Bone and Arthrosurgery Science, 2026, Volume 4, Issue 3
http://ojs.bbwpublisher.com/index.php/BAS
Online ISSN: 2981-8222
Print ISSN: 3083-4856

Research on the Application of Enhanced Recovery After Surgery (ERAS) Concept Combined with Wiltse Approach TLIF in Elderly Patients with Lumbar Spinal Stenosis

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Abstract: *Objective:* To evaluate the clinical efficacy and safety of the enhanced recovery after surgery (ERAS) concept combined with the Wiltse intermuscular approach transforaminal lumbar interbody fusion (TLIF) in the treatment of elderly patients with lumbar spinal stenosis. *Methods:* A prospective study was conducted on 63 elderly patients with lumbar degenerative diseases and lumbar spinal stenosis admitted to our hospital from February 2021 to June 2022, aged ≥60 years. Patients were randomly divided into an ERAS group (32 cases) and a control group (31 cases) using a random number table method. The ERAS group received standardized perioperative management based on the ERAS concept and underwent TLIF via the Wiltse intermuscular approach, while the control group received conventional perioperative management and underwent TLIF via the traditional posterior median approach. Perioperative indicators such as general patient information, length of hospital stay, operative time, intraoperative blood loss, and postoperative complications were compared between the two groups. Pain in the affected limb was assessed using the visual analogue scale (VAS) before surgery and on postoperative days 1, 3, and at 1 month and 3 months. Functional status was evaluated using the Oswestry disability index (ODI) before surgery and at 1, 3, and 6 months postoperatively. The overall therapeutic effect was evaluated according to the modified MacNab criteria at the last follow-up. *Results:* There were no statistically significant differences in general patient information between the two groups ($P > 0.05$). Compared with the control group, the ERAS group had significantly reduced intraoperative blood loss and postoperative hospital stay ($P < 0.05$). There were no statistically significant differences in operative time, preoperative VAS score for pain in the affected limb, or preoperative ODI score between the two groups ($P > 0.05$). The VAS scores in the ERAS group were significantly lower than those in the control group on postoperative days 1, 3, and at 1 month and 3 months ($P < 0.05$), with no significant difference between the two groups at 3 months postoperatively ($P > 0.05$). The ODI scores in the ERAS group were significantly better than those in the control group at 1, 3, and 6 months postoperatively ($P < 0.05$). At the last follow-up, according to the modified MacNab criteria, the ERAS group had 29 excellent cases, 2 good cases, and 1 fair case, with an excellent and good rate of 96.9%; the control group had 26 excellent cases, 2 good cases, and 3 fair cases, with an excellent and good rate of 90.3%. There were 4 postoperative complications in the ERAS group and 9 in the control group, with no postoperative readmissions or deaths within 30 days postoperatively in either group. *Conclusion:* The application of the ERAS concept combined with the Wiltse approach TLIF in elderly patients with lumbar spinal stenosis can reduce blood loss and complications, alleviate early postoperative pain, accelerate functional recovery, and shorten hospital stay while ensuring surgical safety, which is of great clinical significance.

Keywords: Enhanced recovery after surgery concept; Lumbar spinal stenosis; Elderly; Interbody fusion cage; Spinal fusion surgery

Online publication: July 7, 2026

1. Introduction

Enhanced recovery after surgery (ERAS) is a comprehensive set of perioperative optimization strategies proposed based on evidence-based medicine. Through multidisciplinary collaboration, targeted interventions are implemented at every stage—before, during, and after surgery—to reduce the body's stress response, minimize complications and readmission rates, shorten hospital stays, and thereby enhance patient satisfaction. The ERAS model has garnered substantial evidence-based support in fields such as general surgery and joint replacement [1,2]. In recent years, it has also been gradually applied in spinal surgery [3], demonstrating favorable outcomes. However, prospective studies specifically targeting elderly patients with lumbar spinal stenosis remain limited. From a surgical approach perspective, the Wiltse intermuscular approach is a method that accesses the lamina and facet joint regions through the natural muscle gap between the multifidus and longissimus muscles along the lumbar back. This approach reduces paraspinal muscle dissection and retraction, preserving as much of the posterior column muscle-ligament complex as possible, thereby alleviating postoperative low back pain and reducing the risks of muscle atrophy and scar adhesion. When combined with the transforaminal lumbar interbody fusion (TLIF) technique, it is considered a less invasive variant compared to the traditional posterior midline approach TLIF. If further complemented by systematic ERAS management, it holds promise for amplifying the minimally invasive effects in elderly patients.

