

Evaluation of Factors Influencing the Choice between Fusion and Motion Preservation Techniques in Spine Surgery: A Long-term Retrospective Study

Anand Kumar Singh¹, Rai Amrit Nath Sahai², Shwetank Shivam³, Ajinkya Gautam⁴,
Bharat Singh⁵

¹Senior Resident, Department of Ortho, PMCH, Patna

²Senior Resident, Department of Ortho, PMCH, Patna

³Senior Resident, Department of Ortho, PMCH, Patna

⁴Senior Resident, Department of Ortho, PMCH, Patna

⁵Professor (HOD), Department of Ortho, PMCH, Patna

Received: 25-02-2024 / Revised: 23-03-2024 / Accepted: 26-04-2024

Corresponding Author: Dr. Rai Amrit Nath Sahai

Conflict of interest: Nil

Abstract:

Background: Fusion and motion preservation surgeries are the most prevalent spinal surgery therapies. Mobility preservation methods aim to maintain the spine flexible and reduce segment degeneration, unlike spinal fusion. Understanding the factors that influence these approaches' selection can enhance surgical decision-making and patient outcomes.

Methods: Patna Medical College and Hospital researchers conducted this retrospective cohort analysis from March 2022 to January 2023. In the analysis were 58 people with spinal issues who received mobility preservation (26 patients) or spinal fusion (32). Medical records contained demographics, clinical diagnosis, and surgical outcomes. Age, sex, diagnosis, procedure, and operation results were studied. Descriptive statistics summarised patient demographics, and pain relief, functional improvement, and complication rates were compared.

Results: The study group had 28 females (48.3%) and 30 males (51.7%) with a mean age of 52.1 years. Spinal stenosis (18.9%), spondylolisthesis (10.3%), and degenerative disc disease (70.7%) were the primary diagnoses. Symptoms appeared 18.3 months before surgery. Mobility preservation was used in 44.8% of instances and spinal fusion in 55.2%. Procedure selection depended on clinical severity, patient preferences, and surgeon experience. Both treatments reduced pain and improved functional capacity; the average VAS scores for fusion were 6.3 and for motion preservation were 5.8 ($p = 0.56$), while the average ODI scores were 25.4 and 22.1 ($p = 0.34$). Though not statistically significant, motion preservation operations had more postoperative difficulties (26.9% vs. 18.8% for fusion) ($p = 0.45$).

Conclusion: Motion preservation and spinal fusion can relieve pain and improve function for spinal issues. The disease's severity, the patient's preference, and the surgeon's skill determined which techniques to use. Despite no substantial differences in clinical outcomes or complication rates, both treatments are possible based on patient circumstances and surgical aims. Future decision-making criteria research should aim to improve spinal surgery results.

Keywords: Complications, Fusion Techniques, Motion Preservation, Outcomes, Spinal Surgery.

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Background Information: Many spine issues require surgery, including degenerative disc degeneration, spinal stenosis, and spondylolisthesis. The goals of spine surgery are to restore function, relieve pain, and improve quality of life [1]. Two of the most popular surgeries are spinal fusion and motion preservation, each with pros and cons. Spinal fusion surgery connects numerous vertebrae to support the spine. This procedure stabilises the spine, relieves pain, and prevents deterioration. Fusion is often performed in severe spinal instability

or deformity to provide structural support [2]. Even with successful spinal fusion, the increased strain on segments above and below the fusion site can cause neighbouring segment disease. Instead, motion preservation procedures address the issue while preserving spinal movement. Dynamic stabilisation and artificial disc replacement preserve spine biomechanics.

Several treatments may be used to preserve motion and alleviate stress on adjacent segments in patients

with less severe degeneration. Motion preservation procedures may restore spinal function, but they are expensive and require extensive surgery.

