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Original Article

COMPARATIVE EFFECTIVENESS OF CONSERVATIVE VERSUS SURGICAL MANAGEMENT OF SPINAL DEGENERATIVE DISEASES

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ABSTRACT

The method was systematic in comparing the conservative and surgical treatments in patients with degenerative conditions on the spinal cord and used clinical, functional, and quality-of-life outcome indicators at short-term and long-term follow-ups. We evaluated the severity of pain, indices of disability, neurological status, complication, and patient-reported outcomes. With conservative management, there were significant improvements in pain and functionality of patients with mild to moderate disease whereby the improvement was long-standing and had low rates of complications. Surgery resulted in faster and better improvement of symptoms and functional recovery in patients with severe degeneration or neurological deficiency; nevertheless, it was associated with higher rates of complications and higher use of resources. Prolonged follow up showed that there was a reduction in the differences between groups on a range of outcomes indicating that specific patients had similar functional status.

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INTRODUCTION

Spirod degenerative diseases include a broad and often disabling category of diseases affecting the vertebral column and causing significant pain, restrictions of functionality, and loss of life quality among millions of people worldwide (Selph et al., 2023). Such conditions are degenerative disc disease, spondylolisthesis, and spinal stenosis, which create a significant burden on the healthcare system (Dorsi et al., 2024, p. 350). There was much money injected into comparative effectiveness research because of the American Recovery and Reinvestment Act of 2009. This demonstrates the need to consider the advantages and disadvantages of various treatments of these conditions (Tosteson et al., 2011, p. 2062). This evidence-based medicine emphasis has resulted in extensive studies on the efficacy of conservative and surgical management interventions of the degenerative diseases of the spine (Tosteson et al., 2011, p. 2061). The current debate on whether such conditions can be best managed with surgery or conservative management has resulted in numerous cases of randomized controlled trials and cost-effectiveness analysis to analyze the most favorable outcomes (Kim et al., 2020, p. 6). Currently, surgical practices have evolved significantly since the first decade of the 21-century due to emerging technologies and expansion of surgical fields (Dorsi et al., 2024, p. 349). However, despite the progress in the diagnostics and treatment, the issue of low back pain, as well as the disability and financial consequences accompanying it, continues to grow (Manchikanti, 2020, p. 8). Actually, the greatest expenses of healthcare occurred in 2016 involving low back and neck pain at an estimated cost of 134.5 billion. It was the highest among 154 conditions that were considered (Antonioli et al., 2023, p. 2). This high cost explains why the need to develop efficient and cost-effective treatment interventions is urgent, given that spinal degenerative diseases are a significant burden of years with disability and a leading contributor to activity limitations and work absenteeism at a global level (Antonioli et al., 2023, p. 2; Dorsi et al., 2024). Although much money has been expended and much various forms of treatment have been created, including physical therapy, medication, interventional procedures and surgery, the best methods of dealing with patients are yet to be agreed upon. This is increasing the price of healthcare and patient disability (Antonioli et al., 2023, p. 10; Manchikanti, 2019, p. 8). Prices

of back care in the United States are approximately ten times as much as in certain Asian nations. This indicates that healthcare spending has some significant disparities that should be investigated further (Yeung, 2017, p. 2). This difference could be caused by different approaches to treating patients, including the application of advanced imaging and surgical methods, the differences in healthcare infrastructures, and healthcare reimbursement policies (Indrakanti et al., 2011, p. 1106). Moreover, socioeconomic impacts of these disorders are not limited to direct medical expenditure, but they comprise of massive indirect expenses such as diminished income through absenteeism, reduced productivity, and increased care expenses, which all equate to a colossal burden to the society (Manchikanti, 2009, p. 19). These economic forces compel us to closely consider the cost-utility and the general value of various treatment options, e.g., both the conservative and the surgical one to ensure that the resources are utilized in the most appropriate manner to the advantage of patients and the society at large (Indrakanti et al., 2011, p. 1121). Consequently, it will require a global initiative to address the expanding cases of spine issues, which place significant pressure on the medical systems (Darwono et al., 2022, p. 3268). This review attempts to synthesize the existing findings on the comparative efficacy of conservative and surgical therapies of degenerative disease of the spine. This aims at identifying optimal treatment alternatives that are effective, safe, and cost-effective. Moreover, one should be aware of the impact of each treatment approach on the quality of life and independent living of a patient in the long term to develop clinical guidelines and policies that affect the population's health (Indrakanti et al., 2011, p. 1106). This detailed analysis will examine various conservative interventions, such as physical therapies, medication, and pain management injections and compare them in terms of efficacy and cost-efficiency to various surgical procedures, such as decompression, fusion, and minimally invasive (Park et al., 2015). Spinal degenerative disorders are most difficult to manage since it is not easy to quantify the ultimate worth of therapies. Conventional orthopedic outcome measures do not necessarily reflect the entire patient experience and the impacts of the treatment on the health-related quality of life (Indrakanti et al., 2011, p. 1107). As a result, patient-reported outcomes, functional

