Investigation of Causes of Re-Surgery in Patients with Previous Lumbar Spine Surgery

Abstract

Introduction: Spine disorders are one of the common causes of referral to orthopedic clinics and reasons for orthopedic surgeries. Lumbar spinal surgery helps reduce pain and improve function in patients with certain degenerative conditions. In this paper we investigated the causes of revision spine surgery.

Materials & Methods: In a retrospective cohort study the patients who had undergone revision spinal surgery within one year in a teaching hospital were evaluated -in accordance with diagnosis and clinical criteria. The patients were randomly selected and screened, and demographic information (including age, gender, underlying disease, and body mass index (BMI)) was collected through a data collection form using patients' records. The clinical features including diagnosis of spine disease, type of previous surgery, number of fusions, history of spine surgery, Roussouly classification, and T-score, and also radiographic parameters such as sagittal vertical angle (SVA), pelvic incidence (PI), lumbar lordosis (LL), PI-LL mismatch, sacral slope (SS) and pelvic tilt (PT) were collected and included in the checklist.

Results & Discussion: The most common cause of original spine surgery was spinal canal stenosis, which was present in 37 patients (92.5%). The most common surgery was discectomy followed by spinal fusion _ performed in 30 (75%) and 27 patients (67.5%) respectively. 25 patients (62.5%) had a history of only one surgery. According to the Roussouly classification, 30 patients (75%) had SS <35 °, and 10 patients (25%) had SS> 35 °. The mean BMI was 28.28. 2.60 kg / m2. The mean T-score in bone densitometry was -1.86 ± 1.06. The mean size of SVA was 7.12 ± 2.19 cm; the mean PI angle was 52.12 ± 10.80 °; the mean LL angle was 23.42 ± 15.56 °; the mean size of the difference between PI and LL angles was 29.25 ± 15.30 °, the mean SS angle was 27.85 ± 10.69 °, and the mean PT angle was 23.62 ± 7.62 °. SVA size was abnormal in 35 patients (87.5%), PI in 14 patients (35%), the difference between PI and LL in 35 patients (87.5%), SS in 34 patients (85%), and PT in 29 patients (72.5%) was abnormal. There was a significant difference in SVA, PI, PI-LL mismatch, SS, and PT between normal and abnormal groups (P-value <0.001).

The patient factors such as old age, previous medical conditions, high BMI, osteopenia, and intraoperative factors, including failure to correct lumbar lordosis, sagittal balance, and correction of angles in primary surgery, showed increased risk for revision spine surgery.

Conclusion: Osteopenia and osteoporosis, failure in reconstituting lumbar lordosis and proper sagittal balance are common reasons leading to revision spine surgery.

Keywords: Spine, Revision surgery, Failed back surgery syndrome.

Accepted: 33 days before printing

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Introduction

Spinal disorders are among the most common causes of referrals to orthopedic clinics and represent a major indication for orthopedic surgeries. These procedures, particularly in patients with a history of previous operations, are often more technically demanding due to postoperative adhesions and the progression of degenerative changes over time, necessitating longer and more precise surgical interventions. The most frequent indication for spinal surgery is neural element compression, with lumbar disc herniation and spinal stenosis being the two leading etiologies[1].

Radicular pain is one of the primary reasons for patients to seek medical attention in clinics and physicians' offices, often resulting in substantial disability[1]. This condition can occur even at a young age, with approximately 30% of adolescents reporting at least one episode of low back pain requiring medical evaluation during their lifetime[2].

Epidemiological data indicate that the one-month prevalence of low back pain in the general population is approximately 32%. On average, it accounts for 5.5 days of bed rest and leads to work absenteeism in about 19% of individuals[3].

Laminectomy is among the most frequently performed surgical procedures for patients with lumbar radiculopathy[4]. Although these operations generally demonstrate favorable efficacy, they can occasionally result in complications and adverse outcomes[5]. Moreover, between 10% and 20% of surgically treated patients experience recurrent symptoms for various reasons and require further medical evaluation[6].

