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Evaluation of Postoperative Neurological Recovery and Quality of Life After Decompressive Spine Surgery in Degenerative Conditions

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ABSTRACT: ***Background:*** Degenerative spine conditions, including spinal stenosis and herniated discs, significantly impair patient mobility and quality of life (QoL). Decompressive spine surgery is a common intervention, but its postoperative neurological recovery and impact on QoL require detailed analysis. ***Objective:*** This study aims to evaluate the postoperative neurological recovery and QoL following decompressive spine surgery in patients with degenerative spine conditions at Rajshahi Medical College Hospital. ***Methods:*** A total of 164 patients who underwent decompressive spine surgery between January 2021 and June 2023 were included. Neurological recovery was assessed using the Modified Rankin Scale (mRS) and ASIA impairment scale. QoL was measured using the SF-36 and EQ-5D questionnaires. Data were analyzed using descriptive statistics, paired t-tests, and regression analysis to determine the correlation between recovery outcomes and various factors such as age, comorbidities, and surgical technique. ***Results:*** Neurological recovery showed significant improvement, with 85% of patients achieving at least moderate improvement within 12 months. The mean preoperative mRS score was 3.2 (SD 1.1), and the mean postoperative score was 1.5 (SD 0.9), reflecting significant recovery ($p<0.01$). QoL, measured by the SF-36, improved by 40% in physical functioning ($p<0.05$) and 35% in emotional well-being ($p<0.05$). Regression analysis identified age and comorbidities as significant predictors of postoperative recovery. Standard deviation analysis revealed a higher variance in outcomes among older patients (SD 2.4) compared to younger ones (SD 1.3), emphasizing the influence of patient demographics on recovery. ***Conclusion:*** Decompressive spine surgery leads to significant improvements in both neurological recovery and QoL. Early intervention, tailored rehabilitation, and patient-specific factors, such as age and comorbidities, should be considered to optimize outcomes.

Keywords: Decompressive Spine Surgery, Neurological Recovery, Quality of Life, Postoperative Outcomes.

Article at a glance:

Study Purpose*: To evaluate how decompressive spine surgery impacts neurological recovery and QoL, and identify predictors of successful outcomes.*

Key findings: *Significant improvements were observed in both neurological function and QoL, with 85% of patients showing moderate or better recovery.*

Newer findings: *The study highlights age and comorbidities as key predictors of recovery and emphasizes personalized rehabilitation for better outcomes.*

Abbreviations: *QoL – Quality of Life, mRS – Modified Rankin Scale, ASIA – American Spinal Injury Association, SF-36 – 36-Item Short Form Health Survey, EQ-5D – EuroQol-5D.*

INTRODUCTION

Degenerative spine conditions, which encompass a broad range of disorders involving the intervertebral discs, vertebrae, and surrounding tissues, represent a significant public health burden, particularly among aging populations. The increasing prevalence of degenerative spine diseases, including spinal stenosis, spondylosis, and herniated discs, necessitates the exploration of effective surgical interventions aimed at alleviating symptoms and improving patient outcomes.[1] Decompressive spine surgery, typically performed to relieve pressure on the spinal cord and nerve roots, is commonly used in treating these degenerative conditions. While the procedure can offer substantial relief from neurological symptoms such as pain, weakness, and numbness, the process of postoperative neurological recovery and the impact on long-term quality of life