Based on a summary of previous evidence-based research on ERAS and spinal surgery, this study constructed a set of ERAS perioperative management procedures specifically tailored for elderly patients with lumbar spinal stenosis. These procedures were compared prospectively with traditional management approaches, utilizing the Wiltse intermuscular approach TLIF and the traditional posterior midline approach TLIF as surgical methods. By comparing perioperative indicators, pain and functional recovery, and the incidence of complications, the safety and efficacy of this comprehensive strategy were evaluated, providing a reference for the standardized diagnosis and treatment of the ERAS model in elderly patients.

2. Materials and methods

2.1. Study subjects

This study was a prospective controlled trial that included 63 elderly patients with lumbar degenerative diseases accompanied by lumbar spinal stenosis admitted to our hospital from February 2021 to June 2022. All patients met the surgical indications and had imaging-confirmed lumbar spinal stenosis at the responsible levels.

Inclusion criteria: (1) Age ≥60 years; (2) Diagnosed with lumbar degenerative diseases accompanied by lumbar spinal stenosis requiring surgical decompression and fusion, including lumbar spondylolisthesis, lumbar spinal stenosis, and lumbar disc herniation with stenosis; (3) Number of responsible levels ≤2; (4) No severe cognitive impairment, able to cooperate with follow-up and functional assessment.

Exclusion criteria: (1) Spinal lesions and deformities caused by non-degenerative etiologies such as spinal infections, trauma, tumors, and ankylosing spondylitis; (2) Previous history of lumbar surgery; (3) Severe complications during the perioperative period requiring transfer to another department for treatment; (4) Number of responsible levels >2; (5) Severe coagulopathy or systemic conditions intolerant to anesthesia and surgery.

2.2. Grouping and surgical methods

Prospective randomization was used to divide patients who met the inclusion criteria and completed follow-up into an ERAS group (32 cases) and a control group (31 cases) according to a random number table. All surgeries were performed by the same spinal surgery team under general anesthesia, with consistent anesthesia methods and basic perioperative anti-infective and internal medicine management principles.

The ERAS group underwent TLIF via the Wiltse intermuscular approach. Based on the location of the responsible intervertebral space, small incisions of approximately 4–5 cm were made about 2–3 cm laterally from the spinous process on both sides. After incising the lumbar back fascia, blunt dissection was performed along the natural muscle gap between the multifidus and longissimus muscles to expose the spinous process crest, where pedicle screws were inserted. On the decompression side, the multifidus muscle was moderately separated outward to expose the lamina, followed by decompression of the spinal canal and intervertebral foramen, as well as discectomy. A fusion cage was implanted and fixed, and connecting rods were installed and tightened. The wound was irrigated, a drainage tube was placed, and the layers were sutured sequentially.

The control group underwent TLIF via the traditional posterior midline approach. Patients were placed in the prone position, and a longitudinal incision was made along the posterior midline. The paraspinal muscles were stripped subperiosteally from the spinous processes to the roots of the transverse processes on both sides, exposing the laminae, facet joints, and transverse processes. Pedicle screws were inserted at the responsible levels, followed by decompression of the spinal canal and intervertebral foramen, resection of the diseased intervertebral disc, implantation of an appropriately sized interbody fusion cage, installation and tightening of connecting rods, routine irrigation, and layered suture. A drainage tube was placed at the incision site.

2.3. ERAS perioperative management procedures

The ERAS group implemented systematic ERAS management based on the aforementioned surgical approach, with the procedures outlined in **Table 1**.