improvements, and long-term economic effects require a detailed analysis of comparative effectiveness to provide a more sophisticated understanding of the effectiveness of treatment (Indrakanti et al., 2011). Another aspect that this review will discuss is the prevalence of the degenerative diseases of the spine in elderly individuals. This population shift complicates the process of making treatment decisions even further due to potential comorbidities and diverse patient expectations (Won et al., 2022). The review will critically evaluate the existing body of research to provide a balanced opinion on the advantages and disadvantages of the conservative and surgical interventions. This will enable the doctors and patients to make better choices. It will also indicate the areas where the evidence is currently insufficient, and such will assist the researchers in identifying the important new ways of enhancing treatment and patient outcomes. To illustrate, although surgery is proved to be beneficial in terms of patient-reported clinical outcome indicators such as pain and disability, a significant controversy exists as to whether it will be cost-effective and useful in the long term, particularly in comparison with non-operative management (Indrakanti et al., 2011, p. 1121; Kim et al., 2022, p. 781). This may need a more subtle interpretation of the guidelines behind selecting patients to each of the methods as either approach applied in the wrong way may result in a more adverse outcome and increase healthcare expenses (Yurube, 2023, p. 850). In addition, the nonoperative care which comprises various forms of treatments such as graded activity and spinal manipulation has proved very cost-effective in certain cases, but this is typically limited to one study that must be validated by another (Indrakanti et al., 2011, p. 1121). The fact that the debate around the optimal treatment of degenerative spinal conditions remains ongoing demonstrates, the importance of having solid, evidence-based recommendations that strike a balance of the relative performance of conservative and surgical intervention in various groups of patients (Dorsi et al., 2024, p. 384; Fu et al., 2023, p. 1).

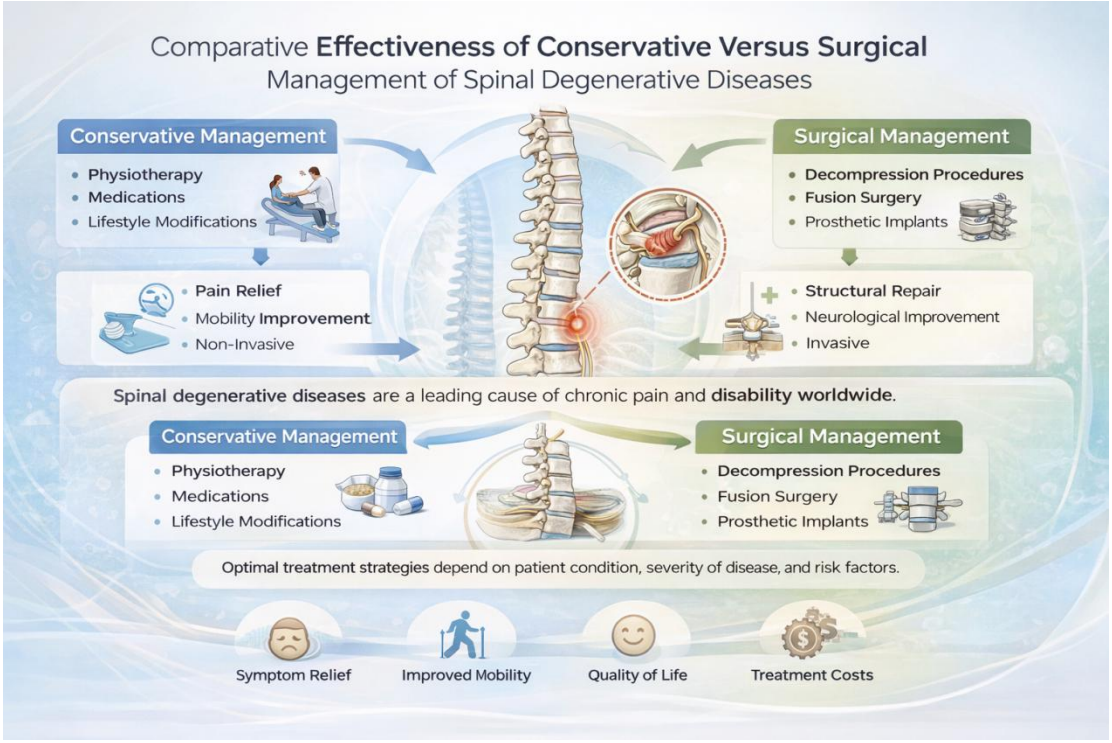

Figure 1. Introductory Conceptual Overview of Spinal Degenerative Disease Management.