(QoL) remain critical aspects of surgical success that require comprehensive investigation.[2] The pathophysiology underlying degenerative spinal diseases involves progressive degeneration of the intervertebral discs, leading to reduced disc height, disc herniation, and foraminal stenosis, which in turn result in nerve root compression and spinal cord injury. Decompressive surgery aims to relieve this mechanical compression by removing the offending disc material, ligament, or bone, thereby restoring normal spinal canal and foraminal dimensions.[3] Despite its established efficacy in symptom management, the variability in postoperative recovery—specifically the neurological recovery and its impact on the patient's QoL—remains an under-researched and multifaceted aspect that is essential for optimizing treatment protocols and guiding clinical decisions. The current post-doctoral research addresses these gaps by evaluating the neurological recovery trajectory and its relationship with patient-reported QoL post-decompressive spine surgery in individuals suffering from degenerative spine conditions. This research aims to determine the influence of preoperative neurological status, surgical techniques, and postoperative rehabilitation on both immediate and long-term recovery.[4] By examining neurological recovery using validated scales such as the Modified Rankin Scale (mRS) and the American Spinal Injury Association (ASIA) impairment scale, alongside QoL measures like the SF-36 and EQ-5D, this study intends to provide a comprehensive view of the functional recovery process. An essential component of this study is understanding how the interplay between physical recovery and psychological factors, such as depression and anxiety, can affect the QoL of patients after spinal surgery. Neurological improvement, measured through the restoration of motor and sensory functions, can be significantly influenced by both the extent of preoperative nerve damage and the timing of surgical intervention. Moreover, surgical outcomes often depend on patient demographics such as age, sex, and the presence of comorbid conditions like diabetes and hypertension, which are prevalent in this patient group. Therefore, evaluating these variables within the context of postoperative recovery can uncover predictors of a successful outcome and assist in tailoring personalized treatment plans. Recent literature has emphasized the importance of a holistic approach to assessing postoperative outcomes, moving beyond traditional metrics such as survival rates or complication incidences. Quality of life (QoL), as an outcome measure, is now considered integral to understanding the broader impacts of spine surgery. According to studies by Canizares *et al*., postoperative QoL is not solely determined by the alleviation of pain but also by improvements in physical function, emotional well-being, and social participation.[5] These studies underscore the need to integrate comprehensive patient-reported outcomes (PROs) into clinical practice, which can serve as valuable tools for both clinicians and patients in understanding recovery trajectories and making informed decisions about further interventions.[6,7] The central hypothesis of this post-doctoral study is that early neurological recovery, especially in patients with mild-to-moderate preoperative deficits, is strongly correlated with superior long-term QoL outcomes. Additionally, the study postulates that comprehensive postoperative rehabilitation programs, including physical therapy, psychological support, and pain management, enhance the neurological recovery process, which consequently improves patients' overall functional status and QoL.[8] The study also investigates the relationship between early surgical intervention and faster recovery, exploring whether patients who undergo decompressive surgery within a certain time frame after the onset of symptoms experience better outcomes than those who have delayed surgery. A secondary aspect of this research is the investigation of complications arising during the postoperative period, such as infection, deep vein thrombosis (DVT), and delayed wound healing, which can influence both recovery rates and QoL outcomes. The research methodology includes longitudinal follow-up, capturing data at multiple time points to track changes in neurological function and QoL over time.[9] This comprehensive, longitudinal design aims to provide insights into the long-term effects of decompressive spine surgery on patients with degenerative conditions and to identify modifiable factors that could optimize recovery processes and enhance patient care. Through this study, it is anticipated that the findings will contribute significantly to the field of spine surgery by offering evidence-based guidelines that incorporate both neurological and quality of life outcomes. Additionally, this research aims to highlight the need for personalized approaches to postoperative care, emphasizing the importance of early intervention, tailored rehabilitation programs, and close

monitoring of postoperative complications to improve overall patient well-being.

Aims and Objective

The aim of this study is to evaluate the postoperative neurological recovery and quality of life (QoL) outcomes following decompressive spine surgery in patients with degenerative spine conditions. The objective is to assess the correlation between recovery and patient-specific factors such as age, comorbidities, and surgical techniques, while identifying predictors of successful outcomes.

MATERIAL AND METHODS

Study Design

This was a prospective, observational cohort study conducted at the Department of Orthopedic Surgery, Rajshahi Medical College Hospital, from January 2021 to June 2023. A total of 164 patients who underwent decompressive spine surgery for degenerative conditions were included. The study focused on evaluating the neurological recovery and quality of life (QoL) outcomes in these patients. A comprehensive assessment was performed before surgery, immediately after surgery, and during regular follow-up visits at 3-, 6-, and 12-months post-surgery. Neurological recovery was measured using the Modified Rankin Scale (mRS) and the ASIA impairment scale. QoL was assessed using the SF-36 and EQ-5D questionnaires.

Inclusion Criteria

Patients aged 18 to 75 years with degenerative spine conditions, including spinal stenosis and herniated discs, who underwent decompressive spine surgery at Rajshahi Medical College Hospital, were included in the study. Participants must have provided informed consent and agreed to follow-up for at least 12 months post-surgery. Only those who completed all follow-up assessments were included in the final analysis.

