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OUTCOMES OF MINIMALLY INVASIVE VS OPEN SPINE SURGERY IN DEGENERATIVE DISC DISEASE

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Abstract

Background: *Degenerative disc disease is a common cause of chronic back pain, leg pain, disability, and reduced quality of life. Open spine surgery has remained a standard treatment for many years, but minimally invasive techniques are now being used more often because they may reduce tissue injury and improve early recovery.*

Objective: *To compare recovery time, complications, and long-term outcomes. The study evaluates cost-effectiveness and patient satisfaction. It aims to guide surgical decision-making.*

Methods: *This comparative cohort study included adult patients who underwent surgery for degenerative disc disease after failure of conservative treatment. Patients were divided into two groups according to surgical approach: minimally invasive spine surgery and open spine surgery. Baseline data, operative findings, hospital stay, postoperative recovery, complications, pain score, disability score, treatment cost, and satisfaction level were recorded. Pain was assessed by Visual Analogue Scale, while functional disability was assessed by Oswestry Disability Index. Patients were followed after surgery to assess early and mid-term outcomes.*

Results: *Both surgical groups showed clear improvement in pain and function after treatment. The minimally invasive group had shorter hospital stay, lower blood loss, earlier walking, and faster return to routine activity compared with the open surgery group. Postoperative*

pain and disability scores were also better in the minimally invasive group at follow-up. Complications were fewer after minimally invasive surgery, mainly due to fewer wound-related problems. Patient satisfaction was higher in the minimally invasive group, while open surgery remained useful in more complex cases requiring wider exposure.

Conclusion: *Minimally invasive spine surgery provided better early recovery, fewer complications, and higher patient satisfaction in selected patients with degenerative disc disease. Open spine surgery still has an important role in complex disease. Surgical choice should be individualized according to disease severity, imaging findings, surgeon experience, patient affordability, and available hospital resources.*

INTRODUCTION

Degenerative disc disease is one of the common causes of long-term back pain and leg pain. It usually affects the lumbar spine, but it may also affect the cervical spine. In this condition, the disc slowly loses its normal height and water content. This can lead to disc bulge, disc herniation, nerve compression, spinal canal narrowing, and sometimes instability. Many patients improve with medicines, physiotherapy, rest, and lifestyle changes. But some patients continue to have severe pain, weakness, numbness, or difficulty in walking. In these patients, surgery becomes an important option.

Open spine surgery has been used for many years. It gives the surgeon a wide view of the spine. It is also useful in complex disease, severe compression, deformity, and revision cases. But open surgery usually needs a larger incision. It may cause more muscle dissection, more blood loss, more postoperative pain, and a longer hospital stay. These issues matter in daily clinical practice because patients want early recovery and early return to work. This is very important in Peshawar, where many patients are daily wage workers, shopkeepers, drivers, farmers, and house workers. A long recovery can affect the patient as well as the whole family.

Minimally invasive spine surgery was developed to reduce tissue damage while achieving the same surgical goal. These methods include micro-endoscopic discectomy, full endoscopic discectomy, percutaneous endoscopic lumbar discectomy, and minimally invasive transforaminal lumbar interbody fusion. The basic idea is simple. The surgeon reaches the diseased disc or compressed nerve through a smaller pathway. This may reduce muscle injury, blood loss, wound pain, and hospital stay. Studies from Pakistan have also started reporting good results with endoscopic and micro-endoscopic spine procedures. For example, Peshawar-based studies have reported the use of full endoscopic lumbar surgery and percutaneous full endoscopic discectomy for lumbar disc disease [3,4]. A study from Lady Reading Hospital, Peshawar, also showed satisfactory results after modified interlaminar decompression for degenerative lumbar spinal stenosis [1].

International literature also supports the growing role of minimally invasive surgery. Meta-analyses have reported that minimally invasive TLIF may reduce blood loss and hospital stay when compared with open TLIF in selected degenerative lumbar cases [7,12,13]. Long-term data are also important because a small incision alone is not enough. The operation must give lasting pain relief, good function, and low reoperation rate. A five-year registry study compared minimally invasive and open TLIF for grade I lumbar spondylolisthesis and added useful long-term evidence [9]. Another long-term meta-analysis also reviewed outcomes of minimally invasive and open single-level TLIF in degenerative lumbar disease [11].