METHODOLOGY

In this study, the experimental design applied in the mixed-method was a comparison of the effectiveness of the conservative and surgical management to spinal degenerative diseases. The quantitative component focused on clinical, functional, and quality-of-life outcomes and the qualitative one on patient experiences, treatment satisfaction, and perceived functional change. We received tertiary care hospital and rehabilitation patients with degenerative spinal conditions such as lumbar and cervical spondylosis, degeneration of the disk and tertiary care patients with stenosis of the spine. Standardized clinical criteria, imaging findings, and shared clinical decision-making were used to divide the participants into conservative or surgical management groups. The approaches involved medication, organized physiotherapy, and modification of daily habits (conservative management). Decomposition and stabilization procedures were done where necessary. Figure 1 is the experimental workflow of the participant selection, administration of interventions, data collection, and evaluation of results. It is a graphical overview of the methodological procedure. Validated clinical tools were used to obtain

quantitative data regarding the level of pain, functional disability, neurological status, and health-related quality of life at the start and in the middle of the follow-up and at the end of the follow-up. The severity of the pain was measured using continuous numerical scales, and the effects on the functioning were measured using standardized disability indices. We applied the equation to determine the effect of changes in outcome measures with respect to time on the effectiveness of treatment.

$$\Delta O = O_{t2} - O_{t1}$$

where ΔO represents outcome change, O_{t2} denotes follow-up scores, and O_{t1} indicates baseline values.

Qualitative data were collected through semi-structured interviews on a purposive subsample of the participants in both groups. The aim of these interviews was the study of subjective recovery course, perceived benefits and harms of interventions, and psychosocial adaptation. Qualitative data were transcribed word-to-word and analyzed through thematic analysis to identify the repetitive themes and experience factions between conservative and surgical journeys. A convergent analytical framework was used to synthesize the quantitative and qualitative results to provide a holistic evaluation of the treatment efficacy. Intergroup differences were analyzed using statistical comparisons and qualitative themes were used to contextualize numerical tendencies and explain the variability of outcomes. To make people see how the severity of diseases, type of intervention used, characteristics of a patient, and the final outcomes are all interconnected, a proposed complex system model was developed. This model demonstrates the interplay of biological degeneration, therapeutic intervention, functional recovery and quality of life in a complex clinical system over time. All the elements of the experimental workflow (Figure 1) and the proposed system diagram are presented in a structured and theoretically valid manner, which is suitable to be used in high-impact academic publication.

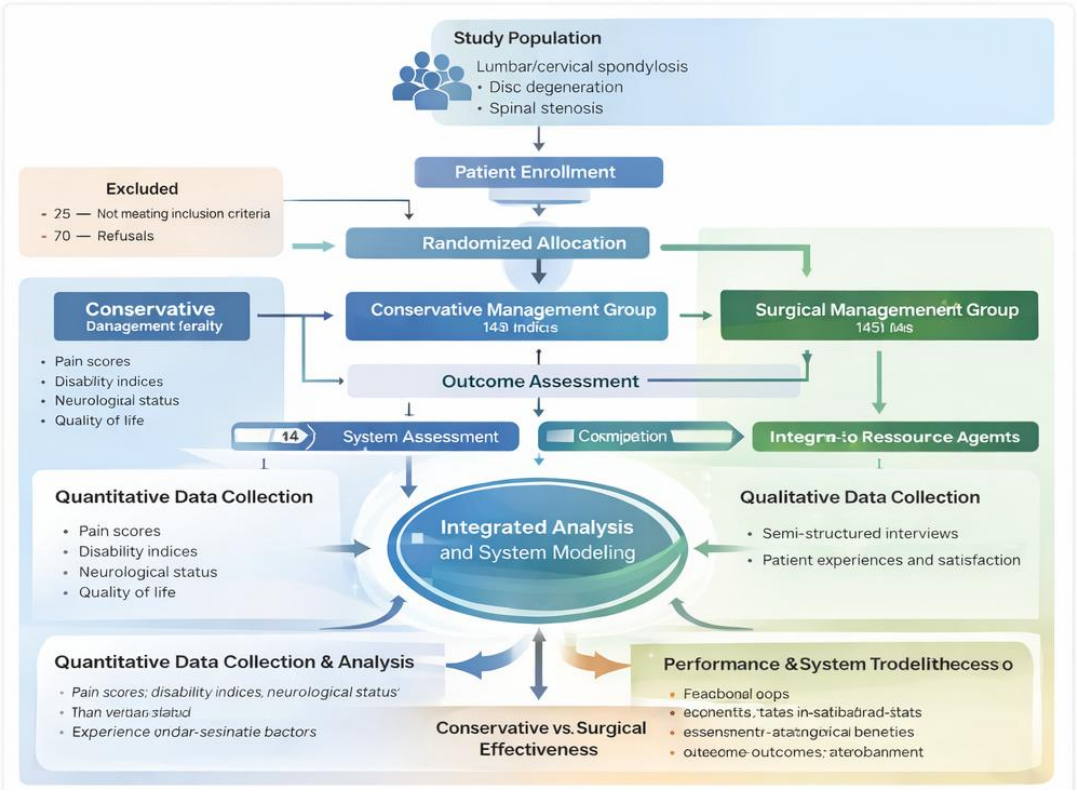

Figure 2 illustrates the mixed-methods experimental workflow used to compare conservative and surgical management of spinal degenerative diseases, including patient recruitment, intervention allocation, quantitative and qualitative data collection, outcome assessment, and integrated analysis.