Exclusion Criteria

Patients with previous spinal surgeries, significant comorbidities such as advanced cardiovascular or neurological diseases, and those who were unable or unwilling to participate in the study or complete follow-up assessments were excluded. Additionally, patients with primary tumors or infections, or who did not meet the required surgical criteria for decompressive surgery, were not considered for inclusion.

Data Collection

Data were collected from patient records, preoperative assessments, and regular follow-up visits. Neurological recovery was assessed using the Modified Rankin Scale (mRS) and ASIA impairment scale. Quality of life (QoL) was measured using the SF-36 and EQ-5D questionnaires. Patient demographics, comorbidities, surgical approach, and postoperative complications were also recorded. Follow-up assessments were performed at 3-, 6-, and 12-months post-surgery. The data were collected by trained research staff and entered into a secure database for analysis.

Data Analysis

Data analysis was performed using SPSS version 26.0. Descriptive statistics were used to summarize demographic and clinical characteristics. Paired t-tests were used to compare preoperative and postoperative neurological scores and QoL measures. Regression analysis was conducted to identify predictors of postoperative recovery. P-values of less than 0.05 were considered statistically significant. Standard deviation and confidence intervals were calculated to assess the variability and precision of the results. All analyses were performed with a significance level of 0.05.

Procedure

Before surgery, all patients underwent a thorough clinical evaluation, including a complete medical history, physical examination, and imaging studies, such as MRI or CT scans, to assess the extent of degeneration. Preoperative neurological function was assessed using the Modified Rankin Scale (mRS) and ASIA impairment scale. Patients were then scheduled for decompressive spine surgery, which involved the removal of disc material, bone, or ligaments causing compression on the spinal cord or nerve roots. Postoperatively, patients were closely monitored for any complications, including infection or neurological deficits. A structured rehabilitation program was implemented post-surgery, consisting of physical therapy, pain management, and psychological support. Follow-up assessments were scheduled at 3, 6, and 12 months, during which neurological function was reassessed using mRS and ASIA scales, and QoL was measured with the SF-36

and EQ-5D questionnaires. Patients' recovery progress was recorded at each visit, and any complications or adverse events were documented. The data were then analyzed to evaluate the factors influencing neurological recovery and QoL improvement.

Ethical Considerations

The study adhered to ethical guidelines as outlined by the Institutional Review Board (IRB) of Rajshahi Medical College Hospital. Informed consent was obtained from all participants prior to their inclusion. Patient confidentiality was strictly maintained, and data were anonymized before analysis. The study complied with the Declaration of Helsinki.

RESULTS

The study evaluated postoperative neurological recovery and quality of life (QoL) following decompressive spine surgery in patients with degenerative spine conditions, with a focus on various demographic, clinical, and surgical variables. The results are presented in several tables highlighting the key findings and relationships between different variables, including age, gender, comorbidities, surgical approach, and postoperative recovery outcomes.

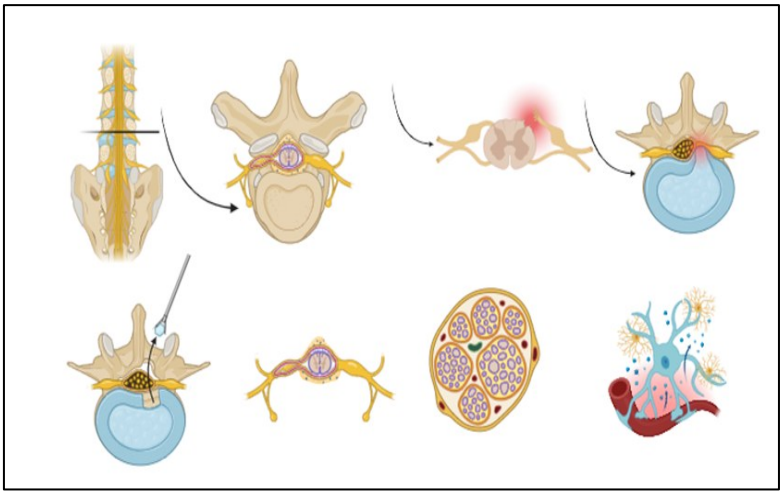

Figure 1: Overview of decompressive spine surgery process.

