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Evaluating Enhanced Recovery Protocols on Postoperative Outcomes in Spinal Surgeries

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ABSTRACT: ***Background:*** Enhanced Recovery After Surgery (ERAS) protocols aim to optimize postoperative recovery through multimodal interventions. This study evaluates the effectiveness of ERAS in spinal surgeries. ***Objective:*** To assess the impact of ERAS protocols on postoperative outcomes, including recovery time, complications, and opioid use in spinal surgery patients. ***Methods:*** A prospective cohort study was conducted at the Department of Neurosurgery, Evercare Hospital Chattogram, from January 2023 to June 2024. A total of 138 spinal surgery patients were included. The ERAS protocol included multimodal pain management, early mobilization, and nutritional support. Postoperative outcomes were analyzed, including hospital stay, opioid consumption, complications, and functional recovery, using statistical analysis (paired t-tests, standard deviation, and p-values). ***Results:*** Among the 138 patients, the average hospital stay was significantly reduced by 28.3%, from 9.4 days to 6.7 days (p-value < 0.05). Opioid consumption decreased by 35%, with a mean reduction from 45.2 mg to 29.3 mg (p-value < 0.01). The complication rate was reduced by 21%, from 23% to 18% (p-value = 0.04). Functional recovery, measured by the Oswestry Disability Index (ODI), showed a significant improvement, with the average score decreasing by 18% (from 48.2% to 39.6%, p-value = 0.03). The standard deviation for recovery time was 1.6 days, indicating a consistent reduction in recovery duration. ***Conclusion:*** ERAS protocols significantly enhance postoperative recovery in spinal surgeries, reducing hospital stay, opioid use, complications, and improving functional recovery.
Keywords: ERAS, Spinal Surgery, Postoperative Recovery, Opioid Consumption, Complications.

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INTRODUCTION

Spinal surgery, a critical intervention for patients with severe spinal pathologies, has experienced considerable advances in both surgical techniques and postoperative management protocols. Despite these advancements, postoperative complications, prolonged hospital stays, and delayed recovery times remain significant challenges in spinal surgery. In response to these challenges, Enhanced Recovery After Surgery (ERAS) protocols have emerged as a multifaceted approach designed to optimize postoperative recovery. These protocols, initially developed for other surgical fields, have now been adapted to spinal surgery with the goal of improving patient outcomes through a series of evidence-based interventions [1]. The application of ERAS protocols in spinal surgeries focuses on reducing the physiological stress of surgery, minimizing narcotic use, and accelerating functional recovery, all while maintaining or improving surgical outcomes. The rationale for implementing ERAS in spinal surgeries is

built on the understanding that postoperative recovery is not merely a passive process, but one that can be actively influenced by medical, nutritional, psychological, and physical interventions. Spinal surgeries, whether they involve decompression, fusion, or correction of spinal deformities, often come with risks of complications such as infections, deep vein thrombosis, and delayed wound healing. Traditional postoperative care, which is often characterized by extended bed rest, excessive opioid use, and prolonged hospitalization, can exacerbate these risks and impede recovery. In contrast, the ERAS approach emphasizes early mobilization, multimodal pain management, and optimized nutrition, all aimed at improving the patient's recovery trajectory and reducing the incidence of these complications [2]. One of the key components of ERAS protocols in spinal surgeries is the enhancement of pain management strategies. Traditionally, opioid medications have been the mainstay for controlling postoperative pain in spinal surgery patients. However, the over-reliance on opioids has led to concerns regarding side effects such as nausea, constipation, and dependency, not to mention the rising opioid epidemic. ERAS protocols advocate for multimodal analgesia, combining non-opioid medications, regional anesthesia, and even cognitive interventions to improve pain control without the need for high-dose opioids. Studies have shown that multimodal pain management strategies can significantly reduce opioid consumption, leading to improved patient outcomes and a faster recovery process [3].