Epidemiological studies have demonstrated that both personal and occupational factors, as well as lifestyle-related variables, are associated with lumbar spine disorders. Non-occupational risk factors include age, sex, physical fitness, cigarette smoking, and congenital structural abnormalities such as spondylolisthesis. Occupational factors such as lifting and pushing heavy loads, repetitive lumbar flexion and extension, and poor posture or non-ergonomic working conditions have also been identified as significant contributors to low back pain[7,8]. Compared with patients who respond well to surgery, those with recurrent symptoms often experience multiple physical and psychological problems, along with a reduced quality of life. Consequently, early identification of these patients is of critical importance, particularly in the context of preoperative planning, as it may help prevent recurrence in subsequent surgical procedures[9].

Spinal surgery has proven effective with pain reduction and functional improvement in specific degenerative spine disease. “Failed back surgery,” “flatback syndrome,” and “post-laminectomy syndrome” are different terms for describing the patents who had one spinal surgery but still continue to present with symptoms. Over the past two decades, there has been a marked increase in the overall rate of spinal surgeries. Consequently, the number of revision procedures, as well as patient referrals to spine surgeons and general practitioners, is expected to rise accordingly[10].

Loosing of normal lordosis of lumbar spine after spinal fusion is typically referred as “flatback syndrome”, which results in change the sagittal balance. The patients usually have complain of pain and inability to hold their upright standing posture. Common etiologies for this syndrome are hypolordotic lumbar fusion in degenerative spondylosis, kyphosis at the thoracolumbar junction and pseudarthrosis leads to progressive deformity. Another cause is extending the distraction instrumentation into the lumbo-sacral spine. On physical examination, decompensated sagittal imbalance can be observed. Additional clinical compensatory mechanisms that may coexist in uncorrected sagittal malalignment include thoracic hypokyphosis, cervical hyperlordosis, knee flexion to offset the loss of lumbar lordosis and pelvic retroversion.

Full length standing spinal radiographs are essential for assessing the amount of imbalance and spinopelvic radiographic parameters and their relationships. In symptomatic cases, corrective surgery to restore normal lumbar lordosis may be needed. In mobile discs, lumbar curvature can be restore by multiple posterior osteotomies (e.g., Ponte osteotomy) and in cases of rigid, fused deformities, by a three-column pedicle subtraction osteotomy[10].

Given the scarcity of studies in this field in Iran, the present study aimed to investigate the causes of revision surgery in patients with a history of prior lumbar spine operations.

Materials & Methods

This observational study was conducted as a retrospective cohort. Overall 40 patients who presented to Baqiyatallah Hospital, with a previous history spinal surgery and who, at the time of admission, fulfilled the clinical and diagnostic criteria for revision surgery, were evaluated. Patients with orthopedic diseases of the hip or lower extremities, or incomplete clinical records, were excluded from the study.

Inclusion criteria

Patients presenting to Baqiyatallah Hospital with a history of spinal surgery who required revision surgery based on clinical and diagnostic criteria at the time of admission.

Exclusion criteria

1. Presence of orthopedic diseases of the hip or lower extremities.
2. Incomplete patient data.

Sampling method and sample size calculation

Convenience sampling was used in this study. Based on the formula for sample size calculation, considering α (type I error) = 0.05, d (precision) = 0.1, and P = 0.1 (according to reference 6, which reported approximately 10% revision surgery rate), the required sample size was estimated at 36 patients. Ultimately, 40 patients who met the inclusion criteria and required revision spinal surgery were included.
Demographic data (age, sex, comorbidities, and BMI) were collected using a structured data collection form derived from medical records. In addition, clinical characteristics including spinal diagnosis, type of previous surgery, number of fusion levels, number of prior spine surgeries, Roussouly classification, T-score, as well as radiographic parameters (SVA, PI, LL, PI-LL, SS, and PT) were recorded in a checklist.