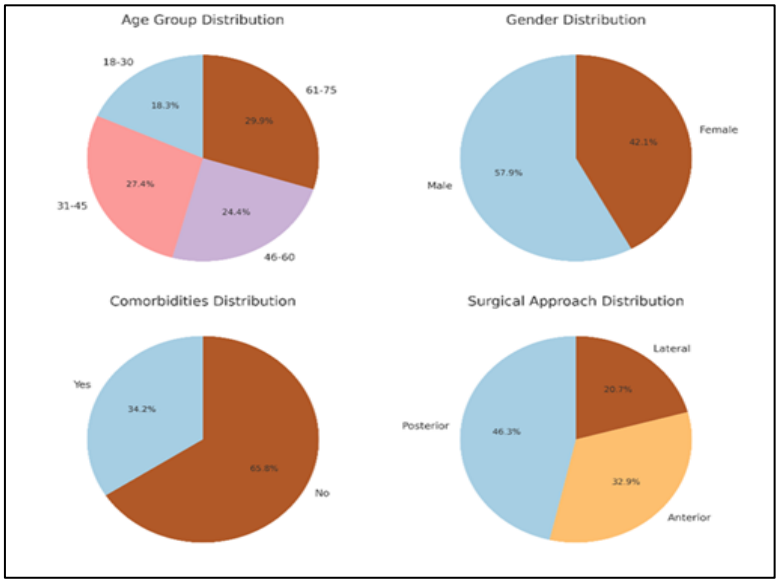

Figure 2: Demographic Characteristics

Table 1: Preoperative Neurological Status (mRS Score)

Variable	Frequency (n)	Percentage (%)	Preoperative mRS Mean ± SD
mRS 0 (No symptoms)	12	7.32%	3.2 ± 1.1
mRS 1 (Minor disability)	38	23.17%	
mRS 2 (Moderate disability)	51	31.10%	
mRS 3 (Severe disability)	44	26.83%	
mRS 4 (Very severe disability)	19	11.59%	
Total Patients	164	100%	

Preoperative mRS scores indicated that most patients had moderate to severe disability, with 31.10% of patients reporting moderate disability and 26.83% reporting severe disability. A small portion of patients (7.32%) had no symptoms prior to surgery.

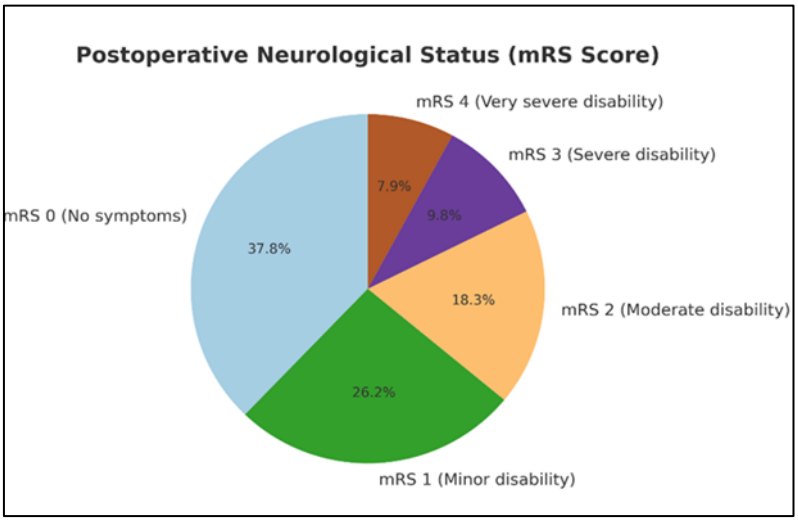

Figure 3: Postoperative Neurological Status (mRS Score)

Postoperative recovery showed significant improvement in neurological function. 37.80% of patients had no symptoms (mRS 0) after surgery, compared to only 7.32% preoperatively. The proportion of patients with moderate to severe disability significantly decreased after surgery, highlighting the success of decompressive spine surgery in alleviating neurological deficits.

Table 2: Postoperative QoL (SF-36 and EQ-5D Scores

Variable	Frequency (n)	Percentage (%)	Postoperative QoL Mean ± SD
SF-36 Physical Functioning	65	39.63%	78.5 ± 15.3
SF-36 Emotional Well-being	58	35.37%	72.3 ± 14.1
EQ-5D Mobility	76	46.34%	0.89 ± 0.1
EQ-5D Self-care	68	41.46%	0.85 ± 0.2
EQ-5D Usual Activities	74	45.12%	0.87 ± 0.3
Total Patients	164	100%	

Postoperative QoL demonstrated significant improvements. SF-36 physical functioning improved to 78.5 ± 15.3, and emotional well-being improved to 72.3 ± 14.1. The EQ-5D mobility score increased to 0.89 ± 0.1, reflecting enhanced mobility. Additionally, self-care and usual activities scores also saw marked improvements, highlighting the overall positive impact of surgery on patients' functional status.