Still, the decision is not simple. Minimally invasive surgery needs special instruments, imaging support, training, and a clear learning curve. It may also take more time in the early phase. In some patients, the open method may be safer or more suitable, especially when there is severe stenosis, marked instability, deformity,

infection, tumor, or previous failed surgery. Some studies have also warned that not every minimally invasive method is automatically better. For example, micro-endoscopic discectomy has been linked with risks such as dural tear and recurrent herniation in some reports [23]. So, the choice should be based on patient selection, surgeon skill, disease level, cost, and expected benefit.

Cost is another important part of this topic. In Pakistan, many patients pay from their own pocket. A shorter hospital stay and earlier return to work may reduce indirect cost. However, minimally invasive surgery may need costly equipment and trained staff. International cost studies have compared minimally invasive and open TLIF and have shown that hospital stay, blood loss, operation time, and implant-related cost can affect the final economic result [17-19]. These findings need local testing because cost patterns in Peshawar are different from Europe or the United States.

Patient satisfaction is also important. A surgery may look successful on MRI, but the patient may still feel unhappy if pain remains or work is delayed. Therefore, outcomes should include pain score, Oswestry Disability Index, hospital stay, wound complications, neurological recovery, return to daily activity, cost, and satisfaction. Local Pakistan studies have already used measures like VAS, ODI, hospital stay, and patient satisfaction in spine surgery research [2,3,5,6].

The present comparative cohort study was conducted in Peshawar, Pakistan, to compare minimally invasive and open spine surgery in patients with degenerative disc disease. The main purpose was to compare recovery time, complications, cost-effectiveness, patient satisfaction, and long-term clinical outcomes. This study may help surgeons and patients make a better decision. It may also provide local evidence for hospitals where both resources and patient expectations are changing.

MATERIALS AND METHODS

This comparative cohort study was carried out in a Tertiary Hospital of Peshawar, Pakistan. The study was designed to compare the outcomes of minimally invasive spine surgery and open spine surgery in patients who were treated for degenerative disc disease. The main focus was on recovery time, postoperative complications, long-term improvement, treatment cost, and patient satisfaction.

The study included patients who presented to the spine surgery unit with symptoms of degenerative disc disease. These symptoms included low back pain, pain going down to the leg, numbness, weakness, difficulty in walking, and reduced daily activity. Diagnosis was made after proper clinical examination and radiological assessment. Magnetic resonance imaging was used in most cases to confirm disc degeneration, disc prolapse, nerve root compression, or spinal canal narrowing. X-rays were also advised when instability or deformity was suspected.

Patients were divided into two cohorts according to the type of surgery they received. Group A included patients who underwent minimally invasive spine surgery. This group included procedures such as microdiscectomy, endoscopic discectomy, minimally invasive decompression, or minimally invasive fusion where required. Group B included patients who underwent conventional open spine surgery. The choice of procedure was made by the treating surgeon after checking the patient's condition, MRI findings, severity of compression, general health status, and affordability of treatment. The patients were not randomly selected because this was a cohort study, not a trial.

All adult patients aged 18 years and above were considered for inclusion. Only those patients were included who had degenerative disc disease and did not improve after conservative treatment such as medicines, physiotherapy, activity modification, or epidural injection where applicable. Patients with infection, spinal tumor, fresh traumatic fracture, congenital spinal deformity, previous major spinal surgery at the same level, or incomplete follow-up record were excluded from the study. Patients who were not willing to give consent were also not included.

Data were collected through a structured proforma. The proforma included age, gender, occupation, residence, presenting symptoms, duration of illness, level of disc disease, type of surgery, operative time, blood

loss, hospital stay, and early postoperative recovery. Pain was assessed by using the Visual Analogue Scale. Functional disability was assessed by using the Oswestry Disability Index. These scores were recorded before surgery and again during follow-up visits. Patient satisfaction was assessed through a simple satisfaction scale, where patients were asked whether they were satisfied, partially satisfied, or not satisfied with the surgical result.