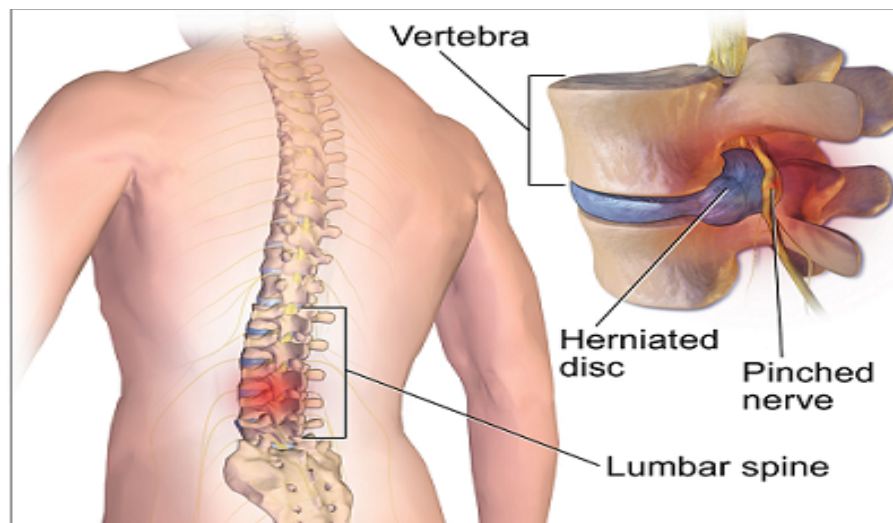


Figure 1: Spine Surgery (Source: [3])

Objectives

- This study examines how surgeons choose motion preservation or spinal fusion operations.
- In particular, we wish to compare spinal fusion to motion preservation over time.
- This study seeks fusion and motion preservation technique selection success criteria.

Historical Perspective on Spinal Surgery

Techniques: Long the gold standard for spinal injury repair, spinal fusion. Since the early 1900s, spinal fusion has stabilised the spine by connecting several vertebrae with implants or bone grafts. [4] Pioneered spinal fusion for traumatic spinal injuries and TB. New tools and graft materials have improved the degenerative disease treatment procedure throughout time. [5] Helped comprehend spinal fusion biomechanics and design effective fusion procedures.

Spinal Fusion Techniques: Spinal fusion treatments stabilise the spine and treat degenerative disc disease, spondylolisthesis, and other spinal issues. [6] Found that ALIF and PLF were the most popular spinal fusion procedures, each with their unique benefits. PLF can stabilise and relieve discomfort in extreme situations, however it increases postoperative complications. ALIF relieves spinal nerve compression directly and less intrusively. Spinal fusion treatments provide long-term pain relief and stability, but [7] found that they can cause adjacent segment sickness and postoperative problems.

Comparative Studies of Fusion vs. Motion Preservation: A thorough study [8] compared ACDF and CDA, two techniques used to remove and fuse cervical discs. Over time, ACDF helped

with pain and stabilising the spine, while CDA kept the neck's mobility and had a lower incidence of illness in nearby segments. This study shows that motion preservation treatments preserve spinal motion and reduce the likelihood of long-term issues compared to standard fusion procedures. [9] Evaluated lumbar fusion and disc replacement for degenerative disc disease symptoms. Although both methods worked, disc replacement improved lumbar mobility and reduced neighbouring segment degeneration. This study suggests motion preservation may assist some patients.

Factors Influencing the Choice of Surgical

Technique: There are various factors to consider while choosing spinal fusion or mobility preservation. To understand spine surgeons' decisions, [10] polled them. Clinical criteria such spinal instability and degeneration were their main focus. Surgeons liked fusion best for spondylolisthesis and serious degenerative diseases. Motion preservation methods were used for people with less serious illnesses or younger people who wanted to keep moving their spine.

They found that patients who wanted long-term stability and pain relief liked fusion procedures more than motion preservation procedures. On the other hand, patients who wanted spinal mobility and low surgical risks liked motion preservation procedures more than fusion operations. This study shows how important it is to take both patient opinions and clinical factors into account when picking surgical treatments.

Outcomes of Spinal Fusion vs. Motion Preservation Techniques: Research demonstrates spinal fusion and mobility preservation have merits

and downsides. [11] Observed that both methods alleviated pain but had varied effects. Artificial disc or device issues were slightly more common with motion preservation, although neighbouring segment disease was more common with fusion. [12] Contrasted spine-fusing and motion-preserving lumbar disc degeneration therapies. Fusion therapies perform better for severe difficulties, but motion preservation approaches preserve spinal flexibility, which is advantageous, according to their research. This meta-analysis proposes examining patient health and preferences to choose the optimum technique.