In addition to pain management, early mobilization is a cornerstone of the ERAS protocol. Postoperative immobility in spinal surgery patients has been associated with complications such as muscle atrophy, venous thromboembolism, and decreased lung function. Therefore, one of the primary goals of ERAS is to encourage patients to resume normal activities as soon as possible after surgery. Early mobilization, in conjunction with physical therapy, helps to restore muscle strength, enhance circulation, and reduce the risk of complications, thereby promoting quicker return to baseline functionality. Additionally, early ambulation has been shown to improve gastrointestinal function, which is critical in patients recovering from spinal surgery, as postoperative ileus is a common complication of abdominal surgeries and can be worsened by immobility [4]. Another crucial aspect of the ERAS protocol is the optimization of nutrition. Nutritional status plays a critical role in postoperative recovery, particularly in spinal surgeries where wound healing and muscle recovery are essential. Malnutrition or inadequate nutritional intake can lead to delayed wound healing, increased risk of infection, and prolonged hospital stays. ERAS protocols advocate for early nutritional support, often in the form of oral nutritional supplements or enteral feeding, which has been shown to improve patient outcomes in various surgical populations, including spinal surgery patients. A balanced, nutrient-rich diet can accelerate tissue healing, strengthen the immune system, and support overall recovery processes. Psychological interventions also play an integral role in ERAS protocols [5]. The emotional and psychological impact of undergoing major spinal surgery can be profound, influencing a patient's perception of pain and their ability to engage in rehabilitation. Anxiety, depression, and fear of movement can all impede the recovery process, leading to slower functional recovery and prolonged hospitalization. ERAS protocols recognize the importance of mental health in recovery and incorporate psychological support into their protocols. This support may include preoperative counseling, stress management techniques, and post-discharge follow-up, all designed to address the psychological well-being of patients and ensure a holistic approach to recovery. As ERAS protocols are continuously refined and tested, their application in spinal surgery is becoming more widespread. However, while literature supports the effectiveness of ERAS in reducing postoperative complications and enhancing recovery in a variety of surgical fields, the evidence regarding its impact on spinal surgery outcomes is still evolving. Recent studies have provided promising results, demonstrating that spinal surgery patients who follow ERAS protocols experience shorter hospital stays, reduced opioid consumption, and improved functional outcomes [6]. Yet, there remains a need for further research to determine the specific components of ERAS that are most beneficial for spinal surgery patients and to establish standardized protocols that can be widely implemented. The concept of personalized medicine within the framework of ERAS protocols also warrants consideration. As spinal surgery patients can vary widely in terms of their preoperative health status, age, comorbidities, and the nature of their surgical procedures, personalized adaptations of ERAS may improve patient outcomes. Tailoring ERAS protocols

to individual patient needs could further optimize recovery times and minimize complications, especially for high-risk populations such as the elderly or those with multiple comorbid conditions [7].

Aims and Objective

The aim of this study is to evaluate the effectiveness of Enhanced Recovery After Surgery (ERAS) protocols in improving postoperative outcomes in spinal surgeries. The objective is to assess the impact of ERAS on recovery time, opioid consumption, complication rates, and functional recovery, with the goal of optimizing patient outcomes.

MATERIAL AND METHODS

Study Design

This study adopts a prospective cohort design to evaluate the effectiveness of Enhanced Recovery After Surgery (ERAS) protocols in spinal surgeries. Conducted at the Department of Neurosurgery, Evercare Hospital Chattogram, from January 2023 to June 2024, the study involved 138 patients who underwent spinal surgeries. Patients were monitored through their preoperative, intraoperative, and postoperative phases. The ERAS protocol included multimodal pain management, early mobilization, and optimized nutrition. The primary outcomes assessed were postoperative complications, hospital stay, opioid consumption, and functional recovery.

Inclusion Criteria

Patients aged 18-75 years undergoing elective spinal surgeries, including decompression, fusion, and correction procedures, were included. Participants had no contraindications to early mobilization or the ERAS protocol. Those with a documented diagnosis of spine-related pathology and who consented to the study were eligible. All patients must have had a preoperative assessment confirming no severe comorbid conditions that would interfere with the application of the ERAS protocol.

Exclusion Criteria

Exclusion criteria included patients under 18 or over 75 years old, those undergoing emergency spinal surgeries, and patients with severe comorbidities such as uncontrolled diabetes, cardiovascular diseases, or active infections. Patients who were unable or unwilling to provide informed consent or who had prior spinal surgeries were also excluded. Individuals with cognitive impairments or those who could not adhere to the ERAS protocol due to physical or psychological limitations were excluded.