Roussouly classification

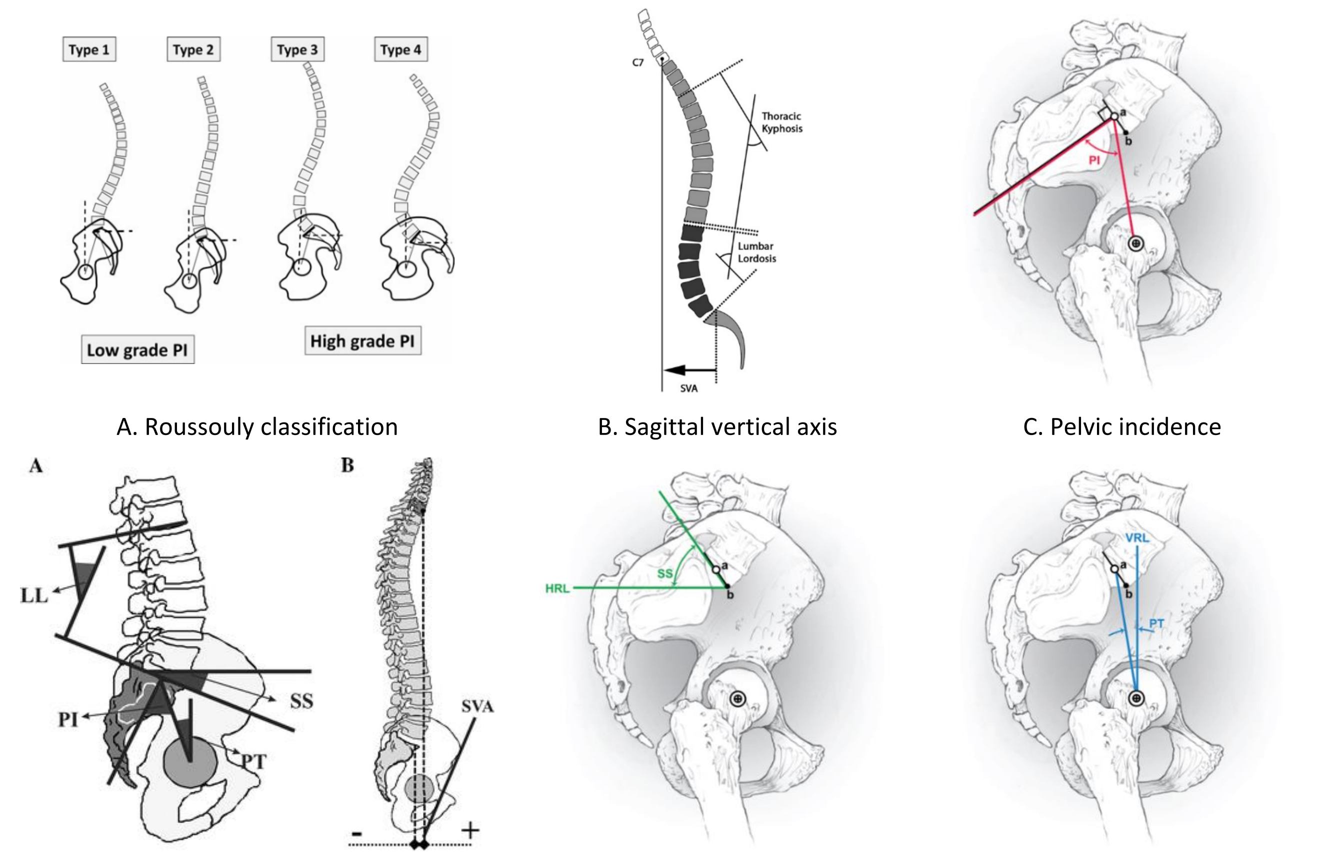
The original Roussouly classification describes the geometric relationship between sacral slope (SS) and the lower arc of lumbar lordosis (from the S1 endplate to a horizontal line through the apex of LL) (Panel 1, part A). Four subtypes are defined: type 1 and 2 for SS < 35°, type 3 for 35° < SS < 45°, and type 4 for SS > 45°. In this study, patients were divided into two groups: SS < 35° and SS > 35° (Figure 1).

Sagittal vertical axis (SVA)

SVA is defined as the plumb line dropped from the center of the C7 vertebral body on the whole spine lateral standing radiograph (Panel B).
Normally, the plumb line passes through or slightly behind the sacrum. Physiological values of SVA in adults range between +48 mm and –48 mm, and negative values indicating a position behind the sacral promontory. In this study, SVA < 50 mm was considered normal.

Pelvic incidence (PI)

PI is termed as the angle between a line perpendicular to the midpoint of the sacral endplate and a line drawn from this point to the axis of the bicoxofemoral joints (Panel C). The mean PI in adults is 52° ± 10°.



A. Roussouly classification B. Sagittal vertical axis C. Pelvic incidence

D. Lumbar lordosis E. Sacral slope H. Pelvic tilt

Figure 1: Radiographic parameter values:

Iranian Journal of Orthopaedic Surgery
Vol. 22, No. 4 (Serial No. 87), Autumn 2024, p. 173-181

Lumbar lordosis (LL)

LL was measured from the superior endplate of L1 to the inferior endplate of S1 (Panel C).

