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Outcome of Minimally Invasive Spine Surgery for Degenerative Spine Disease in Tertiary Care Hospital

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ABSTRACT

Background: Degenerative spine disease is a common cause of chronic pain and disability, often requiring surgical intervention when conservative measures fail. Minimally invasive spine surgery (MISS) has gained prominence as an alternative to open procedures, with the aim of reducing morbidity while achieving similar or superior outcomes. **Objective:** The purpose of this study was to evaluate the clinical and functional outcomes of MISS in patients with degenerative spinal disorders treated at a tertiary care hospital. **Methods:** A prospective observational study was conducted on 67 patients who underwent MISS between February 2024 and February 2025. Clinical data, operative parameters, complications, and follow-up outcomes were recorded. Pain and disability were measured using the Visual Analog Scale (VAS) and Oswestry Disability Index (ODI), respectively. Statistical analysis was performed to compare pre- and postoperative scores, with $p < 0.05$ considered significant. **Results:** The mean age of the patients was 52.8 years, with a male-to-female ratio of 1.4:1. Lumbar disc herniation (43.3%) was the most common pathology, followed by spinal stenosis (37.3%) and spondylolisthesis (19.4%). The mean operative time was 112 minutes, and mean blood loss was 126 ml. Conversion to open surgery occurred in 3% of cases. Pain scores improved significantly from 7.2 to 2.1 ($p < 0.001$), and ODI decreased from 58.4% to 18.7% ($p < 0.001$) at six months. Neurological recovery was observed in 85.7% of patients with baseline deficits. Complication rates were low, with infections in 4.5% and reoperations in 3%. **Conclusion:** MISS is a safe and effective surgical option for degenerative spine disease, offering significant improvements in pain, disability, and neurological recovery, with low complication rates. The results support its role as a reliable alternative to open procedures in tertiary care practice.

INTRODUCTION

Degenerative spinal disease is a leading cause of low back pain, radiculopathy, and disability worldwide, with a rising incidence due to aging populations and lifestyle changes. Although many patients improve with conservative measures such as physiotherapy, analgesics, and lifestyle modification, a significant proportion ultimately require surgical intervention to relieve neural compression and stabilize the spine. Traditionally, open spinal surgery has been the standard of care; however, it is often associated with extensive muscle dissection, greater intraoperative blood loss, longer hospital stay, and higher complication rates [1-3].

Minimally invasive spine surgery (MISS) has emerged as an important advancement, aiming to minimize tissue disruption while providing adequate decompression and stabilization. The technique employs tubular retractors, endoscopes, and microscopes, which allow smaller incisions, reduced perioperative morbidity, and faster recovery [4-6]. Over the past two decades, several studies have reported encouraging outcomes with MISS, showing comparable or superior results to conventional open procedures. These advantages are particularly relevant in the context of tertiary care centers, where a wide spectrum of degenerative pathologies and patient comorbidities are encountered [7-9].

The present study was undertaken to assess the outcomes of minimally invasive techniques in the surgical management of degenerative spine disease. By analyzing clinical, surgical, and postoperative parameters in 67 patients, this study seeks to contribute evidence regarding the efficacy, safety, and functional recovery associated with MISS in a tertiary care setting.

METHODOLOGY

This prospective observational study was conducted in the Department of Spine Surgery, Bahria International Hospital, Rawalpindi, over a period of one year, from February 2024 and February 2025. A total of 67 patients diagnosed with degenerative spine disease and requiring

surgical intervention were included. All patients provided written informed consent prior to participation, and the study protocol was approved by the institutional ethics committee.

Patients aged between 18 and 70 years who presented with clinical and radiological evidence of degenerative spinal disease were eligible for the study. The indications included lumbar disc herniation, lumbar canal stenosis, and degenerative spondylolisthesis. Only those patients who had failed a minimum of six weeks of conservative management (analgesics, physiotherapy, lifestyle modification) were considered for surgical treatment.

