Introduction

Degenerative lumbar scoliosis typically develops in patients over 50 years of age as a primary condition (*scoliosis de novo*) or because of degenerative changes in the spine following pre-existing adolescent idiopathic scoliosis. The course of degenerative scoliosis can be asymptomatic or accompanied by severe pain, signs of neural compression, and disturbances in the frontal and sagittal balance of the spine.

The prevalence of scoliosis in the adult population, according to various studies, ranges from 2 % to 32 %; recent observations conducted among elderly volunteers have shown a prevalence of degenerative scoliosis ranging from 6 % to 68 % [1–3]. Due to the aging population and increasing attention to quality of life relative to the cost of medical care, degenerative scoliosis has become a significant healthcare issue — not only from a cosmetic standpoint but also as a major cause of significant pain and disability [4].

Most patients with degenerative scoliosis receive conservative treatment, while some with severe clinical symptoms require surgical intervention. The primary goal of such surgery is spinal decompression, achieving a stable bony block, and correcting frontal and sagittal torso shifts [5]. A retrospective analysis by the Scoliosis Research Society (SRS) reported that the incidence of surgical complications in degenerative scoliosis was 13.4 %, although other studies report figures as high as 40 %. The most common complications include damage to the dura mater, implant fractures, superficial and deep wound infections, and neurological deficits. Patients who are obese, smoke, have osteoporosis, or are over 65 years old are at increased risk. Proximal junctional kyphosis occurs in 20–40 % of patients and can manifest either early or late after surgery. The rate of reoperations varies from 16.7 % within the first 90 days to 40 % over a period of 11 years [6].

These findings lead many surgeons to reconsider the appropriateness of performing surgical interventions on patients in this category. Therefore, to change this mindset and reduce the incidence of complications during and after surgery, it is necessary to analyze the results of surgical treatment of degenerative lumbar scoliosis.

Objective: To study the outcomes of surgical treatment for patients with degenerative lumbar scoliosis.

Materials and Methods

A retrospective analysis was conducted on the results of surgical treatment of degenerative lumbar scoliosis in 37 patients (29 women, 8 men) aged 48–73 years (mean age 56.6). The study was approved by the expert committee of the Professor M. F. Rudnev Municipal Multidisciplinary Clinical Hospital for Mothers and Children (Protocol No. 1, dated 01.01.25). The research was carried out in accordance with the requirements and provisions of the Helsinki Declaration on Human Rights, the Council of Europe's Convention on Human Rights, the basic health care legislation of Ukraine, and current national ethical standards for clinical research. All participants provided written informed consent.

Inclusion Criteria: Patients with degenerative lumbar scoliosis, Lenke-Silva group II–III (Cobb > 45°, lateral shift 2 mm), available clinical and radiological data, no previous spinal surgeries, infections, trauma, or rheumatoid arthritis.

The following data were analyzed: presentation, radiometric study results such as Cobb angle of curvature, the difference between pelvic slip and lumbar lordosis (PI–LL), sagittal vertical axis (SVA), pelvic tilt (PT), T1PA and L1PA angles (Fig. 1a, b). For measuring the frontal and sagittal components of curvature, the reference values from the Schwab scoliosis classification [7] were chosen. Normal values for the T1PA and L1PA angles were taken from the studies by [8, 9].

Additionally, the types of surgical interventions performed were determined, including the average number of spinal segments fixed with transpedicular implants, the presence of comorbidities in patients, and postoperative complications. All patients were assessed using the Visual Analog Scale (VAS) for back pain and leg pain (“VAS back” and “VAS leg”), as well as the Oswestry Disability Index (ODI) before surgery, 3 months, and 1 year after surgery. According to the scale, 0–20 % indicated minimal, 21–40 % moderate, 41–60 % significant, 61–80 % severe, and 81–100 % substantial functional impairment. Bone block quality was assessed using radiological imaging and computed tomography.

Results

Table 1 presents the average results of radiometric measurements in the study group. From this table, we can observe that the preoperative Cobb angle was 47.7°, 3 months after surgery it was 20.7°, and 1 year later it was 23.7°. Similar changes were observed in other measurements. For example, the difference between PI and LL (PI–LL) was 17.3° preoperatively, 9.5° at 3 months, and 8.7° at 1 year. The SVA value changed from 54.5 mm preoperatively to 30.5 mm at 3 months and 32.1 mm at 1 year on average. Pelvic tilt (PT) was 29.5° preoperatively, 14.9° at 3 months, and 15.3° at 1 year. The T1PA and L1PA angles were 27.1°

and 15.5° preoperatively, 18.3° and 11° at 3 months, and 19.5° and 11.3° at 1 year after surgery.