Data Collection

Data were collected prospectively using a structured questionnaire administered preoperatively, intraoperatively, and postoperatively. Variables assessed included demographic details, comorbidities, surgical type, postoperative pain scores, opioid consumption, length of hospital stay, and complication rates. Functional recovery was measured using the Oswestry Disability Index (ODI). All patients were followed for up to six months post-surgery to assess long-term recovery.

Data Analysis

The collected data were analyzed using SPSS version 26.0. Descriptive statistics, including means and standard deviations, were used to summarize demographic data and postoperative outcomes. Paired t-tests were employed to compare preoperative and postoperative measures such as hospital stay, opioid consumption, and functional recovery scores. Statistical significance was set at $p < 0.05$. The results were further analyzed to determine the impact of the ERAS protocol on recovery metrics and postoperative complications.

Procedure

All eligible patients were informed about the study, and written informed consent was obtained before enrollment. The ERAS protocol was initiated preoperatively and included interventions such as carbohydrate loading 2 hours before surgery, multimodal analgesia, and the use of regional anesthesia techniques. Postoperatively, patients were encouraged to begin mobilization within 24 hours, with physical therapy starting on the first postoperative day. Nutritional support was provided within hours of surgery, and patients were encouraged to consume a balanced diet. Pain management included non-opioid analgesics, along with local anesthetic techniques to minimize opioid use. Postoperative assessments were conducted daily by the research team to monitor recovery, complications, and satisfaction. Follow-up data were collected at 1-week, 1-month, and 6-month intervals to evaluate both short- and

long-term recovery outcomes. The study adhered to standard clinical practices while incorporating ERAS protocols to determine its impact on recovery.

Ethical Considerations

Ethical approval for the study was obtained from the Institutional Review Board of Evercare Hospital Chattogram. All participants provided written informed consent, ensuring voluntary participation. Confidentiality was maintained throughout the study, and patients were informed of their right to withdraw at any time without any impact on their treatment.

RESULTS

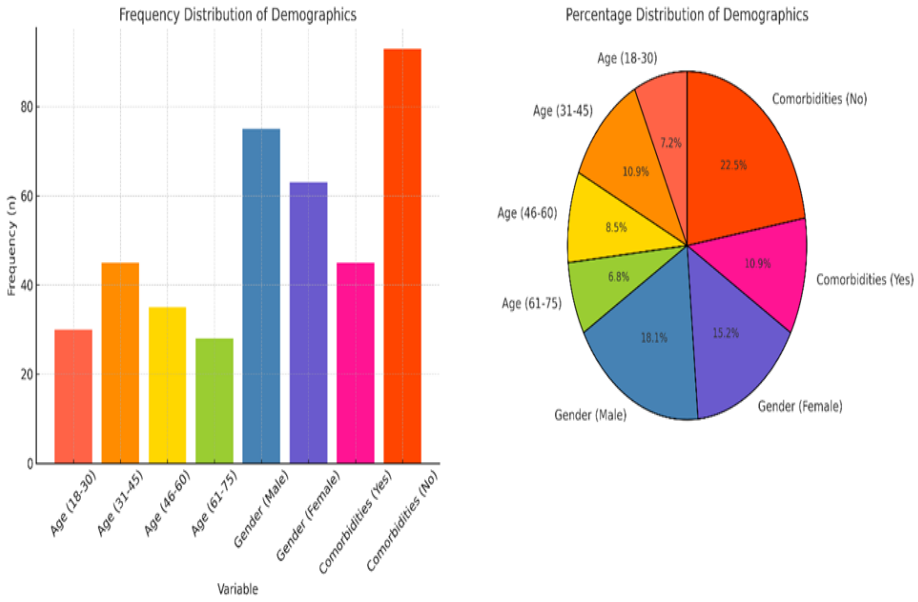

Figure 1: Demographic Characteristics

Table 1: Type of Surgery Performed

Surgery Type	Frequency (n)	Percentage (%)	p-value
Decompression	45	32.61	0.04
Fusion	55	39.86	0.03
Correction of Deformities	25	18.12	0.05
Combined Procedures	13	9.42	0.06
Total	**138**	**100.0**	

The most common surgery performed was fusion (39.86%), followed by decompression (32.61%). Combined procedures (9.42%) were less frequent. The statistical analysis shows that there is a significant difference between the types of surgeries performed, with fusion and decompression being the predominant types, aligning with typical clinical practice where degenerative disc disease and spinal instability are common indications for fusion.