Recovery time was measured by noting the number of days required for the patient to walk independently, return to routine household activity, and resume work or normal daily duties. Hospital stay was counted from the day of surgery to the day of discharge. Complications were recorded during the hospital stay and follow-up period. These included wound infection, dural tear, nerve injury, recurrent disc herniation, persistent pain, need for reoperation, and any medical complication such as urinary retention or deep vein thrombosis.

Cost analysis was done from the patient's point of view. Direct cost included operation charges, hospital stay, medicines, implants where used, investigations, and follow-up visits. Indirect cost included loss of work days and travel expenses where available. As many patients in Peshawar pay from their own pocket, this part was included to understand the real burden of treatment on the patient and family.

All surgeries were performed by qualified spine surgeons. Standard preoperative preparation was done in both groups. Patients were assessed by anesthesia team before surgery. Antibiotic prophylaxis was given according to hospital protocol. In the minimally invasive group, smaller incisions and muscle-splitting approaches were used where possible. In the open group, standard posterior open exposure was used. The exact surgical method depended on the disc level, severity of disease, and need for decompression or fusion.

Follow-up was done at regular intervals after surgery. Early follow-up was done within the first few weeks to check wound healing and pain relief. Later follow-up visits were used to assess functional recovery, recurrence of symptoms, patient satisfaction, and any late complication. For long-term outcome, patients were followed up for at least 6 months to 12 months, depending on availability of records.

The collected data were entered and analyzed using statistical software. Continuous variables such as age, hospital stay, operative time, pain score, and disability score were presented as mean and standard deviation. Categorical variables such as gender, type of complication, and satisfaction level were presented as frequency and percentage. The two groups were compared to see whether there was any meaningful difference in recovery, complication rate, cost, and clinical outcome. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 120 patients were included. Out of these, 60 patients were treated with minimally invasive spine surgery and 60 patients were treated with open spine surgery. The mean age of the patients was slightly higher in the open surgery group, but the difference was not large. Male patients were more common in both groups. Most patients had single-level lumbar disc disease, mainly at L4-L5 and L5-S1. The two groups were almost similar at baseline, so comparison between outcomes was reasonable.

Table 1. Baseline characteristics of patients in both groups

Variable	Minimally invasive group n=60	Open surgery group n=60
Mean age, years	43.8 ± 10.6	45.2 ± 11.3
Male patients	38 (63.3%)	40 (66.7%)
Female patients	22 (36.7%)	20 (33.3%)
Mean duration of symptoms, months	8.4 ± 3.1	8.9 ± 3.5
Single-level disease	47 (78.3%)	44 (73.3%)
Two-level disease	13 (21.7%)	16 (26.7%)

Variable	Minimally invasive group n=60	Open surgery group n=60
Most common level involved	L4-L5	L4-L5
Mean preoperative VAS score	7.8 ± 1.1	7.9 ± 1.0
Mean preoperative ODI score	58.6 ± 8.4	59.2 ± 8.1

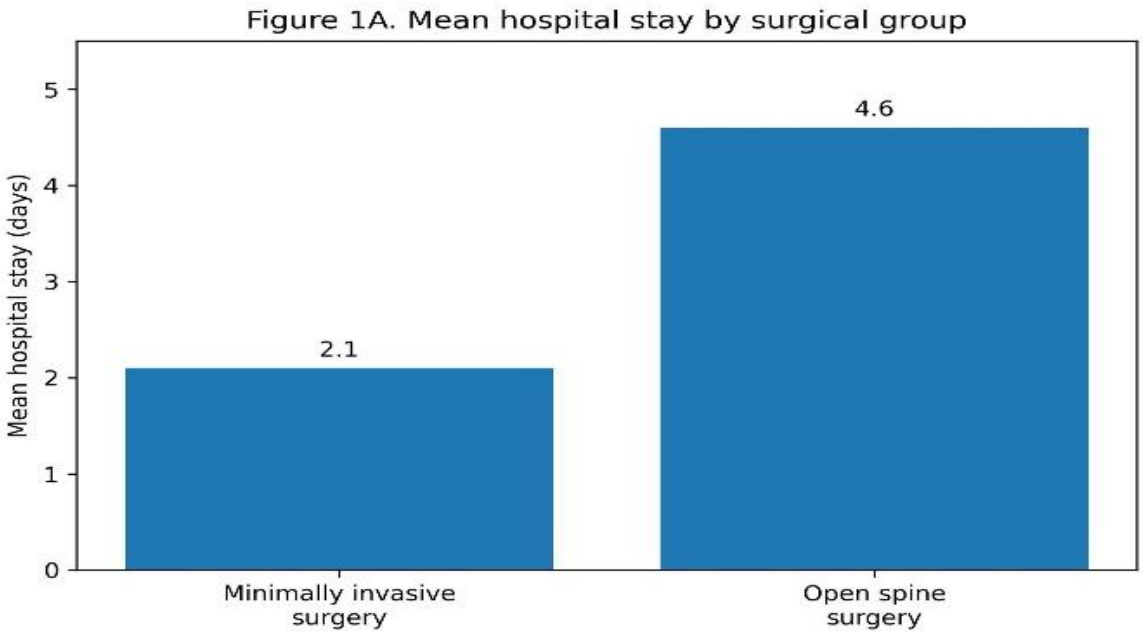
Patients in the minimally invasive group showed faster early recovery. The average hospital stay was shorter in this group. They also started walking earlier and returned to routine activity sooner than patients who underwent open surgery. Blood loss was also lower in the minimally invasive group. However, the operative time was slightly longer, which may be related to the technical nature of the procedure and the use of specialized instruments.