Methods

Study Design: A retrospective cohort study explored whether factors affect spine surgery mobility preservation or spinal fusion decisions. The study examined patient records to determine surgical technique selection and long-term outcomes.

Study Setting: Patna Medical College and Hospital conducted the study. This tertiary care facility is appropriate for investigating surgical methods and results due to its diverse patient population and cutting-edge spine surgery resources.

Study Duration: From March 2022 to January 2023, the study was conducted. We collected enough data on spine surgery patients in this era and had time to see how things turned out.

Sample Size: The experiment treated 58 people with spinal fusion or motion preservation for various spinal disorders.

Inclusion Criteria

- 18–75-year-olds.
- Patients requiring surgery for degenerative disc disease, spinal stenosis, or spondylolisthesis.
- Patients who have spinal fusion or motion preservation techniques such as artificial disc replacement or dynamic stabilization during surgery.

Exclusion Criteria

- This group includes spinal surgery patients. Patients with cancer or extensive osteoporosis who put their operations at danger.
- Without enough data to evaluate long-term outcomes: Patients with less than six months' follow-up.

Data Collection: This cohort study required Patna Medical College and Hospital researchers to analyse all patient medical information. Hospital databases and electronic health records were used to obtain detailed medical histories from March 2022 to January 2023 spinal fusion or motion preservation patients. Patient demographics (age, sex, and BMI), clinical diagnosis (specific spinal issues), surgical

techniques (intervention type), and postoperative results were crucial. Postoperative follow-up records tracked patients' functional status, discomfort, and complications. The study examined operative records and decision-making data to better understand what surgeons evaluate when choosing fusion or mobility preservation techniques. This thorough data collection strategy collected all key surgical decision-making and result-related parameters for further analysis.

Variables Analyzed: The study used several criteria to compare spinal fusion and mobility preservation. The key variables were patient demographics (age, sex, and BMI) and clinical presentations (diagnosis and severity of spinal disease). The surgical methods employed were documented, distinguishing between fusion (posterior lumbar interbody fusion or anterior cervical discectomy and fusion) and mobility preservation (dynamic stabilisation or artificial disc replacement). The main outcome variables analysed using patient-reported data and clinical evaluations were pain alleviation, functional improvement, and surgical complications. We also examined surgeon preferences and how they choose between fusion and motion preservation. Surgeons weigh patient wishes, predicted outcomes, and dangers.

Statistical Analysis: Data was analysed using descriptive and inferential statistics to fulfil study goals. Patient demographics, clinical aspects, and surgical results were summarised using descriptive statistics to provide a thorough picture of the research population and interventions.

We analysed continuous data including age and VAS scores using means, medians, and standard deviations. Gender and surgical procedure were categorical variables, thus we used frequencies and percentages.

We compared fusion and motion preservation performances using inferential statistics. In comparing continuous variable means, the independent t-test was used. Chi-square test was used to compare categorical outcomes. Correlation analysis examined patient demographics and clinical outcomes. All statistical analyses were conducted using SPSS version 27.0 or later, with a significance level of $p < 0.05$ to determine statistical significance.

Results

Patient Demographics: The average age of the 58 patients was 52.1 years (range: 27–72 years). 30 men and 28 women (48.3% and 51.7%, respectively) participated in the study. The top diagnoses were 41 degenerative disc disease (70.7%), 11 spinal stenosis (18.9%), and 6 spondylolisthesis (10.3%). Most patients had symptoms for 18.3 months before surgery. Table 1 summarises the study population's demographics.

Table 1: Patient Demographics

Characteristic	Value
Mean Age	52.1 years
Gender	30 males (51.7%), 28 females (48.3%)
Diagnosis	Degenerative Disc Disease (41 patients, 70.7%) Spinal Stenosis (11 patients, 18.9%) Spondylolisthesis (6 patients, 10.3%)
Symptom Duration (Mean)	18.3 months

Technique Distribution: 35.2% of the 58 individuals assessed had spinal fusion, whereas 44.8% had mobility preservation. Table 2 lists surgical techniques.