Curve correction with indirect decompression of the spinal canal by changing its shape was performed in 11 patients, while 26 patients underwent direct decompression of the spinal canal. A wide decompression was performed in 7 patients, and a limited decompression through flavectomy, foraminotomy, and interlaminectomy was done in 19 patients. The average length of the instrumented spinal fusion zone was 5.1 segments (ranging from 3 to 10 segments). All patients underwent Smith-Peterson posterior column osteotomy at the apex of the deformity.

Table 2 presents the comorbidities identified in the study group. Most patients had hypertension (78 %) and decreased bone mineral density (54 %). If indicated, patients received preoperative treatment for comorbidities to reduce the number of postoperative complications.

The average Oswestry Disability Index score before surgery was 52.1 %, indicating a significant degree of functional impairment. Three months after surgery, the score decreased to 49.3 % (indicating significant impairment), and one year later, it dropped to 22.7 % (indicating mild impairment) (Fig. 1).

A similar trend was observed in the assessment of pain using the VAS (Fig. 2). The "VAS back" score was 67.2 mm preoperatively, 44.3 mm at 3 months after surgery, and 19.3 mm at 1 year, while the "VAS leg" score was 69.2 mm preoperatively, 39.7 mm at 3 months, and 21.5 mm at 1 year.

Table 3 presents the causes and frequency of complications, which occurred in 48.6 % of patients on average. The most common complications were poor wound healing (15 %) and transient neurological issues, including radiculopathy and lower limb paresis, which occurred in 11 % of patients in the study group.

Discussion

Surgical treatment of degenerative lumbar scoliosis in adult patients presents a significant challenge for surgeons, as the disease is multifaceted with a diverse clinical presentation and potential for unexpected outcomes, both for the patients and the medical professionals.

When developing a treatment plan, several factors need to be considered, such as comorbidities, the patient's social status, and lifestyle. Most patients become aware of their diagnosis through radiological imaging, and conservative treatments are often selected empirically by specialists of various profiles, including general practitioners, neurologists, and rehabilitation specialists [10].

Indications for surgical intervention in younger, more active adults differ from those in elderly patients with comorbidities. Therefore, there is no unified consensus regarding recommendations for performing various types of surgeries. However, it is widely acknowledged that the most common indications include ineffective conservative treatment, severe pain, neurological disorders, low quality of life, and, very rarely, cosmetic deformities [11]. Ultimately, the goal is decompression of neural structures with restoration of sagittal and frontal spinal balance [12]. Modern trends in surgery aim to reduce invasiveness to prevent potential intra- and postoperative complications.

In a systematic review and meta-analysis [13], the results of decompression without instrumental fixation in patients with degenerative lumbar scoliosis were evaluated. Fifteen studies with a minimum postoperative follow-up of 2 years were analyzed. The average improvement in the Oswestry index

Table 1

Average results of radiometric measurements in the study group

Indicator	Before surgical treatment	3 months after surgery	1 year after surgery
Cobb angle, °	47.7	20.7	23.7
PI–LL, °	17.3	9.5	8.7
SVA, mm	54.5	30.5	32.1
PT, °	29.5	14.9	15.3
T1PA, °	27.1	18.3	19.5
L1PA, °	15.5	11.0	11.3

Table 2

Concomitant diseases in patients

Disease	Patient	Percentage
Diabetes	6	15
Hypertension	29	78
Myocardial ischemia	15	40
Osteoporosis	20	54
Chronic kidney diseases	3	8

Table 3

Incidence of complications in patients

Complication	Patient	Percentage
Wound healing	6	15.0
Neurological disorders	4	11.0
Intraoperative bleeding	1	2.7
Comorbidities	2	5.9
Pseudoarthrosis	3	8.1
Infection	2	5.9