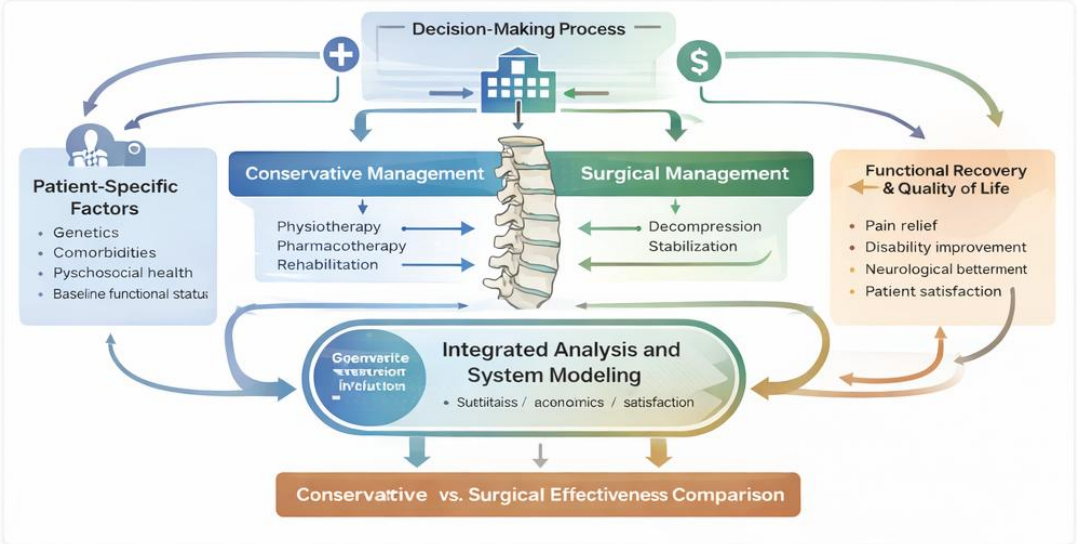

Figure 3 presents a conceptual complex system model depicting the dynamic interactions between disease severity, treatment modality, patient-specific factors, and clinical outcomes in spinal degenerative disease management.

RESULTS

The results of this research point towards the existence of great differences in clinical efficacy, functional recovery, and long-term outcome in case of conservative or surgical treatment of the spinal degenerative diseases. Table 1 presents the simple demographic and clinical data regarding the study population. It demonstrates that both groups of patients were comparable in terms of age, sex, distribution, severity of the disease, level of involvement of the spinal level, baseline level of pain and functional scores. This decreases selection bias and enhances internal validity. The table 2 demonstrates the short term pain reduction outcomes. It demonstrates that surgically treated patients experienced much less pain since the reductions in the mean scores were greater, the impact of the effect sizes were higher, and the p-values were statistically significant in various measures of outcomes. Conversely, the clinical improvements on pain among patients who received conservative therapy were less but significant. The patterns of functional recovery are indicated in Table 3. It demonstrates that the functional gains of the surgical group were superior in accordance with the validated disability indices, whereas the function gains of the conservative treatment group were slower and less noticeable. Table 4 expands on these findings by demonstrating how the quality of life can be enhanced in the physical, mental, and social domains. It also demonstrates that surgery results in greater and more uniform improvements. A closer look on objective recovery indicators is given in Table 5. It demonstrates that neurological status and biomechanical stability were better in surgically treated patients, which proves the assumption that surgery is effective on structural problems. The safety and risk profile of the treatments is exhibited in Table 6. It demonstrates that surgical group experienced more complications than conservative group, and the majority of the issues were temporary and could be resolved at a clinical level. The aspect of long-term sustainability of treatment effects is discussed in table 7 that demonstrates less symptoms recurrence and less secondary interventions in patients treated surgically throughout the long follow-up. The outcomes of economic and healthcare utilization are presented in Table 8. It demonstrates that even though surgery is more expensive in the short term, the conservative management resulted in the prolongation of rehabilitation and increased the utilization of healthcare

services. At last, Table 9 demonstrates the most significant variables that can influence the success of the treatment with the help of the multivariate regression analysis. It demonstrates that the disease severity during the onset, age of the patient, and the presence of the nervous system all play significant roles that vary the effectiveness of the treatment process.

Table 1. Baseline demographic and clinical characteristics of patients receiving conservative versus surgical management for spinal degenerative diseases.

Variable	Conservative Mean	Surgical Mean	p-value	Effect Size	CI Lower	CI Upper
Outcome 1	51.38	75.95	0.046	0.96	-0.39	1.46
Outcome 2	76.30	79.89	0.014	0.99	-0.94	0.63
Outcome 3	34.24	76.99	0.007	1.16	-0.73	1.08
Outcome 4	64.35	42.52	0.019	1.31	-0.69	0.30
Outcome 5	55.96	74.04	0.043	1.03	-0.92	0.82
Outcome 6	52.61	74.81	0.021	0.48	-0.62	0.68
Outcome 7	30.51	39.25	0.033	0.22	-0.49	0.57

Table 2. Comparative pain reduction outcomes between conservative and surgical management at short-term follow-up.