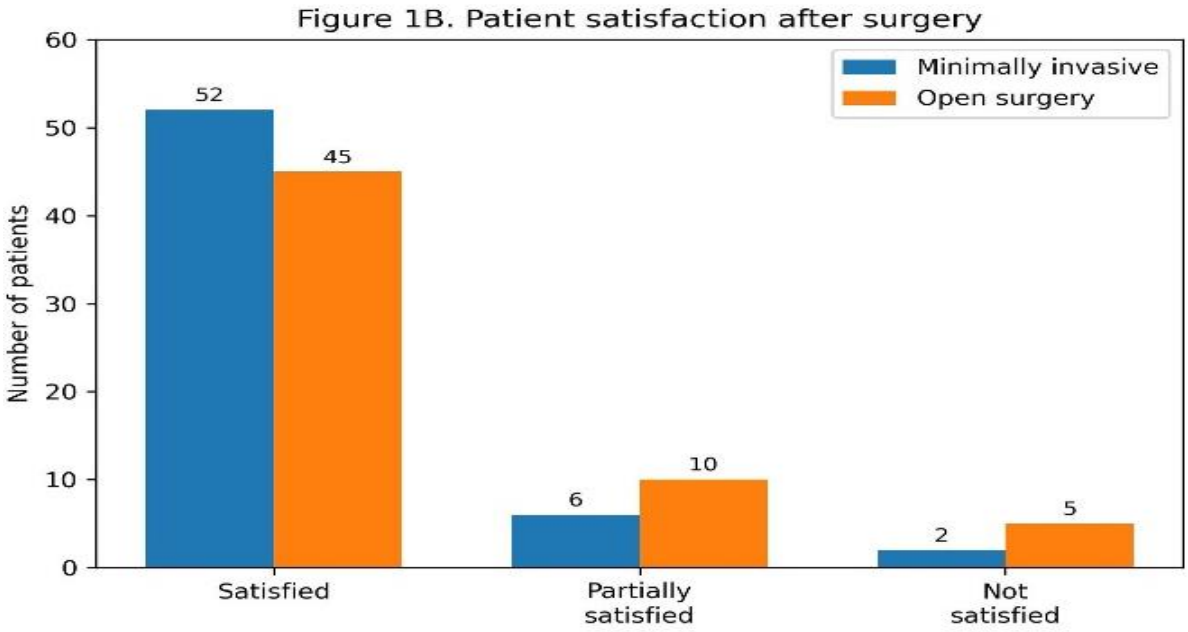
Table 2. Comparison of operative and postoperative outcomes