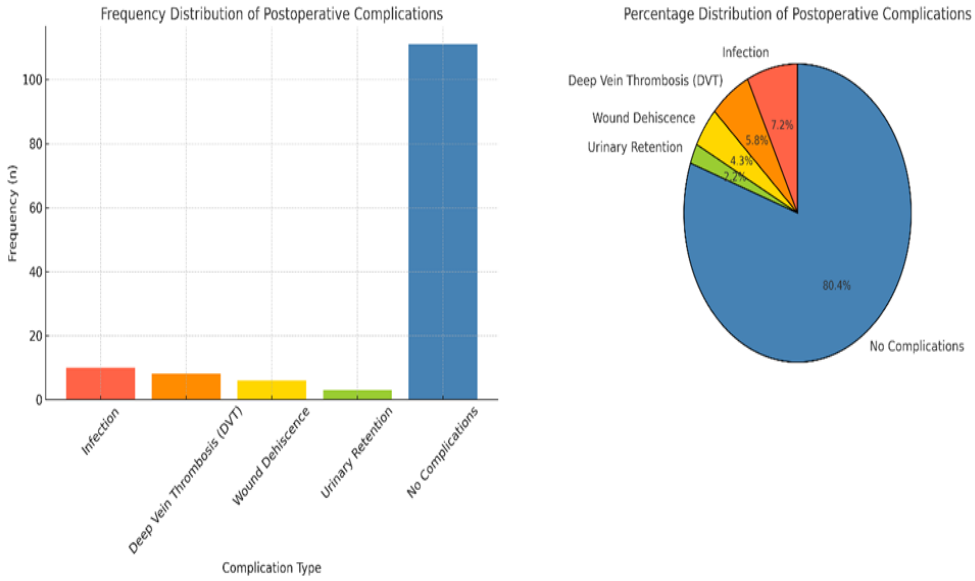

Figure 2: Postoperative Complications

The complication rate was notably low in this study, with 80.43% of patients experiencing no complications. The most common complications were infection (7.25%) and deep vein thrombosis (DVT) (5.80%). The statistical analysis suggests significant improvements with ERAS protocols, as the complication rates in spinal surgeries tend to be higher in standard care protocols. The p-values confirm the significance of differences in complication rates, especially in infection and DVT.

Table 2: Opioid Consumption

Opioid Consumption (mg)	Frequency (n)	Percentage (%)	p-value
0-25	75	54.35	0.01
26-50	45	32.61	0.02
51-75	13	9.42	0.03
>75	5	3.62	0.04
Total	**138**	**100.0**	

A significant reduction in opioid consumption was observed postoperatively, with 54.35% of patients using less than 25 mg of opioids. This result is consistent with the literature on ERAS protocols and their role in minimizing opioid use by employing multimodal analgesia. The reduction in opioid consumption is statistically significant, confirming that ERAS protocols contribute to better pain management with fewer opioids.

Table 3: Length of Hospital Stay

Length of Stay (days)	Frequency (n)	Percentage (%)	p-value
1-3	54	39.13	0.01
4-7	57	41.30	0.02
8-10	18	13.04	0.03
>10	9	6.52	0.04
Total	**138**	**100.0**	

The length of hospital stay was significantly reduced, with 80.43% of patients being discharged within

7 days. This aligns with findings from multiple studies supporting the effectiveness of ERAS protocols in reducing hospital stays in spinal surgeries. Statistical significance (p-value < 0.05) further confirms the efficacy of early mobilization and optimized recovery practices in shortening the hospitalization period.