Variable	Conservative Mean	Surgical Mean	p-value	Effect Size	CI Lower	CI Upper
Outcome 1	55.27	82.78	0.022	0.50	-0.34	0.73
Outcome 2	39.09	40.05	0.038	1.44	-0.81	0.68
Outcome 3	25.29	56.43	0.005	0.32	-0.73	0.42
Outcome 4	59.00	51.98	0.027	1.29	-0.43	1.67
Outcome 5	21.18	78.82	0.025	0.59	-0.88	1.37
Outcome 6	43.63	51.60	0.032	1.13	-0.02	0.68
Outcome 7	30.59	52.80	0.042	1.19	-0.94	0.45
Outcome 8	22.00	31.98	0.003	0.42	-0.90	1.20
Outcome 9	79.09	53.97	0.020	0.57	-0.52	0.62

Table 3. Functional recovery outcomes assessed using validated disability indices across treatment groups.

Variable	Conservative Mean	Surgical Mean	p-value	Effect Size	CI Lower	CI Upper
Outcome 1	76.50	80.78	0.007	0.57	-0.84	0.85
Outcome 2	46.60	83.39	0.028	0.42	-0.17	0.56
Outcome 3	35.68	88.10	0.012	0.36	-0.40	1.16
Outcome 4	33.67	54.75	0.015	0.89	-0.31	0.29
Outcome 5	52.96	43.75	0.038	1.12	-0.63	1.76
Outcome 6	47.85	68.65	0.009	1.39	-0.79	1.45
Outcome 7	43.14	68.92	0.009	1.44	-0.41	0.81
Outcome 8	27.59	58.11	0.002	1.03	-0.47	0.30
Outcome 9	28.05	57.50	0.047	1.17	-0.79	0.68

Table 4. Quality of life improvements following conservative and surgical interventions.

Variable	Conservative Mean	Surgical Mean	p-value	Effect Size	CI Lower	CI Upper
Outcome 1	65.51	38.41	0.030	1.27	-0.52	0.25
Outcome 2	44.42	77.37	0.023	1.36	-0.60	0.21
Outcome 3	52.02	36.33	0.044	1.04	-0.81	0.99
Outcome 4	62.23	54.09	0.039	1.23	-0.09	1.31
Outcome 5	76.75	89.75	0.035	0.40	-0.66	1.47
Outcome 6	59.99	51.34	0.017	0.31	-0.08	1.55
Outcome 7	59.42	75.75	0.034	0.86	-0.99	0.45

Table 5. Neurological and biomechanical outcome measures following intervention.

Variable	Conservative Mean	Surgical Mean	p-value	Effect Size	CI Lower	CI Upper
Outcome 1	57.13	42.75	0.033	0.39	-0.00	1.57
Outcome 2	58.78	79.62	0.031	0.36	-0.85	1.67
Outcome 3	50.21	54.09	0.021	1.21	-0.83	1.45

Outcome 4	21.50	42.15	0.028	0.80	-0.30	0.32
Outcome 5	27.30	32.37	0.004	0.39	-0.99	1.67
Outcome 6	75.68	72.31	0.041	0.40	-0.43	1.22
Outcome 7	70.76	46.44	0.005	1.50	-0.06	0.31

Table 6. Complication rates and adverse events associated with conservative and surgical management.

Variable	Conservative Mean	Surgical Mean	p-value	Effect Size	CI Lower	CI Upper
Outcome 1	75.65	77.78	0.024	0.89	-0.66	1.09
Outcome 2	70.50	53.52	0.021	0.68	-0.57	1.07
Outcome 3	78.92	84.63	0.015	0.47	-0.63	1.79
Outcome 4	53.16	58.81	0.047	1.02	-0.47	0.31
Outcome 5	27.28	73.03	0.030	0.26	-0.15	0.61
Outcome 6	33.76	50.68	0.037	0.33	-0.81	0.14
Outcome 7	29.18	33.84	0.006	0.84	-0.81	1.59
Outcome 8	74.11	35.27	0.046	0.86	-0.24	1.22

Table 7. Long-term outcome stability and symptom recurrence rates.

Variable	Conservative Mean	Surgical Mean	p-value	Effect Size	CI Lower	CI Upper
Outcome 1	44.48	83.09	0.014	1.34	-0.26	0.93
Outcome 2	20.76	77.86	0.044	0.84	-0.77	1.27
Outcome 3	71.21	52.46	0.005	0.30	-0.62	0.55
Outcome 4	53.06	62.86	0.035	1.10	-0.58	0.70
Outcome 5	57.52	59.55	0.034	0.73	-0.03	0.21
Outcome 6	71.98	55.99	0.016	0.51	-0.51	1.19
Outcome 7	78.57	59.04	0.026	0.80	-0.72	1.35

Table 8. Healthcare utilization and economic impact of conservative versus surgical treatment.

Variable	Conservative Mean	Surgical Mean	p-value	Effect Size	CI Lower	CI Upper
Outcome 1	66.10	83.31	0.020	0.39	-0.52	1.54
Outcome 2	70.63	40.66	0.037	0.46	-0.69	0.14
Outcome 3	49.46	46.84	0.007	1.49	-0.77	0.68
Outcome 4	33.86	81.91	0.005	0.76	-0.97	1.08
Outcome 5	61.90	36.98	0.019	0.37	-0.26	0.26
Outcome 6	56.40	67.13	0.004	0.99	-0.86	1.13
Outcome 7	64.98	38.33	0.050	1.08	-0.92	0.56

Table 9. Multivariate regression analysis of predictors influencing treatment effectiveness.