PI-LL mismatch

The normal difference between PI and LL is <10°. In this study, PI-LL <9° was considered normal.

Sacral slope (SS)

SS is termed as the angle between the sacral endplate and a horizontal reference line (Panel E). Normal values were considered between 35° and 45°.

Pelvic tilt (PT)

PT is termed as the angle between a vertical reference line and the line connecting the midpoint of the sacral endplate to the axis of the femoral heads (Panel F). PT < 20° was considered normal.

Ethical Considerations

Written informed consent was obtained from all participants and this study was approve by obtained the institutional ethics committee. All collected data were kept confidential and anonymized. The study was conducted in accordance with the principles of the Declaration of Helsinki. No additional financial burden was imposed on the patients.

Data Analysis

Data were analyzed using SPSS version 26. Quantitative variables were expressed as mean ± standard deviation (Mean ± SD), while categorical variables were reported as frequencies and percentages. Comparisons of quantitative variables were performed using the independent samples **t**-test or, in cases of non-normal distribution, the Mann–Whitney U test. Comparisons of categorical variables were conducted using the Chi-square test or Fisher's exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant.

Results

In this study, 40 patients requiring revision spinal surgery were evaluated. The mean age was 62.92 ± 7.07 years (52–77 years). Of these, 24 patients (60%) were female. The most common comorbidities were hypertension in 14 (35%) and diabetes mellitus in 13 patients (32.5%). Other comorbid conditions included chronic kidney disease (CKD) in 5 (12.5%), heart failure (HF) in 4 (10%), cerebrovascular accident (CVA) in 2 (5%), Parkinson's disease in 1 (2.5%), rheumatoid arthritis (RA) in 1 (2.5%), and other conditions in 3 patients (7.5%) (Table 1).

The most common reason for spine surgery was canal stenosis, observed in 37 patients (92.5%). Additional indications included spondylolisthesis in 26 patients (65%), device failure in 13 patients (32.5%), and disc herniation in eight patients (20%) (Table 1).

With respect to the type of surgery, discectomy was the most common procedure, performed in 30 cases (75%), and spinal fusion in 27 cases (67.5%). Other surgical procedures were performed in nine patients (22.5%) (Table 1).

Regarding the number of fusion levels, no fusion was performed in 10 patients (25%), four-level fusion in eight patients (20%), three-level fusion in seven patients (17.5%), seven-level fusion in six patients (15%), nine-level fusion in three patients (7.5%), five-level fusion in three patients (7.5%), two-level fusion in two patients (5%), and six-level fusion in one patient (2.5%) (Table 1).

In terms of the number of previous spinal surgeries, 25 patients (62.5%) had undergone one prior surgery, seven patients (17.5%) had two surgeries, four patients (10%) had four surgeries, two patients (5%) had three surgeries, and two patients (5%) had five previous spinal surgeries (Table 1).

According to the Roussouly classification, 30 patients (75%) had SS < 35°, while 10 patients (25%) had SS > 35° (Table 1).

The mean body mass index (BMI) of patients was 28.28 ± 2.6 kg/m^2 (minimum: 23.10; maximum: 35) (Table 2). According to the BMI classification, 22 patients (55%) were overweight, 14 patients (35%) had moderate obesity, one patient (2.5%) was morbidly obese, and the remaining three patients (7.5%) were within the normal range (Table 3).

The mean T-score in bone densitometry was −1.86 ± 1.06 (range: −3 to 2.40) (Table 2). Based on T-score classification, 20 patients (50%) had osteopenia, 14 patients (35%) had osteoporosis, and the remaining six patients (15%) were within the normal range (Table 3). The mean sagittal vertical axis (SVA) was 7.12 ± 2.19 cm (range: 1–12 cm).

The mean values of sacral slope (SS), lumbar lordosis (LL), pelvic incidence (PI), PI–LL mismatch, and pelvic tilt (PT), along with their minimum and maximum values, are presented in Table 2.