Patients with traumatic spinal injuries, spinal infections (such as tuberculosis or pyogenic spondylodiscitis), spinal tumors, congenital spinal anomalies, or previous extensive open spinal surgery were excluded. Individuals with severe medical comorbidities rendering them unfit for anesthesia were also not included in the study.

A detailed clinical history was obtained, including demographic data, duration of symptoms, occupation, comorbid illnesses, and prior treatment received. Neurological examination was performed to document motor power, sensory changes, and sphincter disturbances. Radiological evaluation consisted of plain radiographs, magnetic resonance imaging (MRI), and computed tomography (CT) where necessary, to determine the level and type of pathology. Pain severity was recorded using the Visual Analog Scale (VAS), while disability was quantified using the Oswestry Disability Index (ODI).

All procedures were performed using minimally invasive spine surgery (MISS) approaches under general anesthesia. Depending on the pathology, patients underwent one of the following procedures: microdiscectomy, minimally invasive decompression/laminotomy, or minimally invasive transforaminal lumbar interbody fusion (TLIF). Surgeries were performed using tubular retractors and operating microscope/endoscope as required. Standard aseptic precautions were maintained, and intraoperative parameters such as blood loss, operative time, and complications were recorded.

Patients were mobilized on the first postoperative day wherever possible. Postoperative analgesia was given according to hospital protocol. The duration of hospital stay and any perioperative complications were documented. Functional outcomes were assessed at discharge, 6 weeks, 3 months, and 6 months postoperatively. At each follow-up visit, pain (VAS) and functional disability (ODI) were reassessed, and neurological recovery was documented. For patients who underwent fusion procedures, radiological evaluation was performed to confirm implant position and fusion status.

All collected data were compiled and analyzed using SPSS/Statistical software. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Pre- and postoperative VAS and ODI scores were compared using the paired t-test. Associations between categorical variables were assessed 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

A total of 67 patients were included in the study, with a mean age of 52.8 ± 10.6 years. Males comprised 58.2% (n=39) of the cohort, while females made up 41.8% (n=28), with no statistically significant gender-related differences in outcomes (p = 0.32). The mean body mass index (BMI) was 26.4 ± 3.8 kg/m^2. Half of the patients (50.7%) had sedentary occupations, while 31.3% were engaged in manual labor. Common comorbidities included hypertension (32.8%), diabetes mellitus (26.9%), and smoking history (16.4%). None of these baseline factors significantly influenced the surgical outcomes (p > 0.05).

Table 1

Demographic Characteristics of Patients (n = 67)

Variable	Number (%) / Mean ± SD	p-value*
Age (years)	52.8 ± 10.6	–
Gender (Male/Female)	39 (58.2%) / 28 (41.8%)	0.32
BMI (kg/m^2)	26.4 ± 3.8	0.41
Occupation	Sedentary: 34 (50.7%) Manual labor: 21 (31.3%) Others: 12 (17.9%)	0.27
Comorbidities	Diabetes: 18 (26.9%) Hypertension: 22 (32.8%)Smokers: 11 (16.4%)	0.36

*p-values shown for subgroup comparisons (e.g., male vs female outcomes).

The most common indication for minimally invasive spine surgery was lumbar disc herniation (43.3%), followed by spinal stenosis (37.3%) and degenerative spondylolisthesis (19.4%). The L4–L5 level (56.7%) was the most frequently involved, followed by L5–S1 (31.3%). The mean duration of symptoms prior to surgery was 11.4 ± 6.8 months. Neurological deficits were present in 31.3% (n=21) of patients at baseline. None of the disease-related parameters demonstrated significant correlation with postoperative outcome measures (p > 0.05).