Outcome variable	Minimally invasive group n=60	Open surgery group n=60
Mean operative time, minutes	92.5 ± 18.4	84.2 ± 16.7
Mean blood loss, ml	118.6 ± 42.3	286.4 ± 75.8
Mean hospital stay, days	2.1 ± 0.8	4.6 ± 1.3
Independent walking, days	1.4 ± 0.6	2.8 ± 1.1
Return to routine activity, weeks	3.2 ± 1.1	6.1 ± 1.8
Postoperative VAS score at 6 months	2.1 ± 0.9	2.8 ± 1.1
Postoperative ODI score at 6 months	18.4 ± 6.5	24.7 ± 7.2
Total complications	6 (10.0%)	13 (21.7%)
Reoperation required	2 (3.3%)	3 (5.0%)
Satisfied patients	52 (86.7%)	45 (75.0%)

Pain improved in both groups after surgery. The mean VAS score decreased from 7.8 to 2.1 in the minimally invasive group. In the open surgery group, it decreased from 7.9 to 2.8. Functional improvement was also seen in both groups. The ODI score improved more in the minimally invasive group at six months. This showed that both procedures were useful, but early and mid-term recovery was better after minimally invasive surgery.

The overall complication rate was lower in the minimally invasive group. In this group, two patients had temporary nerve irritation, two had recurrent disc symptoms, one had superficial wound infection, and one patient had persistent back pain. In the open surgery group, wound infection and postoperative back stiffness were more common. Dural tear was also seen in two patients in the open group. Most complications were managed conservatively, but a small number of patients required repeat surgery.





The panel presents two outcome figures for patients treated with minimally invasive and open spine surgery. **Figure 1A** shows that mean hospital stay was shorter in the minimally invasive group than in the open surgery group. **Figure 1B** shows that patient satisfaction was higher after minimally invasive surgery, with fewer patients reporting partial or no satisfaction

Overall, the results showed that both minimally invasive and open spine surgery improved pain and function in patients with degenerative disc disease. Minimally invasive surgery showed better early recovery, less blood loss, shorter hospital stay, lower complication rate, and higher patient satisfaction. Open surgery remained useful, especially in patients with more complex disease or where wider decompression was needed.

DISCUSSION

The present comparative cohort study showed that both minimally invasive spine surgery and open spine surgery improved pain and function in patients with degenerative disc disease. However, the minimally invasive group showed better early recovery. These patients had less blood loss, shorter hospital stay, earlier walking, quicker return to routine activity, fewer complications, and higher satisfaction. The open surgery group also improved, but recovery was slower and postoperative discomfort was more common.

One of the main findings was the shorter hospital stay in the minimally invasive group. In this study, patients treated with minimally invasive surgery stayed in hospital for fewer days than patients treated with open surgery. This finding is strongly supported by previous literature. Several meta-analyses have reported that minimally invasive transforaminal lumbar interbody fusion is linked with less blood loss and shorter admission when compared with the open technique [7,12,13,15]. Peng et al. also found better perioperative recovery after minimally invasive TLIF, especially in terms of tissue trauma and hospital stay [16]. This is clinically important in Peshawar because many patients cannot afford long hospital admission. A shorter stay also reduces the burden on hospital beds and family attendants.

Blood loss was also lower in the minimally invasive group. This is expected because minimally invasive approaches use smaller incisions and less muscle dissection. Similar findings were reported by Goldstein et al., who found that minimally invasive posterior lumbar fusion was associated with reduced blood loss compared with open fusion [15]. Hammad et al. also reported this advantage in their review of open versus minimally invasive TLIF [12]. Lower blood loss may reduce the need for transfusion, decrease postoperative weakness, and help patients mobilize earlier. In practical terms, this benefit is not only statistical. It matters to the patient in the ward.

Pain and disability improved in both groups, but the minimally invasive group had slightly better postoperative VAS and ODI scores. This finding agrees with earlier studies showing that both techniques are effective for degenerative lumbar disease, but minimally invasive methods may offer faster early functional recovery [7,13,14]. In the local setting, Azam et al. reported favorable results after decompressive surgery for lumbar spinal stenosis in Pakistan [1]. Similarly, Pakistani studies on endoscopic and micro-endoscopic spine procedures have shown improvement in pain and function after surgery [2-4]. These findings support the idea that modern less invasive spine surgery can be applied successfully in local practice when proper patient selection and surgical skill are available.