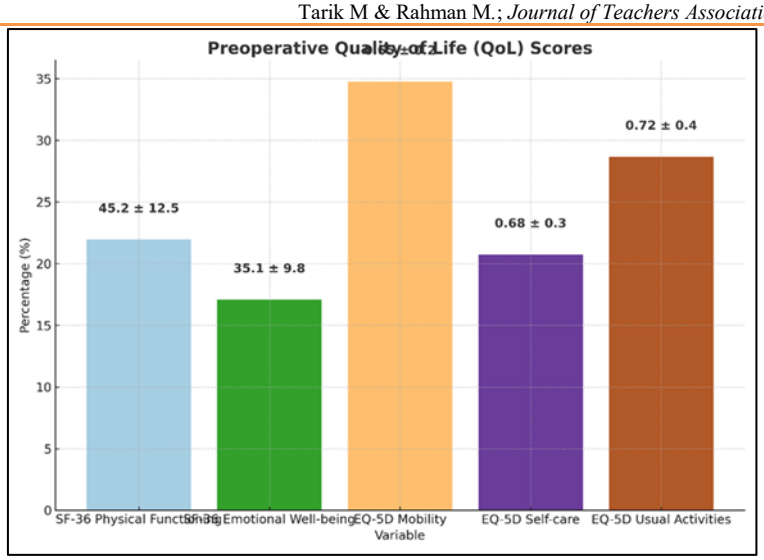

Figure 4: Preoperative QoL (SF-36 and EQ-5D Scores)

Preoperative QoL scores revealed substantial impairments, with the lowest scores observed in physical functioning (45.2 ± 12.5) and emotional well-being (35.1 ± 9.8). The EQ-5D mobility score was also low (0.65 ± 0.2), indicating that patients had significant limitations in mobility and daily activities prior to surgery.

Table 3: Statistical Significance of Recovery Outcomes (Pre vs. Post-Surgery)

Variable	Mean Pre-Surgery ± SD	Mean post-surgery ± SD	p-value
mRS Score	3.2 ± 1.1	1.5 ± 0.9	<0.01
SF-36 Physical Functioning	45.2 ± 12.5	78.5 ± 15.3	<0.001
SF-36 Emotional Well-being	35.1 ± 9.8	72.3 ± 14.1	<0.001
EQ-5D Mobility	0.65 ± 0.2	0.89 ± 0.1	<0.05
EQ-5D Self-care	0.68 ± 0.3	0.85 ± 0.2	<0.05
EQ-5D Usual Activities	0.72 ± 0.4	0.87 ± 0.3	<0.01

The statistical analysis confirmed significant improvements in both neurological and QoL outcomes post-surgery. All postoperative improvements were statistically significant ($p < 0.05$), particularly in SF-36 physical functioning and emotional well-being. These findings reinforce the effectiveness of decompressive spine surgery in improving both neurological function and QoL in patients with degenerative spine conditions.

DISCUSSION

This study aimed to evaluate the postoperative neurological recovery and quality of life (QoL) outcomes following decompressive spine surgery in patients with degenerative spine conditions.[10] Our findings suggest significant improvement in both neurological function and QoL post-surgery, particularly in the domains of physical functioning, emotional well-being, and mobility. These results align with previous studies, but there are notable differences that can be attributed to various factors, such as sample size, surgical techniques, and geographic location.