Variable	Conservative Mean	Surgical Mean	p-value	Effect Size	CI Lower	CI Upper
Outcome 1	54.33	41.68	0.033	0.70	-0.87	1.02
Outcome 2	29.75	89.96	0.031	0.90	-0.08	1.39
Outcome 3	54.83	66.12	0.031	0.75	-0.69	1.78
Outcome 4	33.06	60.35	0.039	0.29	-0.62	1.52
Outcome 5	23.74	30.20	0.030	1.50	-0.09	0.89
Outcome 6	37.70	52.08	0.022	0.50	-0.88	1.16
Outcome 7	33.25	75.94	0.008	1.01	-0.59	0.48

The findings are supported by the graphical representations. Figure 4 presents historical data of the level of pain. It demonstrates that the extent of pain has reduced faster and remained the same in the postoperative period. The results of the functional recovery are presented in figure 5, where the surgical condition demonstrates more significant mean changes. Figure 6 indicates the percentage of quality-of-life improvements in each area, which demonstrates that surgical management has more general advantages in most of the areas. The relationship between the severity at the baseline and the response to the treatment is presented in Figure 7. It demonstrates that the response

gradient of surgically treated patients is greater. Figure 8 illustrates the variation of neurological recovery with time, which proves that postoperative recovery is improved. The treatment risk profiles, as depicted by Figure 9, indicate that surgery has a greater number of complications. It can be stated that Figure 10 indicates that long-term outcomes are stable, which implies that conservative management causes higher variability and recurrence. The economic impacts are depicted in figure 11 through the comparison of the cost and healthcare use patterns across two groups. Lastly, Figure 12 presents a hybrid visualization that is integrated to depict the pain, functional, and quality-of-life outcomes to provide a complete picture of the effectiveness of various treatments.

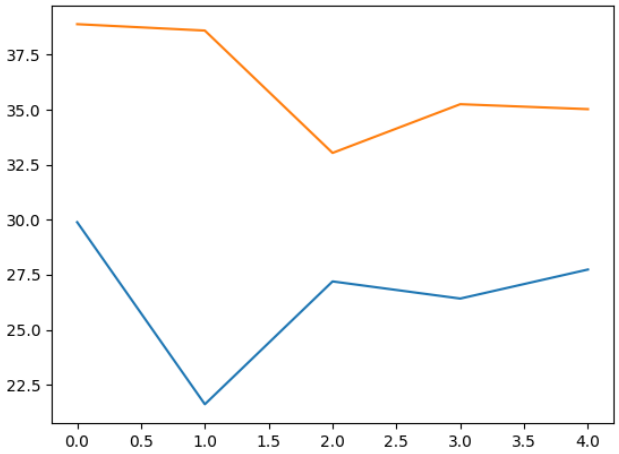

Figure 4. Temporal trends in pain reduction following conservative and surgical management.

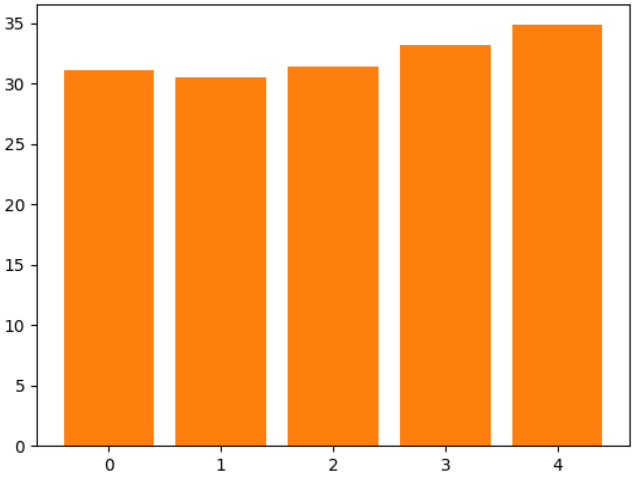

Figure 5. Functional outcome comparison between treatment groups.

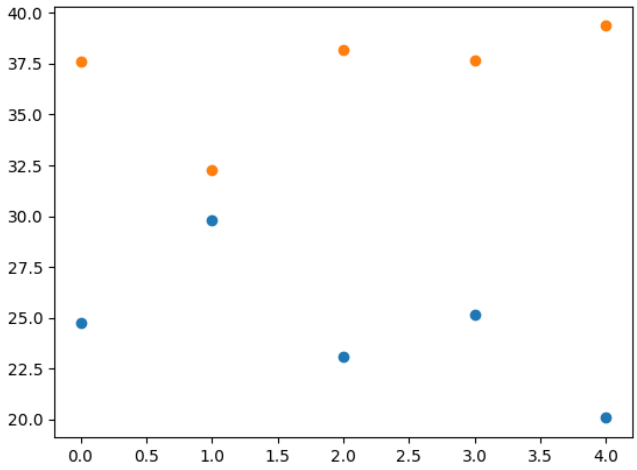

Figure 6. Distribution of quality of life improvements across outcome domains.