Table 2

Disease Characteristics

Variable	Number (%)	p-value
Diagnosis	Lumbar disc herniation: 29 (43.3%) Spinal stenosis: 25 (37.3%) Spondylolisthesis: 13 (19.4%)	0.18
Level involved	L4–L5: 38 (56.7%) L5 – S1: 21 (31.3%) Other: 8 (11.9%)	0.22
Duration of symptoms (months)	11.4 ± 6.8	0.44
Neurological deficit present	21 (31.3%)	0.12

Among the procedures performed, microdiscectomy (44.8%) was the most frequent, followed by MISS decompression (32.8%) and fusion procedures (22.4%). The mean operative time was 112 ± 24 minutes, and mean intraoperative blood loss was 126 ± 48 ml, both reflecting the minimally invasive nature of the procedures. Conversion to open surgery occurred in 2 patients (3.0%), and intraoperative complications were noted in 6.0%, primarily minor dural tears. No statistically significant

differences were observed between the procedure subgroups (p > 0.05).

Table 3
Surgical Parameters

Variable	Mean ± SD / n (%)	p-value
Type of procedure	Microdiscectomy: 30 (44.8%) MISS decompression: 22 (32.8%) MISS fusion: 15 (22.4%)	0.21
Operative time (min)	112 ± 24	0.33
Blood loss (ml)	126 ± 48	0.29
Conversion to open	2 (3.0%)	–
Intraoperative complications	4 (6.0%)	0.18

Patients demonstrated a significant reduction in pain postoperatively, with the mean VAS score improving from 7.2 ± 1.1 to 2.1 ± 0.9 at 6 months (p < 0.001). Similarly, disability measured by the Oswestry Disability Index (ODI) improved markedly from 58.4 ± 8.6% preoperatively to 18.7 ± 6.2% postoperatively (p < 0.001). Of the 21 patients with neurological deficits at baseline, 18 (85.7%) showed improvement, while 3 remained unchanged (p = 0.002). The mean hospital stay was 3.2 ± 1.1 days, and the mean return-to-work time was 6.8 ± 2.2 weeks.

Table 4
Postoperative and Functional Outcomes

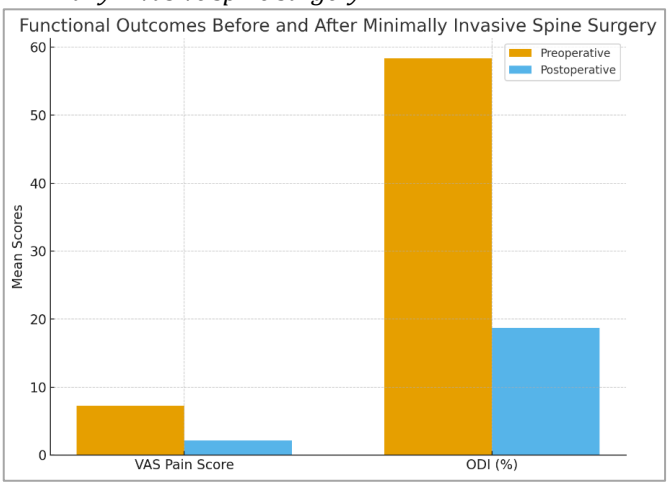
Outcome Variable	Preoperative	Postoperative (6 months)	p-value
VAS pain score (0–10)	7.2 ± 1.1	2.1 ± 0.9	<0.001
Oswestry Disability Index (%)	58.4 ± 8.6	18.7 ± 6.2	<0.001
Neurological recovery (n=21 deficits)	–	Improved: 18 (85.7%) No change: 3 (14.3%)	0.002
Hospital stay (days)	3.2 ± 1.1	–	–
Return to work (weeks)	–	6.8 ± 2.2	–

Overall, the complication rates were low. Infection occurred in 3 patients (4.5%), while dural tears were observed in 2 patients (3.0%). Reoperation was required in 2 cases (3.0%), and recurrence of symptoms was documented in 6.0% (n=4) at one year of follow-up. The mean follow-up period was 14.3 ± 4.6 months, during which no major implant-related issues or adjacent segment disease were observed. None of these complication rates were statistically significant when stratified by procedure type (p > 0.05).