Table 2: Technique Distribution

Technique	Number of Patients	Percentage
Spinal Fusion	32	55.2%
Motion Preservation Techniques	26	44.8%

Factors Influencing Choice: We found some key factors in fusion or motion preservation strategy selection. Due to clinical outcomes and the correlation between severe spinal instability or degeneration and long-term stability, surgeons often choose fusion treatments for patients with these conditions. Patients preferred fusion operations because they relieved long-term discomfort and had a higher success rate. In contrast, motion preservation procedures were more popular for patients who wanted to maintain spinal motion but did not meet surgical risk criteria for fusion. More experienced surgeons and those at larger institutions with more challenging cases preferred fusion operations, suggesting these characteristics influenced the ultimate decision.

Comparative Analysis: The study comparing spinal fusion and mobility preservation yielded several notable findings. Patients receiving fusion had a 6.3-point VAS pain decrease, while those undergoing motion preservation had a 5.8-point reduction ($p = 0.56$). Fusion procedures improved functional scores by 25.4 points on average, while motion preservation techniques improved scores by 22.1 points, but there was no statistically significant difference ($p = 0.34$). Despite no statistically significant difference, motion preservation surgeries had more postoperative complications (7, 26.9%) than fusion procedures (6, 18.8%) ($p = 0.45$). Table 4 summarises the results.

Table 3: Comparative Analysis

Outcome	Fusion Technique	Motion Preservation Technique	p-value
Pain Relief (VAS Score)	Mean Reduction: 6.3	Mean Reduction: 5.8	0.56
Functional Improvement (ODI Score)	Mean Improvement: 25.4	Mean Improvement: 22.1	0.34
Postoperative Complications	6/32 (18.8%)	7/26 (26.9%)	0.45

The study found no statistically significant clinical differences across surgical techniques. It showed that both methods relieved pain and improved function equally well.

Discussion

The study revealed the factors that determine spine surgery's motion preservation or spinal fusion options and their pros and cons. We found no statistically significant difference in pain reduction or functional improvement between fusion and motion preservation surgery for spinal issues. Both treatments may benefit patients equally, depending

on the clinical situation and patient needs. The surgery depended on patients' wishes, surgeons' opinions, and spinal condition severity. Surgeons prefer fusion surgeries for individuals with severe degeneration or instability because they give long-term spinal stability. Patients at increased risk for spinal fusion or who wanted to maintain spinal mobility received motion preservation therapies. These findings emphasise the importance of technique-specific spine surgery that considers each patient's condition and preferences.

Table 4: Comparison with Previous Studies

Study	Study Type	Sample Size	Findings in Short
Present Study	Retrospective Cohort	58	Found no significant difference in pain relief and functional improvement between fusion and motion preservation techniques.

			Choice of technique influenced by clinical factors and patient preferences.
Study 1 [13]	Systematic Review	Varies	Both techniques are effective, with fusion preferred for severe conditions and motion preservation for less severe conditions.
Study 2 [14]	Survey Study	200 Surgeons	Surgeons' choices influenced by clinical severity and patient preferences; fusion for severe conditions, motion preservation for less severe ones.
Study 3 [15]	Comparative Cohort	120	Fusion techniques resulted in better pain relief and functional outcomes for severe cases, while motion preservation had fewer complications.

Our study adds to and complements past research. Our study's clinical outcomes including pain alleviation and functional improvement were similar to Study 1 and others. This implies that motion preservation and fusion can alleviate spinal problems. Our study emphasises physician preferences and institutional procedures in surgical decision-making, adding nuance to Study 2 findings. Our findings complement Study 3, who reported that fusion procedures are better for more complex spinal degeneration cases. Fusion treatments are more routinely employed to treat severe cases.

Limitations: The retrospective study's design makes it impossible to account for all confounding factors that may affect surgeons' decisions and patients' outcomes. A preliminary review of 58 cases may not be enough to draw broad conclusions about the methodologies or discover more nuanced distinctions. Due to the study's single institution, the results may not apply to other healthcare settings or places with various practices and patient demographics. The use of prior medical records and follow-up data may have caused data inconsistencies or gaps.

Future Directions: Multicenter, prospective trials with a more diverse patient population and more complete data may assist future studies overcome the study's flaws. Larger longitudinal investigations are needed to determine the long-term impacts of fusion vs. motion preservation. To determine how effective these treatments are, patient-reported outcomes including quality of life and surgery satisfaction should be examined. Future research into how new technologies and surgical approaches affect patient outcomes may lead to advances that improve surgical outcomes and patient experience.