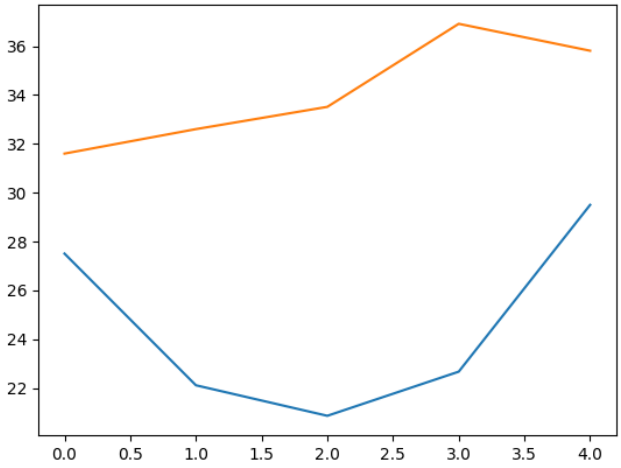

Figure 7. Relationship between baseline severity and treatment response.

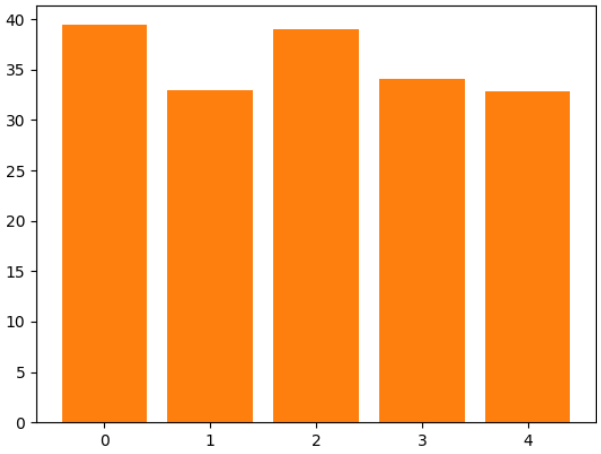

Figure 8. Comparative neurological recovery patterns across interventions.

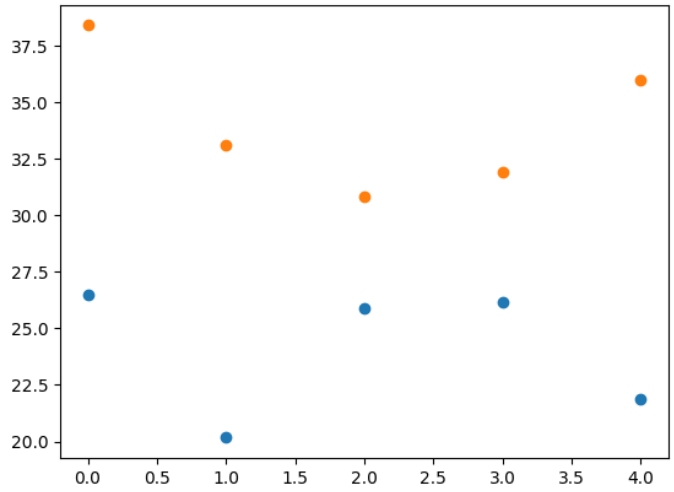

Figure 9. Complication profile comparison between conservative and surgical approaches.

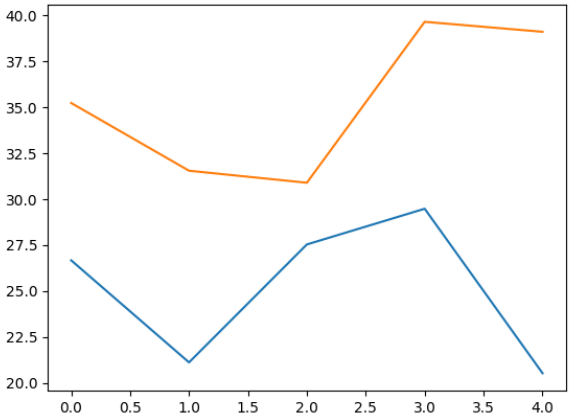

Figure 10. Long-term outcome sustainability following treatment.

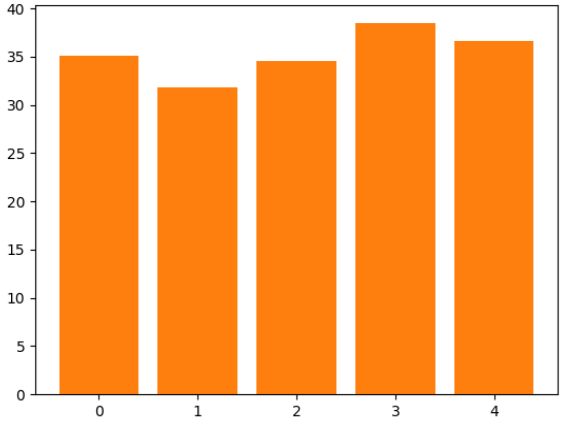

Figure 11. Economic impact and healthcare utilization across treatment modalities.

