobb angle preoperatively		18.18	18.24
Cobb angle postoperatively		12.34	12.68
Type of scoliosis	Thoracic curve	10	2
	Thoracic and lumbar curve	6	4
Implant of pedicle screw	Adjusting position of screw	1	1
	Clear hematoma		1

**Table 4.** Comparison of long-segmental and short-segmental fixation complications

	Long-segmental fixation (96)	Short-segmental Fixation (229)	p-Value (X <sup>2</sup> test)
Incidence of overall complications	19 (19.79%)	16 (6.99%)	0.000
Incidence of nerve injury	11 (11.46%)	11 (4.80%)	0.001

was done in 229 cases, long-segmental fixation ( $\geq 3$  levels) in 96 cases (dynamic fixation was done in one case and minimally invasive lateral cage fusion was done in one case). All patients were available for the follow-up at 3 months postoperatively, but in the subsequent follow-up visits, 28 patients were lost. The preoperative combined diseases were 128 cases with abnormal ECG, 90 cases with hypertension, as well as diabetes, osteoporosis and pulmonary diseases (**Table 1**).

epidural or general anesthesia, the scoliosis, which needed to be corrected, was exposed and long-segmental pedicle internal fixation combined with fusion was chosen for those patients, who complained back pain. Alternatively, we performed a laminectomy with intervertebral fusion at the levels of disc herniation plus lamina fusion at the levels without disc herniation for patients, who complained back and lower limb pain or intermittent claudication.

### Statistical analysis

We used SPSS 16.0 software for all statistical analyses. Chi-square test was used for comparison of rates. A *P* value of  $< 0.05$  was regarded to be significant.

## Results

### Basic characteristics of the patients

From Jan 2000 to Apr 2013, 325 DS patients treated with pedicle screw internal fixation in our hospital were retrospectively involved, including 121 males and 204 females, with an average age of 62 years (45-86). Types of scoliosis were 219 cases of thoracic curve and 106 cases of thoracic and lumbar curve scoliosis. The average Cobb angle preoperatively was 22.11°. Short-segmental fixation ( $< 3$  levels)

### Incidence of overall complications

Early postoperative complications occurred in 35 patients (35/325, 10.77%), which were lower limb pain or numbness in 16 cases (16/35, 45.71%) as well as decreased lower limb sensitivity and motor function in six patients. Because this two accounted for 62.9% of all postoperative complications (22/35, 62.86%), we suggest that the main postoperative complication of internal pedicle fixation for DS was nerve injury. In 4 cases, the incision became infected, in three cases cerebrospinal leakage occurred, in two cases postoperative cardiac inadequacy developed, urinary tract diseases occurred in two cases, whereas renal inadequacy and pulmonary infection happened each only in one patient after surgery (**Table 2**).

Different strategies were employed to deal with the postoperative complications. After nerve nurturing with vitamin B medications and analgesia, the lower limb numbness or pain reduced after the first 3 months and disappeared in the 6-month follow-up. From the patients with severe nerve injury, symptoms improved in two cases, no sign of improvement in four cases in the 3 month follow-up, the symptoms remained in 3 cases until the 6 month follow up. Other complications were all cured in about 2 weeks postoperatively after relevant management as described in **Table 2**.

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### *Incidence of nerve injury*

Next we analyzed incidences of minor (lower limb pain or numbness) and severe (decreased lower limb motor and sensitivity function) nerve injuries. We found that long-segmental internal fixation lead to a higher incidence of complications than short-segmental internal fixation (**Table 3**).

A statistical analysis revealed that there were higher incidences of overall and nerve injury complications after long-segmental compared with short-segmental fixations (**Table 4**).

### **Discussion**

In our study, the incidence of complications was (35/325, 10.77%). Although there are seven types of complications, the majority of them were nerve injuries and incision infections. The DS patients were generally at advanced age and their daily exercise was limited due to back and leg pain, which may cause cardiac and pulmonary dysfunction and poor bone density and lead them to postoperative complications, such as pulmonary [17] and urinary system infections [18] and loosen of screws. Furthermore, patients with three-dimensional deformities often had certain degree of vertebral hyperostosis and associated structures like hypertrophy, adhesions of the ligamenta flava and spinal stenosis, which increased the risk of cerebrospinal leakage during the process of laminectomy. In addition, an improper extraversion angle may let the pedicle screw enter the spinal canal, resulting in an injury of the endorhachis. However, all these complications were cured after proper managements in this study.