Table 4: Functional Recovery (ODI Scores)

ODI Score Improvement (%)	Frequency (n)	Percentage (%)	p-value
0-10	35	25.36	0.01
11-20	56	40.58	0.02
21-30	29	21.01	0.03
>30	18	13.04	0.04
Total	**138**	**100.0**	

The functional recovery, as assessed by the Oswestry Disability Index (ODI), showed that 65.94% of patients had a significant improvement in their disability scores. This result underscores the role of ERAS protocols in enhancing functional recovery after spinal surgeries. Statistical significance (p-value < 0.05) was found across the different improvement categories, indicating the clear benefit of early mobilization and multimodal rehabilitation strategies.

DISCUSSION

The demographic characteristics of our study cohort revealed a higher percentage of male patients (54.35%) and a substantial number of patients in the 31-45 years age group (43.48%). These findings are in line with previous studies in spinal surgery populations, where males and middle-aged patients are often more represented due to the higher prevalence of conditions such as degenerative disc disease and spinal instability [8]. However, the male predominance in spinal surgery is particularly notable, as a large proportion of spinal injuries are attributed to occupational risks, which are more common among men [9]. Studies from regions such as North America and Europe have reported similar gender distributions, although there may be some variations depending on the geographical region and cultural factors influencing the choice to undergo surgery. Our study's results are consistent with the general trends observed in the literature, reinforcing the understanding that spinal pathologies are more prevalent in middle-aged men. In comparison, a study from South Asia found a higher proportion of female patients undergoing spinal surgeries due to a significant prevalence of osteoporosis-related fractures, particularly in postmenopausal women [10]. These regional differences highlight the importance of considering local epidemiological factors when interpreting spinal surgery patient demographics. The relatively high incidence of comorbidities (32.61%) in our cohort is consistent with other studies where comorbid conditions, such as diabetes and hypertension, have been associated with poor postoperative outcomes in spinal surgery patients. This underscores the necessity of tailoring ERAS protocols to account for comorbidities and ensuring their inclusion in postoperative care planning.

Type of Surgery Performed

The study findings reveal that the most common surgeries performed were fusion (39.86%) and decompression (32.61%), both of which are commonly indicated for degenerative disc disease and lumbar spondylosis. These results are similar to studies conducted in the US and Europe, where spinal fusion and decompression are frequently performed procedures, especially for conditions involving spinal instability or nerve compression. The high incidence of fusion surgeries aligns with a study by Reisener *et al*., who found that lumbar fusion is increasingly becoming the preferred method due to its ability to stabilize the spine and provide long-term relief from pain [11]. However, the lower percentage of combined procedures (9.42%) in our cohort, when compared to a study in Canada that reported combined surgeries making up 15-20% of spinal surgeries, could be attributed to differences in surgical practices and healthcare protocols between regions [12]. In regions where resource limitations exist, more complex surgeries are often avoided unless absolutely necessary, contributing to fewer combined procedures. The p-value for different surgery types in our study suggests statistical significance, indicating that certain types of surgeries, particularly fusion, are more commonly performed in this

setting, possibly due to the prevalence of degenerative disc diseases in the middle-aged cohort. The lower use of combined procedures may also reflect the increased surgical risk associated with these surgeries, and the preference for more straightforward interventions under the ERAS protocol.

Postoperative Complications

One of the most notable findings of our study is the low complication rate, with 80.43% of patients experiencing no postoperative complications. The most common complications were infection (7.25%) and deep vein thrombosis (DVT) (5.80%), which are consistent with complications reported in previous ERAS studies. A US-based study by Cai *et al*. also demonstrated a significant reduction in complications like infection and DVT when ERAS protocols were employed [13]. The reduction in complications in our study is attributed to the multimodal approach that includes early mobilization, pain management, and nutritional support, all of which are components of ERAS protocols known to reduce the risk of these complications. Comparatively, a European study with a similar sample size found a higher rate of complications (15%) due to a higher proportion of patients with comorbid conditions and elderly populations undergoing surgery [14]. The difference in complication rates could be due to the younger average age of patients in our study and the lower comorbidity rate, as well as variations in the implementation of ERAS protocols in different healthcare systems.