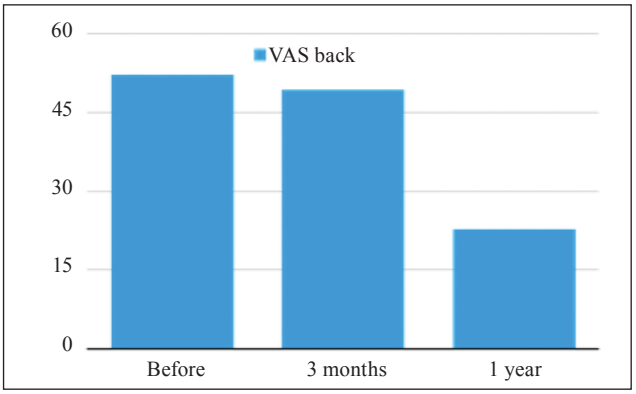

Fig. 1. Diagram of changes in Oswestry scale scores before, 3 months, and 1 year after surgical intervention

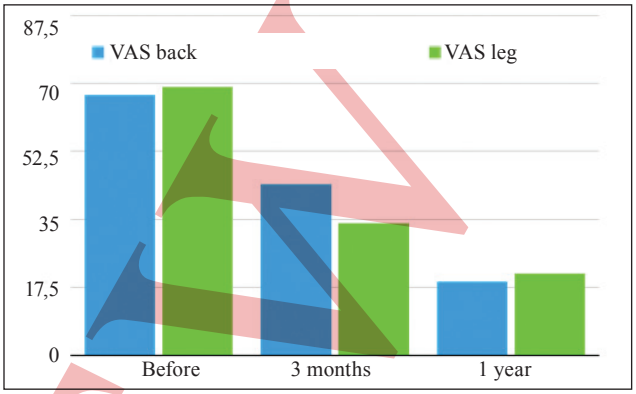

Fig. 2. Diagram of changes in "VAS back" and "VAS leg" scale scores before, 3 months, and 1 year after surgical intervention

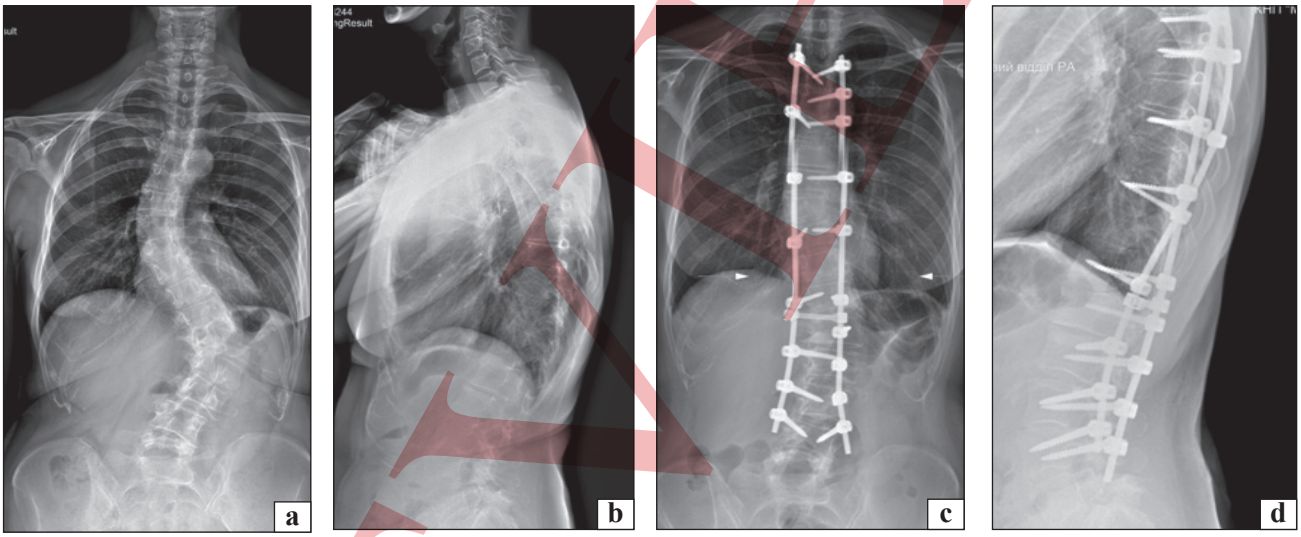

Fig. 3. X-rays of a 60-year-old patient with combined scoliosis in the anterior-posterior (a, b) and lateral (b, g) projections before and after surgical intervention. Thoracic Cobb angle before surgery — 45º, after — 23º. Lumbar Cobb angle before surgery — 56º, after — 30º. Thoracic kyphosis before surgery — 45º, after — 31º. Lumbar lordosis — 62° before and after PI value — 54º