Table 1. ERAS process management measures

Time	Item	ERAS group	Control group
Preoperative	Preoperative education	From pre-hospitalization, use multimedia videos, spinal anatomy models, etc., to explain to patients and family members the condition, surgical approach, possible complications, postoperative functional exercises, etc. Systematic re-education is given 1 day before surgery.	Education given 1 day before surgery, explaining the condition, surgical approach, possible complications.
	Psychological assessment	A psychiatrist performs psychological assessment and intervention after admission.	None
	Preemptive, multimodal analgesia	Perform VAS score after admission; give regular daily oral NSAIDs.	None
	Preoperative fasting time	Fluid fasting time: 2h before surgery, with oral clear fluids allowed before that (total < 400 ml); Food fasting time: 6h before surgery.	Fast from food 12h before surgery, fluids 4h before surgery.
	Preoperative nutritional support	Use nutritional risk screening to assess nutritional status; provide high-protein diet during perioperative period.	Regular diet
Intraoperative	Temperature management	Maintain room temperature at 20-24°C; cover exposed areas with blankets promptly after disinfection and surgery; use a forced-air warmer during surgery; warm irrigation fluid to ~37°C; use a fluid warming device for intravenous fluids.	Surgery performed at 20-24°C.
	Surgical approach	Unilateral Wiltse approach TLIF surgery.	Traditional posterior midline approach TLIF surgery.
	Bleeding management	Give a bolus of tranexamic acid 10-20 mg/kg before incision to reduce intraoperative blood loss.	None
	Incision management	Mix ropivacaine and lidocaine before closure; inject around the incision at multiple points using a 5 mL syringe needle.	Routine suture closure of the incision.
Postoperative	Early feeding	After full recovery from anesthesia, encourage water intake; give room-temperature liquid food orally 2–4h after surgery. After 3–4h from the first feeding, increase frequency and amount according to gastrointestinal tolerance.	Feed after the patient has passed flatus.
	Tube management	Remove urinary catheter after recovery from anesthesia. Male patients with high risk factors for urinary retention may have the catheter removed on the morning of postoperative day 2. Remove the incision drain when output is <50 mL.	Remove urinary catheter on postoperative day 2; remove incision drain when output is <50 mL.
	Early rehabilitation activities	After recovery from anesthesia, begin toe flexion/extension, ankle pump, quadriceps isometric contraction, and straight leg raise exercises. After physical strength recovers, ambulate with the assistance of professional rehabilitation personnel.	After removal of urinary catheter and drain, gradually begin bed exercises under guidance.

2.4. Observation indicators and evaluation methods

Perioperative clinical indicators included: gender, age, operation time, intraoperative blood loss, postoperative hospital stay, types and incidence of postoperative complications, as well as postoperative readmission and mortality within 30 days.

Pain assessment was conducted using the Visual Analog Scale (VAS) (0–10 points), with the degree of pain in the affected limb recorded before surgery and on postoperative days 1, 3, and at 1 month and 3 months. Functional assessment was performed using the Oswestry Disability Index (ODI) to evaluate the degree of lumbar-related dysfunction before surgery and at 1 month, 3 months, and 6 months postoperatively. At the final follow-up, overall efficacy was evaluated according to the modified MacNab criteria, categorized into four grades: excellent, good, fair, and poor, with the excellent and good rates calculated.

2.5. Statistical analysis

Statistical analysis was performed using SPSS 27.0 software. Continuous data that followed a normal distribution and had homogeneous variances were expressed as mean ± standard deviation (SD). Comparisons between groups were made using repeated measures analysis of variance. Non-normally distributed data were analyzed using the Mann-Whitney U test. Categorical data were compared using the χ^2 test or Fisher's exact test. A P-value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of general data

The ERAS group consisted of 32 patients, including 12 males and 20 females, with an average age of 65.13 ± 4.30 years. The control group consisted of 31 patients, including 16 males and 15 females, with an average age of 66.55 ± 3.82 years. There were no statistically significant differences between the two groups in terms of gender composition, age, operation time, preoperative VAS pain scores for the affected limb, and ODI scores ($P > 0.05$, **Table 2**).