Table 1: Distribution of demographic and clinical variables in patients requiring revision spinal surgery (n = 40)

Variable	n	%
Sex		
Female	24	60.0
Male	16	40.0
Comorbidities		
Hypertension (Yes)	14	35.0
Hypertension (No)	26	65.0
Diabetes (Yes)	13	32.5
Diabetes (No)	27	67.5
Chronic kidney disease (Yes)	5	12.5
Chronic kidney disease (No)	35	87.5
Heart failure (Yes)	4	10.0
Heart failure (No)	36	90.0
Cerebrovascular accident (Yes)	2	5.0
Cerebrovascular accident (No)	38	95.0
Parkinson’s disease (Yes)	1	2.5
Parkinson’s disease (No)	39	97.5
Rheumatoid arthritis (Yes)	1	2.5
Rheumatoid arthritis (No)	39	97.5
Other comorbidities (Yes)	3	7.5
Other comorbidities (No)	37	92.5
Spinal disease diagnosis		
Spinal canal stenosis (Yes)	37	92.5
Spinal canal stenosis (No)	3	7.5
Spondylolisthesis (Yes)	26	65.0
Spondylolisthesis (No)	14	35.0
Device failure (Yes)	13	32.5
Device failure (No)	27	67.5
Disc herniation (Yes)	8	20.0
Disc herniation (No)	32	80.0
Previous surgery type		
Discectomy (Yes)	30	75.0
Discectomy (No)	10	25.0
Fusion (Yes)	27	67.5
Fusion (No)	13	32.5
Laminectomy (Yes)	17	42.5
Laminectomy (No)	23	57.5
Other surgeries (Yes)	9	22.5
Other surgeries (No)	31	77.5
Number of fusion levels		
None	10	25.0
Two	2	5.0
Three	7	17.5
Four	8	20.0
Five	3	7.5
Six	1	2.5
Seven	6	15.0
Nine	3	7.5
Number of previous spinal surgeries		
One	25	62.5
Two	7	17.5
Three	2	5.0
Four	4	10.0
Five	2	5.0
Roussouly classification		
Type 1 (SS < 35°)	30	75.0
Type 2 (SS > 35°)	10	25.0

Table 2: Age, BMI, T-score, and radiographic findings in patients requiring revision spinal surgery

	Mean±SD	Min	Max
Age (years)	62.92 ± 7.07	52	77
BMI (kg/m²)	26.00 ± 8.00	23.10	35
T-score	1.06 ± 1.86	-3	2.4
SVA (cm)	7.12 ± 2.19	1	12
PI (degree)	52.12 ± 10.80	28	75
LL (degree)	23.42 ± 15.56	6	65
PI-LL (degree)	29.25 ± 15.30	1	58
SS (degree)	27.85 ± 10.69	5	48
PT (degree)	23.82 ± 7.62	9	40

Table 3: Frequency distribution of BMI subgroups, T-score, and radiographic findings in patients requiring revision spinal surgery

Variable	n (%)	P-value
BMI		
Morbid obesity (35 < BMI < 40)	1 (2.5%)	
Obese (30 < BMI < 35)	14 (35%)	
Overweight (25 < BMI < 29.9)	22 (55%)	
Normal (18.5 < BMI < 24.9)	3 (7.5%)	
T-score		
Osteoporosis (T-score < −2.5)	14 (35%)	
Osteopenia (−2.5 < T-score < −1)	20 (50%)	
Normal (T-score > −1)	6 (15%)	
SVA		<0.001
Abnormal	35 (87.5%)	
Normal (SVA < 5 cm)	5 (12.5%)	
PI		
Abnormal	14 (35%)	
Normal (42° < PI < 62°)	26 (65%)	
PI–LL mismatch		<0.001
Abnormal	35 (87.5%)	
Normal (Difference < 9°)	5 (12.5%)	
SS		<0.001
Abnormal	34 (85%)	
Normal (35° < SS < 45°)	6 (15%)	
PT		<0.001
Abnormal	29 (72.5%)	
Normal (PT < 20°)	11 (27.5%)	

Specifically, the mean PI was 52.12 ± 10.80° (range: 28–75°), the mean LL was 23.42 ± 15.56° (range: 6–65°), the mean PI–LL mismatch was 29.25 ± 15.30° (range: 1–58°), the mean SS was 27.85 ± 10.69° (range: 2–48°), and the mean PT was 23.82 ± 7.62° (range: 9–40°) (Table 2).
Patients were classified into normal and abnormal groups based on the reference values for SVA, PI, PI–LL mismatch, SS, and PT. SVA was abnormal in 35 patients (87.5%), PI in 14 patients (35%), PI–LL mismatch in 35 patients (87.5%), SS in 34 patients (85%), and PT in 29 patients (72.5%) (Table 3; Figure 6-2). Significant differences were observed between the normal and abnormal groups for SVA, PI, PI–LL mismatch, SS, and PT (P < 0.001) (Table 3).