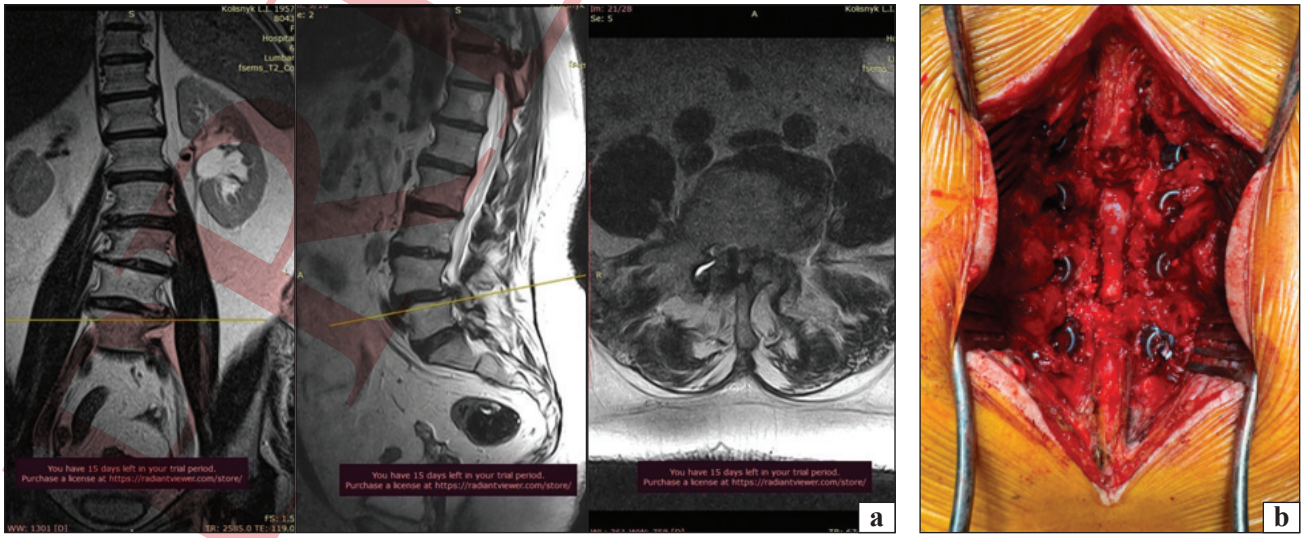

Fig. 4. Magnetic resonance imaging of the lumbar spine (a) in frontal, lateral, and axial projections of a patient with degenerative lumbar scoliosis at the LIV, LV levels, and the appearance of the surgical wound (b) after decompression of the spinal canal and fixation with pedicle screws.

was around 29 %, patient satisfaction was 71 %, and the progression of the Cobb angle was minimal (1.8°). The frequency of reoperations ranged from 3 % to 33 %. The results suggest that decompression without fixation is an effective and relatively safe method for carefully selected patients with small scoliosis angles and no significant instability. The authors emphasize the limited available data and the need for further high-quality prospective studies. However, it should be noted that this approach will not be effective in patients with unstable, progressive spinal deformities.

M. Echt and colleagues conducted a study comparing clinical outcomes and perioperative morbidity in patients with adult degenerative lumbar scoliosis who underwent minimally invasive decompression or short-segment spinal fixation. In a retrospective analysis using paired matching and probability scoring, 31 pairs of patients were formed. The results showed that minimally invasive decompression was associated with shorter operation and hospitalization times and less blood loss, while short-segment spinal fixation provided significant improvements in the Oswestry index and mental health, as well as a reduction in back pain one year after surgery. The time to reach the minimal clinically significant difference was similar in both groups. These findings suggest the need for an individualized approach when choosing a surgical strategy, balancing perioperative morbidity with clinical improvement through stabilization of spinal segments with implants.

A systematic review and meta-analysis by B. Zheng compared the effectiveness and safety of long versus short spinal fixation in patients with degenerative lumbar scoliosis. Thirteen studies with a total of 1,261 patients were analyzed. Long fixation provided better correction of the Cobb angle and both coronal and sagittal balance, but was associated with greater blood loss, longer surgery duration, and higher complication rates. Short fixation had less surgical invasiveness, while clinical outcomes (VAS, Oswestry scale) and the frequency of reoperations were similar in both groups. Thus, it is important to tailor the choice of fixation length to the degree of spinal deformity and the clinical condition of the patient [15].