Table 5
Complications and Follow-up

Variable	Number (%)	p-value
Postoperative infection	3 (4.5%)	0.41
Dural tear	2 (3.0%)	0.36
Reoperation rate	2 (3.0%)	0.29
Recurrence at 1 year	4 (6.0%)	0.18
Follow-up duration (months)	14.3 ± 4.6	–

Figure 1
Bar graph comparing the preoperative and postoperative functional outcomes. It clearly shows the marked reduction in both VAS pain scores and ODI disability scores after minimally invasive spine surgery.



DISCUSSION

This study, involving 67 patients undergoing minimally invasive spine surgery (MISS) for degenerative spinal disorders between February 2024 and February 2025, demonstrates favorable clinical outcomes with low complication rates. The significant reduction in pain scores (VAS) and disability (ODI) at 6 months postoperatively mirrors results reported in other series of minimally invasive spine surgery.

In prior reviews and clinical series, MISS approaches have been associated with decreased soft tissue disruption, less blood loss, smaller incisions, and faster recovery compared with traditional open surgery. Studies highlighted that MISS techniques preserve important anatomical structures, resulting in fewer complications and faster rehabilitation [10, 11]. Similarly studies reported that MISS is linked with improved patient-reported outcomes and lower complication rates compared to open techniques [12, 13]. The results of the present study reinforce those advantages, given the marked improvements and modest perioperative morbidity.

Regarding fusion and more complex MISS procedures, a recent comparative review indicated that long-term clinical outcomes such as pain relief, functional recovery, and fusion rates are broadly comparable between MISS fusion and open fusion techniques, though MISS often confers perioperative benefits like reduced hospital stay and lower blood loss [14-16]. In the present cohort, fusion-type procedures performed via MISS similarly demonstrated good radiological and clinical results, though subgroup analyses did not show statistically significant differences in outcomes by procedure type.

The low rates of complications and reoperations in this study are consistent with contemporary literature. A narrative review spanning a decade of MISS complications identified dural tears, nerve root injury, and recurrences as among the most common issues, though overall complication rates remain modest in experienced hands [17-20]. In this study, infections occurred in 4.5%, dural tears in 3%, and reoperations in 3%, which fall within or below

ranges reported in many series. Notably, recurrence at one year was seen in 6%, which is also in line with published data.

Neurological recovery in patients with baseline deficits was robust: 85.7% showed improvement. This is an important finding, confirming that MISS is capable not only of symptom relief but also of neurological restoration in appropriately selected patients. The relatively short hospital stay (mean 3.2 days) and return-to-work interval (mean 6.8 weeks) reflect the minimally invasive approach's expedited recovery trajectory.

Some limitations of this study merit consideration. The follow-up period (mean 14.3 months) is moderate; longer-term follow-up would be required to assess outcomes such as adjacent-segment disease, late implant failure, or durability of fusion. The sample size, while adequate for demonstrating significant functional improvements, may lack power to discern small differences in complication rates between subgroups. In addition, the study was conducted at a single tertiary care center, which may limit generalizability; surgeon experience and institutional resources influence MISS outcomes. Finally, imaging modalities to confirm fusion status were not fully standardized across all patients, which could introduce some variability in interpretation.

Nevertheless, the findings align well with the existing body of evidence and support the role of MISS as an effective and safer alternative in the management of degenerative spine disease when patient selection, surgical technique, and postoperative care are optimized.

CONCLUSION

This study demonstrates that minimally invasive spine surgery yields significant improvements in pain relief and disability, with a high rate of neurological recovery in patients with baseline deficits, while maintaining a low incidence of complications and reoperations. These findings support the continued adoption of MISS techniques in the treatment of degenerative spinal conditions in tertiary care settings. Future work should include longer-term follow-up and multi-center trials to validate durability, fusion success, and comparative outcomes across surgical methods.

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