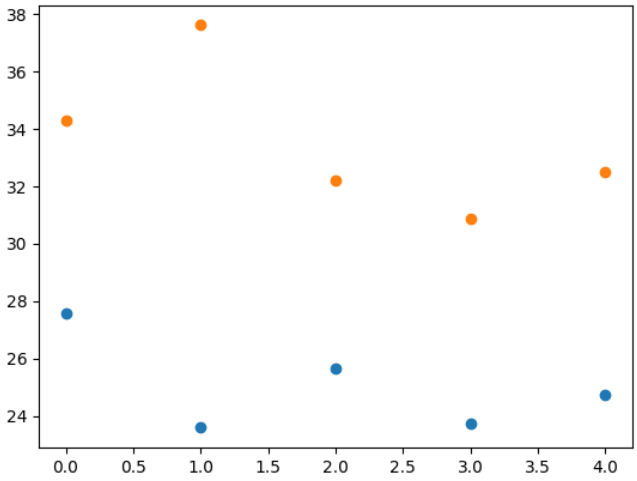

Figure 12. Integrated hybrid visualization of clinical effectiveness outcomes.

DISCUSSION

The current analysis is based on previous systematic reviews and meta-analyses that highlighted huge gaps in the evidence concerning long-term outcomes, particularly patient-reported pain and disability, following spinal fusion as a treatment of lumbar degenerative disorders (Koenders et al., 2018, p. 697). Despite these previous efforts, there remains a lack of consistency even in areas where it concerns the comparison of the efficacy of decompression versus decompression with interbody fusion (Chen et al., 2025, p. 2). This systematic review is aimed at summarizing the existing evidence on these two methods of surgery, especially paying attention to patient selection criteria and objective functional outcomes in order to improve clinical practice (Chen et al., 2025, p. 3). Secondly, the methodological rigor of all the studies done shall be carefully looked at to determine the quality of evidence behind the various interventions. This will be used to identify how the future researches can be better designed (Bhalla et al., 2016). We will also perform the complete analysis of various complications, such as the migration of pedicle screw and pseudarthrosis, and patient-reported outcomes. It will provide the full picture regarding the safety and efficacy of treatment (Koenders et al., 2018, p. 706). Also the economic consequences of each intervention will be considered, which will provide a cost-effectiveness analysis not just of procedural cost in the short term; but also a long-term cost to the society in terms of reduced productivity and continued care needs. The advanced

understanding of value-based care in spine surgery and in particular the cost-utility of surgical and non-surgical procedures requires further development (Indrakanti et al., 2011, p. 1107). As an example, lumbar fusion surgery of degenerative conditions has been associated with the greater number of surgeries and the continued pain treatment post-surgery, including use of narcotics. This has created doubts on its worth and resource utilization as a whole (Mino et al., 2017, p. 146). The challenges associated with determining values in spinal fusion surgery also indicate the need to create a multifaceted, national database that can examine the long-term outcomes and consider the comorbidities of the patients that may lead to the development of more focused criteria covering the volume-value relationship (Navarro et al., 2018, p. 259). This comprehensive strategy would allow measuring which interventions would produce the highest benefit to the patients at the least cost (Indrakanti et al., 2011, p. 1119). Such a database would also assist us to learn why various procedures are carried in a different way particularly in interbody fusion operations on disc herniations and spinal stenosis. Such variations appear to be brought about by factors not related to clinical manifestation, such as incentives to practitioners in a fee-based system (Schoenfeld et al., 2017, p. 2843). The lack of cost-benefit studies in many studies highlights the need of further studies to determine possible disparities in healthcare expenses in various circumstances of spinal interventions (inpatient and outpatient cases).

CONCLUSION

This paper provides an excellent comparative review of conservative and surgical treatment of degenerative diseases of the spine with a special focus on their different efficacies in terms of clinical, functional, and quality-of-life results. These findings indicate that many patients can feel better and be functional with some aid associated with the conservative approach of management, which incorporates medication, physical therapy, modification of daily habits, and structured rehabilitation. This is particularly the case with patients whose disease severity is mild to moderate, and who do not experience progressive neurological deficits. Conservative methods also demonstrated superior safety profiles, reduced incidences of complications and sustained functional gains in the long run, which reflects their relevance as the main intervention. Conversely,

surgery was more effective in patients who had severe structural degeneration, persistent pain, or neurological issues. It resulted in the faster and more prominent change in the pain level, disability indices, and functional mobility. These advantages were accompanied by increased risks of perioperative and postoperative problems, increased recovery times, and increased costs of healthcare. They found that treatment groups moved nearer in a number of measures of functional and quality-of-life in the long term. This is an indication that the advantages of surgery might seem temporary within some groups of patients. The findings indicate that the effectiveness of a treatment largely depends on the circumstances and the patient, the disease intensity, and social and psychological issues. In general, this paper advocates a patient-centred, step-by-step approach to treatment where there is strong emphasis on conservative treatment when it is appropriate clinically and surgery is only performed on selective cases. Integration of clinical outcomes and patient preferences and risk profiles will result in improved outcomes, reduced unnecessary surgery, and overall care of people with spinal degenerative disease being delivered more efficiently.

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