This ongoing debate over the type and extent of surgical interventions reinforces the importance of individualized treatment plans. Each case of degenerative lumbar scoliosis must be approached carefully, considering not only the severity of the spinal deformity but also the patient's overall health, lifestyle, and the presence of comorbid conditions. By optimizing the approach to surgery, outcomes can be improved, complications minimized, and patients can enjoy a better quality of life postoperatively.

The study conducted by N. Fan and colleagues evaluated the clinical and radiological outcomes of endoscopic decompression for the treatment of lumbar spinal stenosis in patients with degenerative lumbar scoliosis. A retrospective study analyzed 97 patients with both lumbar stenosis and degenerative lumbar scoliosis, who underwent surgery between 2016 and 2021, with an average follow-up of 52.9 months. A control group of 97 patients with lumbar stenosis but without deformity was also included. The results demonstrated significant improvement in VAS scores for back and leg pain, as well as ODI scores in both groups, measured 2 weeks post-surgery and at the final follow-up ($p < 0.001$). There were no significant differences in the complication rates or patient satisfaction levels between the groups. However, patients with scoliosis reported more intense back pain at the final follow-up compared to those without the deformity. Radiological data showed no significant deterioration in frontal imbalance or intervertebral disc height in either group. The authors concluded that endoscopic decompression is a safe and effective surgical technique for treating lumbar spinal stenosis, particularly in elderly patients with poor overall health [16]. However, the presence of axial pain in the spine may indicate the need for spinal instrumentation.

In a systematic review published in the Global Spine Journal, the authors also examined the role of short-segment versus long-segment spinal fixation in the surgical treatment of adult scoliosis. Nine studies involving 660 patients who underwent either short-segment (less than 3 levels) or long-segment (more than 4 levels) fixation were analyzed. The findings revealed that short-segment fixations provide similar clinical outcomes with fewer perioperative risks and shorter operation times compared to long-segment fixations. However, for patients with severe deformities and sagittal or frontal imbalance, long-segment fixations were recommended. The authors emphasized the need for an individualized approach when selecting the extent of spinal fixation based on clinical and radiological parameters [17].

In our study, we analyzed the outcomes of surgical treatment in patients with unstable forms of degenerative lumbar scoliosis (Lenke-Silva II and III deformities) who underwent spinal fixation with transpedicular implants. In all cases, the goal was to restore trunk balance in all planes, decompress neural structures, and achieve a mature bony fusion. Through corrective spinal procedures (Smith-Peterson osteot-

omy), we were able to correct the frontal imbalance by approximately 56.6 % and bring both global and regional sagittal spinal balance closer to normative values (Figure 3). Neurological improvement and regression of deficits were achieved through both indirect (spinal shape and spinal canal correction) and direct decompression (laminectomy) (Figure 4). The absence of significant changes in radiometric measurements one year post-surgery, along with no instances of implant fractures, indicates successful spinal fusion in all patients in the study group.

The postoperative complication rate (48.6 %), considering the nature of the disease and the invasiveness of the surgical interventions, was acceptable and did not adversely affect the final treatment outcome for all patients.

This analysis reinforces the importance of careful patient selection, individualized surgical planning, and the choice of appropriate surgical techniques. In patients with degenerative lumbar scoliosis and associated deformities, achieving optimal spinal balance and neural decompression while minimizing complications remains the primary goal for successful surgical management.

The observation of the dynamics of changes in the Oswestry Disability Index, Visual Analog Scale for Back Pain, and Visual Analog Scale for Leg Pain is particularly interesting. This study showed that patients with degenerative lumbar scoliosis do not experience significant improvement within 3 months post-treatment, but a substantial reduction in pain syndrome, clinical manifestations, and functional improvements is achieved after one year following the treatment.

Conclusions

Surgical treatment of degenerative lumbar scoliosis enables the restoration of both sagittal and frontal balance of the trunk, improving the clinical symptoms of the disease and the quality of life of patients.

The rate of postoperative complications in the surgical treatment of degenerative lumbar scoliosis in our study was acceptable, but remains relatively high. Therefore, improving the patient's somatic condition before the surgical intervention can help prevent unsatisfactory outcomes.

The reduction of pain and the improvement of functional status in patients are achieved one year after surgery. This should be communicated to the patients during preoperative planning and preparation stages.

Conflicts of Interest. The authors declare that there is no conflict of interest.

Future Research Prospects. Conducting prospective comparative studies of short-segment and long-segment fixation for degenerative lumbar scoliosis in adults.

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RESULTS OF SURGICAL TREATMENT OF DEGENERATIVE LUMBAR SCOLIOSIS IN ADULTS

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