Discussion

If the end result of lumbar spine surgery could not reach the expectations of the patient or surgeon before surgery, it may result in surgical failure and the need for revision spine surgery or other forms of follow-up[25]. While around 50% of first spine surgeries are successful, over 30%, 15%, and 5% of patients do not achieve favorable outcomes after the second, third, and fourth surgeries, respectively[10–27]. Therefore, identifying the factors contributing to surgical failure and mitigating them is of critical importance.

In this study, 40 patients requiring revision spinal surgery were evaluated, with a mean age of 62.92 ± 7.07 years. According to Seyed Mahdi et al., age over 40 is a risk factor for recurrence of symptoms after surgery[24]. However, Wang et al. reported that age is not a decisive factor for surgical success[10–17]. These discrepancies may be attributed to geographic, genetic, and lifestyle differences among populations. In our cohort, 22 patients (55%) were overweight and 14 patients (35%) had moderate obesity. Previous studies also indicate that obesity and overweight are risk factors for surgical failure. For instance, Marquez et al. demonstrated that BMI serves as a predictor for postoperative complications as well as overall surgical outcomes[28].

The most common comorbidities in our study were hypertension and diabetes (35% and 32.5%, respectively). According to Talbot et al., patients with comorbidities are at higher risk of surgical failure[14]. Consequently, encouraging patients to reduce weight preoperatively, controlling comorbidities, and promoting healthy lifestyle changes may reduce the risk of surgical failure. Additionally, our study indicated that older age is a predictor of surgical failure. Implementing early screening, regular examinations, and patient education on timely reporting of symptoms can help manage disease at an earlier stage, improving treatment efficacy and reducing the physical, psychological, and financial burden associated with recurrent pain and revision surgery.

The mean T-score in bone densitometry was −1.86 ± 1.06, with 50% of patients classified as osteopenic. Watanabe et al. also reported a high prevalence of osteopenia in patients who experienced vertebral fractures following lumbar surgery[27–29]. In our study, 35% of patients had osteoporosis. Prior studies indicate that osteoporosis increases the risk of postoperative complications, surgical failure, and the need for revision surgery[30].

The mean SVA was 7.12 ± 2.19 cm (range: 1–12 cm), with 35 patients (87.5%) classified as abnormal (SVA > 5 cm). The mean PI–LL mismatch was 29.25 ± 15.30°, abnormal in 35 patients (87.5%). The mean PT was 23.82 ± 7.62°, abnormal in 29 patients (72.5%; PT > 20°). According to Schwab et al., SVA > 47 mm, PT > 22°, and PI–LL mismatch > 11° are predictors of severe disability, and patients with these risk factors are more likely to require revision surgery[31]. Similarly, Kim et al. reported that patients with higher postoperative SVA and LL had a significantly increased risk of complications such as proximal junctional kyphosis (PJK), often necessitating revision surger[12]. These findings underscore the importance of correcting lumbar lordosis and sagittal alignment during the initial surgery, which was not fully achieved in our cohort.

Overall, patient-related factors—such as advanced age, comorbidities, high BMI, osteopenia, and osteoporosis—along with intraoperative factors like inadequate correction of lumbar lordosis, sagittal balance, and spinal alignment during the primary surgery, contribute to increased risk of surgical failure and the need for revision procedures[32]. Patients experiencing these outcomes face greater physical and psychological challenges and reduced quality of life compared to those with successful surgeries, highlighting the importance of identifying risk factors. Nevertheless, some researchers suggest that symptom recurrence or surgical failure is an inevitable and gradual process associated with aging[33].

However, patient education regarding disease management, including obesity and diabetes, and specialized surgeon training can reduce the risk of surgical failure.

Conclusion

In summary, patient-related factors such as advanced age, comorbidities, high BMI, osteopenia, and osteoporosis, along with intraoperative factors including insufficient correction of lumbar lordosis, sagittal balance, and spinal alignment during the primary surgery, can significantly increase the risk of surgical failure and the need for revision spine surgery.

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