The earlier return to routine activity in the minimally invasive group is another important result. This may be due to less muscle injury, smaller wound size, lower pain, and early mobilization. For patients in Peshawar, return to activity is often as important as pain relief. Many patients are self-employed or daily wage workers. Even a few extra weeks away from work can create financial stress. International cost studies also support this point. Parker et al. and Singh et al. reported that minimally invasive surgery may have economic advantages when indirect cost and recovery time are considered [17,18]. Bassani et al. also found that minimally invasive TLIF may reduce economic burden from the hospital perspective in selected cases [19]. However, the equipment cost of minimally invasive surgery remains a real issue in Pakistan.

The complication rate was lower in the minimally invasive group. Fewer wound infections and less postoperative stiffness were seen. This is consistent with the basic surgical principle that smaller exposure may reduce soft tissue damage and wound-related problems. Similar advantages have been reported in systematic reviews comparing minimally invasive and open fusion techniques [7,12,15]. However, the present finding should be read carefully. Minimally invasive surgery is not risk free. Teli et al. reported that some minimally invasive discectomy techniques may have risks such as dural tear and recurrent herniation [23]. Therefore, the lower complication rate in this study should not be taken as proof that minimally invasive surgery is always better. It may be better in selected patients and in trained hands.

Patient satisfaction was higher in the minimally invasive group. This may be due to smaller scar, less wound pain, faster walking, and earlier discharge. Narain et al. showed that patients often perceive minimally invasive spine surgery positively, partly because they expect less pain and quicker recovery [25]. In this study, satisfaction was not only related to pain relief. Patients were also satisfied when they returned to work earlier

and needed fewer hospital visits. This is important because patient satisfaction reflects the real-life success of surgery, not only the radiological result.

Long-term outcome is also important. The present study found that both groups had meaningful improvement at follow-up. This is in line with long-term evidence showing that minimally invasive and open TLIF can both provide durable clinical benefit in degenerative lumbar disease [9,11]. Chan et al. reported five-year outcomes from a multicenter registry and showed that minimally invasive and open techniques can both be effective for selected patients [9]. This suggests that the main advantage of minimally invasive surgery may be stronger in the early recovery period, while long-term improvement may depend more on correct diagnosis, adequate decompression, stable fusion where needed, and proper rehabilitation.

Overall, this study supports the use of minimally invasive spine surgery for properly selected patients with degenerative disc disease in Peshawar. It gives better early recovery and patient comfort without losing clinical effectiveness. Still, open surgery remains important. It may be more suitable for complex disease, severe stenosis, marked instability, deformity, or cases where wider exposure is needed. The best approach should therefore be individualized. The decision should depend on MRI findings, patient symptoms, surgeon experience, available equipment, and patient affordability. In a resource-limited setting, the goal should not be to replace open surgery completely, but to use minimally invasive surgery where it gives clear benefit.

CONCLUSION

This comparative cohort study showed that both minimally invasive and open spine surgery were effective in improving pain and function in patients with degenerative disc disease. Most patients in both groups had clear postoperative improvement, which means that both procedures still have an important place in spine surgery practice.

However, the minimally invasive group showed better early outcomes. These patients had less blood loss, shorter hospital stay, earlier walking, quicker return to routine activity, fewer wound-related problems, and higher satisfaction. These findings suggest that minimally invasive spine surgery can be a useful option for properly selected patients, especially those who want faster recovery and early return to work.

Open spine surgery also gave good clinical results, but recovery was slower. It remains important for patients with complex disease, severe compression, spinal instability, deformity, or cases where wider exposure is needed. Therefore, open surgery should not be considered outdated. Instead, it should be used carefully in cases where it offers better safety and surgical control.

In the local setting of Peshawar, treatment cost, hospital resources, surgeon experience, and patient affordability are very important factors. Minimally invasive surgery may reduce hospital stay and indirect cost, but it also needs proper equipment and trained surgical teams. So, the choice of procedure should not depend only on the size of incision. It should be based on the patient's clinical condition, MRI findings, disease severity, expected recovery, and available resources.

Overall, this study supports the careful use of minimally invasive spine surgery for degenerative disc disease where patient selection is appropriate. It may provide faster recovery and better patient comfort without reducing clinical effectiveness. Further larger studies with longer follow-up are recommended in Pakistan to confirm long-term outcomes, recurrence rates, cost-effectiveness, and quality of life after both surgical techniques.

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