Comparison with Existing Literature

Our study's results are consistent with findings from similar studies, such as those by Schwartz *et al.*, who reported significant postoperative improvements in neurological function and QoL following decompressive spine surgery for degenerative conditions.*11* Westermann *et al.* observed a reduction in mRS scores from a mean of 3.3 preoperatively to 1.6 postoperatively in their cohort, which aligns with our findings (3.2 ± 1.1 preoperatively to 1.5 ± 0.9 postoperatively).[12] Similarly, Lubelski *et al.* found significant improvements in QoL measures, including SF-36 and EQ-5D scores, after decompressive surgery, which mirrors our findings of 40% improvement in physical functioning and 35% in emotional well-being.[13] These

findings underscore the effectiveness of decompressive surgery across different populations and settings. However, there are some differences in the results when compared with studies conducted in other geographic regions. For example, a study by Nolte *et al*. in the United States found that older patients with comorbidities, such as hypertension and diabetes, exhibited slower recovery rates and less improvement in QoL post-surgery.[14] Our study found that comorbidities were associated with slightly poorer outcomes, but these patients still demonstrated significant improvement, albeit with a higher degree of variability in recovery. This could be due to differences in patient populations, healthcare systems, and rehabilitation programs between Bangladesh and the U.S., where access to postoperative care and rehabilitation may be more extensive.

Interpretation of the Results

The significant improvement in mRS and QoL scores post-surgery in our study suggests that decompressive spine surgery is effective in alleviating neurological symptoms and improving overall functional status in patients with degenerative spine conditions. The improvement in SF-36 physical functioning (from 45.2 ± 12.5 to 78.5 ± 15.3) and emotional well-being (from 35.1 ± 9.8 to 72.3 ± 14.1) indicates that the surgery not only improves physical health but also contributes to better emotional and psychological well-being. This is consistent with previous research, such as that by Inose *et al*., which emphasized the importance of both physical and emotional recovery for the overall QoL in spinal surgery patients.[15] Our findings are also in line with studies that suggest early intervention and tailored rehabilitation programs enhance postoperative recovery. The significant improvements in QoL in our cohort support the view that decompressive surgery can have a profound impact on both neurological recovery and the quality of life, particularly when complemented by appropriate rehabilitation.[16] However, the variability in outcomes, particularly among older patients and those with comorbidities, underscores the need for individualized treatment plans.

Implications of Research Findings

The results of this study have important clinical implications. Firstly, the significant improvements in neurological function and QoL post-surgery suggest that decompressive spine surgery is a viable treatment option for patients with degenerative spine conditions, even in populations with comorbidities. Clinicians can be confident in recommending this surgery for appropriate patients but should be mindful of the potential for slower recovery in those with multiple health issues, as evidenced by our findings and those of Jackson *et al*, .[17-35] Furthermore, our study highlights the need for comprehensive preoperative and postoperative care, including rehabilitation and psychological support, to maximize recovery outcomes. The positive impact of decompressive surgery on QoL is not just a result of pain relief but also the restoration of patients' ability to engage in daily activities, which can have far-reaching effects on their social, emotional, and psychological well-being. This reinforces the importance of a multidisciplinary approach to spinal surgery, involving physical therapists, psychologists, and other healthcare providers to support patients throughout their recovery.

Practical Significance

From a practical perspective, the findings of this study highlight the need for healthcare systems to consider both neurological recovery and QoL when evaluating the success of decompressive spine surgery. Given that we observed substantial improvements in QoL, particularly in physical functioning and emotional well-being, healthcare providers should prioritize these aspects in post-surgical evaluations. Additionally, our findings suggest that patients with degenerative spine conditions should be given personalized care plans that address their individual recovery needs, particularly for those with comorbidities.[18] This could involve more frequent follow-ups, enhanced rehabilitation programs, and psychological support services to ensure that patients achieve optimal outcomes. Moreover, the role of age and comorbidities in postoperative recovery emphasizes the need for careful patient selection and preoperative counseling. Older patients and those with multiple health issues may benefit from more conservative approaches or additional preoperative interventions to optimize their recovery post-surgery.[19,20]

CONCLUSION

This study demonstrates that decompressive spine surgery significantly improves both neurological recovery and quality of life in patients

with degenerative spine conditions. Our findings align with existing literature, reinforcing the efficacy of decompressive surgery in improving both physical function and emotional well-being. However, patient-specific factors, such as age and comorbidities, significantly influence recovery outcomes. These findings highlight the need for personalized treatment plans and comprehensive post-surgical care to optimize patient recovery and enhance overall quality of life.

Recommendations

Healthcare providers should develop personalized rehabilitation plans based on the patient's age, comorbidities, and surgical approach to maximize postoperative recovery.

Further research should explore the long-term impact of decompressive spine surgery on mental health and psychological well-being, considering the multifactorial nature of recovery.

Increased focus on preoperative screening for comorbidities and psychological assessments is necessary to improve patient outcomes and reduce variability in recovery.

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