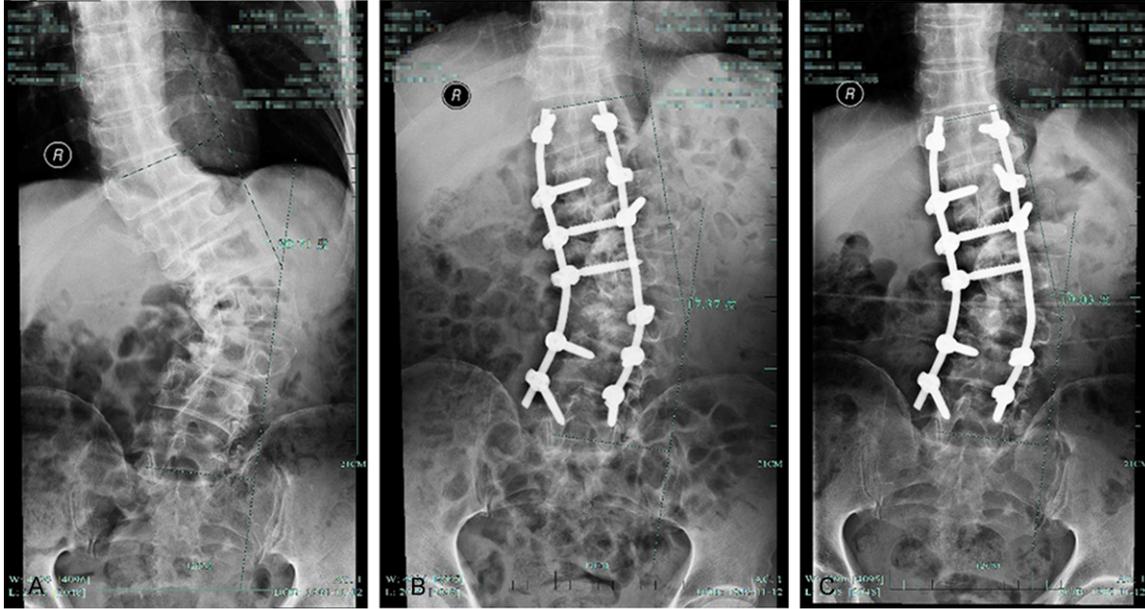
Nerve injuries deserved more attention due to their high incidence rate of (22/35, 62.86%) among all complications. Generally, over correction of scoliosis stretching or twisting the spinal cord and nerve root and improper pedicle screw implantation damaging directly the nerve are the causes of nerve injury. Wilber et al. [19] noted that a skilled and highly experienced surgical technique is very important for the prevention of complications, especially in DS surgery with serious hyperostosis and three dimensional deformities, because pedicle screws are hard to implant and easy to enter the spinal canal, thereby causing nerve injuries. Misplaced pedicle screws should be corrected

once observed intraoperatively and if observed postoperatively, reoperation is necessary after unsuccessful conservative treatments, such as dehydration, nerve nurturing and analgesia. In this study, refractory lower limb pain occurred in one patient and disappeared after removal of an improper located pedicle screw in another operation (**Figure 1**).

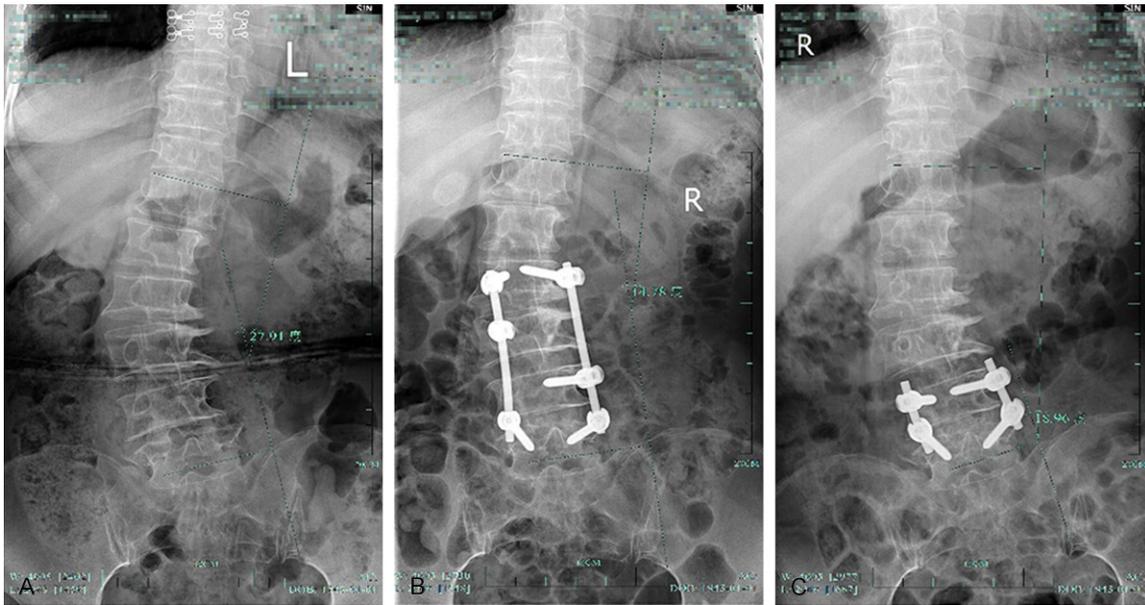
Based on our experience, scoliosis lamina and facet joints should be clearly exposed, the crossing point of the horizontal line passing the midpoint of the transverse process with the vertical line passing the lateral upper articular process should be used as entering point for the pedicle screw [20]. The extraversion angle of the pedicle screw should be increased in the bulge and decreased in the concave side and the wall of the screw hole should be of bony content after drilling, because after implanting of the pedicle screw the pin tract otherwise could become loose and cannot hold the pedicle screw if the position needs to be adjusted. Repeated drilling could damage the anatomy structure of the pedicle, which makes the pedicle screw hard or failed to be implanted. In addition, angle corrections are not the major purpose of DS surgery and over stretching or twisting of nerves may be caused by over correction of scoliosis (**Figure 2**).