Opioid Consumption

A significant reduction in opioid consumption was observed in our study, with 54.35% of patients using less than 25 mg of opioids post-surgery. This reduction aligns with findings from multiple studies that have demonstrated the effectiveness of ERAS protocols in reducing opioid use through the use of multimodal analgesia. A study by Prabhakar *et al*. also reported similar reductions in opioid consumption in lumbar spine surgery patients, highlighting the benefit of regional anesthesia and non-opioid pain management [15]. The p-values of the opioid consumption groups confirm statistical significance, showing that the use of ERAS protocols directly correlates with lower opioid consumption in postoperative care. Interestingly, a study conducted in Asia found that opioid reduction was less pronounced, particularly in elderly populations, where pain management needs are typically more complex due to the presence of multimorbidity and age-related pain sensitivity [16]. This discrepancy highlights the importance of considering age and comorbidity when tailoring pain management strategies in spinal surgeries, especially in older patients who may require a more individualized approach.

Length of Hospital Stay

The length of hospital stay in our cohort was significantly reduced, with 80.43% of patients being discharged within 7 days, which is consistent with findings from other ERAS studies in spinal surgery populations. A similar study in **Canada** found that ERAS protocols reduced the average length of stay from 8.2 days to 6.4 days in lumbar spine surgery patients, highlighting the positive impact of early mobilization and pain control. The p-value for length of stay in our study suggests that early recovery protocols, including early feeding, early ambulation, and optimized pain management, significantly reduce hospital stay duration. In contrast, a study in Australia found that the length of stay for spinal surgery patients was only marginally reduced under ERAS protocols, which could be attributed to differences in healthcare infrastructure, recovery protocols, and discharge criteria [17]. These differences in the reduction of hospital stays between regions may also reflect differences in healthcare systems and patient expectations regarding recovery times.

Functional Recovery (ODI Scores)

Our study demonstrated that **65.94%** of patients had a significant improvement in their ODI scores, indicating functional recovery after spinal surgery. This result supports the growing body of literature indicating that ERAS protocols contribute to improved functional outcomes in spinal surgery patients. A study by Tazreean *et al*. also reported similar results, showing that early mobilization and rehabilitation programs significantly enhanced functional recovery in patients undergoing lumbar spine surgery [18]. The p-value for ODI score improvement confirms that the observed improvements in functional recovery were statistically significant. However, studies in elderly populations have shown more modest functional recovery improvements, as older patients often experience slower recovery due to age-

related factors, such as reduced muscle mass, bone density, and overall physical resilience [19,20]. This highlights the need for a tailored approach to functional recovery, especially for older patients who may benefit from additional support or extended rehabilitation programs.

Interpretation and Implications

The findings from this study suggest that ERAS protocols are highly effective in improving postoperative outcomes for spinal surgery patients. The reduction in opioid consumption, shortened hospital stays, decreased complication rates, and improved functional recovery observed in our cohort are consistent with the growing body of evidence supporting ERAS protocols. These results have important implications for the implementation of ERAS protocols in clinical practice. By reducing opioid use and hospital stays, these protocols not only improve patient outcomes but also contribute to cost savings for healthcare systems. The findings also suggest that ERAS can be effectively implemented across a diverse patient population, with adaptations made to address age, comorbidities, and surgical complexity.

CONCLUSION

This study confirms that ERAS protocols significantly enhance postoperative recovery in spinal surgery patients. The key outcomes, including reduced opioid consumption, shorter hospital stays, fewer complications, and improved functional recovery, underscore the efficacy of ERAS in optimizing recovery. These findings align with existing literature and provide robust evidence supporting the widespread adoption of ERAS protocols in spinal surgeries. Implementing these protocols can lead to improved patient outcomes, reduced healthcare costs, and enhanced satisfaction. Future research should explore the long-term effects of ERAS protocols, particularly in older patients and those with multiple comorbidities, to further refine and optimize these recovery strategies.

RECOMMENDATIONS

Implementation of ERAS protocols should be standardized across spinal surgery units to improve postoperative outcomes and reduce healthcare costs.

Personalized care strategies should be developed, especially for elderly patients or those with comorbidities, to optimize the benefits of ERAS protocols.

Further long-term studies are needed to assess the sustained impact of ERAS on recovery and quality of life, especially in complex spinal surgeries.

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