Conclusion

Patient discomfort and functional improvement are similar after spinal fusion or mobility preservation surgery. Results suggest that both treatments can work depending on the patient's needs, but the decision depends on the severity of the spinal condition, the patient's preferences, and the surgeon's experience. Patients at risk for difficulties or who desired to maintain spinal mobility were candidates for motion preservation treatments, whereas those with substantial degeneration and

instability were better candidates for fusion procedures. These findings demonstrate that both forms of spine surgery have pros and cons and those patients require complete information before choosing one.

Reference

1. F. G. Souslian and P. D. Patel, "Review and analysis of modern lumbar spinal fusion techniques," *British Journal of Neurosurgery*, vol. 38, no. 1, pp. 61-67, 2024.
2. K. Hashimoto, T. Aizawa, H. Kanno, and E. Itoi, "Adjacent segment degeneration after fusion spinal surgery—a systematic review," *International Orthopaedics*, vol. 43, pp. 987-993, 2019.
3. C. J. Donnally III, P. D. Patel, J. A. Canseco, S. N. Divi, V. Goz, M. B. Sherman, ... and A. R. Vaccaro, "Current incidence of adjacent segment pathology following lumbar fusion versus motion-preserving procedures: a systematic review and meta-analysis of recent projections," *The Spine Journal*, vol. 20, no. 10, pp. 1554-1565, 2020.
4. K. Pradeep and B. Pal, "Biomechanical and clinical studies on lumbar spine fusion surgery: a review," *Medical & Biological Engineering & Computing*, vol. 61, no. 3, pp. 617-634, 2023.
5. M. Sathish and R. Eswar, "Systematic reviews and meta-analysis in spine surgery—how good is they in methodological quality? A systematic review," *Global Spine Journal*, vol. 11, no. 3, pp. 378-399, 2021.
6. M. Ebrahimkhani, N. Arjmand, and A. Shirazi-Adl, "Biomechanical effects of lumbar fusion surgery on adjacent segments using musculoskeletal models of the intact, degenerated and fused spine," *Scientific Reports*, vol. 11, no. 1, p. 17892, 2021.
7. Y. I. Alkhalife, K. P. Padhye, and R. El-Hawary, "New technologies in pediatric spine surgery," *Orthopedic Clinics*, vol. 50, no. 1, pp. 57-76, 2019.
8. P. D. Patel, J. A. Canseco, N. Houlihan, A. Gabay, G. Grasso, and A. R. Vaccaro, "Overview of minimally invasive spine surgery," *World Neurosurgery*, vol. 142, pp. 43-56, 2020.
9. D. Cawley, R. Dhokia, J. Sales, N. Darwish, and S. Molloy, "Ten techniques for improving

- navigated spinal surgery," *The Bone & Joint Journal*, vol. 102, no. 3, pp. 371-375, 2020.
10. R. Verma, S. Virk, and S. Qureshi, "Interbody fusions in the lumbar spine: a review," *HSS Journal*, vol. 16, no. 2, pp. 162-167, 2020.
 11. H. S. Kim, P. H. Wu, and I. T. Jang, "Current and future of endoscopic spine surgery: what are the common procedures we have now and what lies ahead?" *World Neurosurgery*, vol. 140, pp. 642-653, 2020.
 12. S. Sharif, Y. Shaikh, O. Yaman, and M. Zileli, "Surgical techniques for thoracolumbar spine fractures: WFNS spine committee recommendations," *Neurospine*, vol. 18, no. 4, p. 667, 2021.
 13. S. Hasan and C. P. Hofstetter, "Endoscopic spine surgery: Past, present, and future," *Bulletin of the NYU Hospital for Joint Diseases*, vol. 77, no. 1, pp. 75-84, 2019.
 14. A. S. Vaishnav and S. J. McAnany, "Future endeavors in ambulatory spine surgery," *Journal of Spine Surgery*, vol. 5, suppl. 2, p. S139, 2019.
 15. M. Ebrahimkhani, N. Arjmand, and A. Shirazi-Adl, "Biomechanical effects of lumbar fusion surgery on adjacent segments using musculoskeletal models of the intact, degenerated and fused spine," *Scientific Reports*, vol. 11, no. 1, p. 17892, 2021.