Insufficient intraoperative blood supply of the spinal cord may be a reason of nerve injury. DS patients are always at advanced age and many of them suffer hypertension. However, blood pressure may be adjusted to a lower level by the anesthetist for reducing blood loss, which may cause hypoperfusion of the spinal cord. Owen et al. reported, that mean arterial pressures less than 60 mmHg would increase the incidence of nerve injuries [21] and the insufficient blood supply may be worsen by stretching or twisting of the spinal cord during scoliosis over corrections [22]. Therefore, precise implant of the pedicle screw, modest scoliosis correction and proper mean arterial pressure may be important to decrease the incidences of nerve injuries in DS surgery. In addition, some methods of monitoring the spinal cord and nerve function intraoperatively, such as somatosensory evoked potential (SEP), motor evoked potential (MEP) and wake-up tests may also be employed to decrease the incidences of nerve injuries [23, 24]. Incision infection was another common complication after DS opera-

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**Figure 1.** A. Image of a patient, who complained back and right lower limb pain for three years, which worsen the last year. The Cobb angle was  $30.71^\circ$  preoperatively. B. Image of the patient 2 days after operation. The right lower limb pain had obviously improved, but left lower limb pain occurred at 2 days postoperatively and became worse after conservative treatments. The X-ray image indicated a misplaced pedicle screw in lumbar 3. C. After removal of the misplaced pedicle screw by surgery, the left lower limb pain disappeared.



**Figure 2.** A. Image of a DS patient complaining back and right lower limb pain since 1 year. The preoperative Cobb angle was  $27.91^\circ$ . The muscle strength for extending the right hallux was at level III and the left side was normal. B. Decompression and intervertebral fusion at the right side of L4-5, lamina fusion at L2-L5 and distraction at the left side of the scoliosis were performed. The postoperative Cobb angle was  $14.78^\circ$ . After the surgery, back and right lower limb pain improved, but lower limb pain occurred and the muscle strength for extending the left hallux was at level III. C. Surgical correction of L4-5 was performed, the Cobb angle was adjusted to  $18.96^\circ$  and the muscle strength for extending the left hallux became gradually normal.

tions. Poor nurturing conditions, large dimension implants, long operation durations and

allograft bones were considered to be the risk factors for this complication [25, 26]. In this

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study, (96/325, 29.54%) of the patients received long-segmental fixations. This method is thought to lead to prolonged operation times and increased blood losses [27]. In addition, large areas of muscles are separated during the operation, which may weaken the blood supply of associated tissues and thus reducing the antibacterial defense ability of the body. Furthermore, the necessity of using allograft bone is increased in long-segmental fixation. Reducing operation trauma and shortening operation times combined with strict sterility during operation and proper postoperative management such as correcting anemia and electrolyte imbalance is important for preventing incision infections based on our experience. Applying gentamicin powder into crushed bones when performing intervertebral fusion and washing the incision with saline and diluted iodine solution might also be useful for decreasing the incidence of intervertebral infections [28]. Notably, we found a higher incidence of nerve injuries and overall complications in the long-segmental fixation compared with short-segmental fixation interventions in our statistical analysis. This is in line with a previous publication, in which fusion of multiple levels performed in long-segmental fixation and repeated fusion operation enhanced the probability of injuring the spinal cord. Up to now, no systematic comparison between complications of long and short-segmental fusion have been done, but Tezeren et al. [29] compared the efficacies of this two methods in 18 cases of thoracolumbar burst fractures. They found, that operation time and blood loss was significantly increased in long-segmental fixations, but there was no significant difference of clinical efficacy between the two surgery methods. In our study, long-segmental fixation was used for patients complaining back and leg pain and this pain was mainly caused by excessive traction of muscles due to scoliosis deformities. Although deformity corrections were needed during the surgery, over correction of particularly rigid deformations in elderly increase the risk of nerve tugs and twists. Therefore, deformity corrections, remission of symptoms and stability of the spine should be organically balanced during the treatment of DS in elderly patients.

### Conclusions

Most of the postoperative complications could be cured in the 6 month follow up and more

than half of them were nerve injuries followed by incision infections.

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### Disclosure of conflict of interest

None.

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