Table 2. Comparison of general data and perioperative data between the two groups

Group	Number of cases	Male/Female (*n/n*)	Age (years)	Preoperative VAS score of affected limb	Preoperative ODI score
ERAS group	32	12/20	65.13 ± 4.30	7.81 ± 1.03	78.16 ± 9.88
Control group	31	16/15	66.55 ± 3.82	8.16 ± 1.13	78.39 ± 9.92
$\chi^2/t/Z$ value		1.270	2.932	-1.282	-1.349
P value		0.260	0.170	0.205	0.183

3.2. Perioperative clinical indicators

Compared with the control group, the ERAS group demonstrated a significant reduction in intraoperative blood loss and a shorter postoperative hospital stay, with statistically significant differences ($P < 0.001$, **Table 3**). In terms of operative time, the ERAS group was slightly longer, but the difference was not statistically significant ($P > 0.05$, **Table 3**). Regarding postoperative complications, there were 4 cases in the ERAS group and 9 cases in the control group, indicating a significantly lower complication rate in the ERAS group. Neither group experienced readmission or death within 30 days postoperatively.

There was no statistically significant difference in preoperative VAS scores between the two groups ($P = 0.205$, **Table 2**). The VAS scores for pain in the affected limb in the ERAS group showed a gradual decrease on postoperative days 1, 3, and at 1 and 3 months ($P < 0.001$, **Table 4**), with a consistent trend of improvement, suggesting superior early and mid-term pain control with ERAS management combined with the Wiltse approach.

There was no statistically significant difference in preoperative ODI scores between the two groups ($P = 0.183$, **Table 2**). Postoperative assessments at 1, 3, and 6 months showed significant improvement in ODI scores over time in both groups, with the ERAS group consistently outperforming the control group, with statistically significant differences (P < 0.001, **Table 5**). This suggests that ERAS management combined with the Wiltse approach TLIF facilitates accelerated postoperative functional recovery.

This study employed modified MacNab criteria for efficacy evaluation and recorded complications. At the last follow-up, the ERAS group had 39 excellent cases, 2 good cases, and 1 fair case, with an excellent and good rate of 95.3%; the control group had 35 excellent cases, 2 good cases, and 3 fair cases, with an excellent and good rate of 87.5%. Both groups showed good overall efficacy, with the ERAS group slightly outperforming the control group, as shown in **Table 6**.

In terms of postoperative complications, there were 4 cases in the ERAS group, including pulmonary infection and urinary tract infection, while there were 9 cases in the control group, with a statistically significant difference in complication rates. Neither group experienced severe complications requiring readmission or resulting in death within 30 days postoperatively.

Table 3. Comparison of hospital stay, operative time, and blood loss between the two groups

Group	Number of cases	Hospital stay (days)	Operation time (min)	Intraoperative blood loss (ml)
ERAS group	32	12.00 ± 1.63	77.78 ± 11.54	120.63 ± 9.31
Control group	31	17.00 ± 1.61	74.19 ± 8.77	203.23 ± 51.29
$\chi^2/t/Z$ value		-12.251	1.393	-8.826
P value		<0.001	0.169	<0.001

Table 4. Comparison results of VAS scores for pain in the affected limb at different time points between the ERAS group and the control group (mean ± SD, points)

Group	*n*	Preoperative	Postoperative day 1	Postoperative day 3	Postoperative month 1	Postoperative month 3
ERAS group	32	7.81 ± 1.03	2.31 ± 0.69	1.56 ± 0.67	1.38 ± 0.49	1.28 ± 0.46
Control group	31	8.16 ± 1.13	2.81 ± 0.83	2.06 ± 0.63	1.71 ± 0.64	1.32 ± 0.54
F value		F_{time} = 1168.907, F_{group} = 8.858, $F_{interaction}$ = 1.292				
P value		P_{time} < 0.001, P_{group} = 0.004, $P_{interaction}$ = 0.278				

Note: Comparison was made using multivariate analysis of variance. Compared with the preoperative values within the same group, *P < 0.05.

Table 5. Comparison results of ODI scores at different time points between the ERAS group and the control group (mean ± SD, points)

Group	*n*	Preoperative	Postoperative 1 month	Postoperative 3 months	Postoperative 6 months
ERAS group	32	78.16 ± 9.88	22.75 ± 4.54	15.19 ± 2.97	6.87 ± 1.34
Control group	31	78.39 ± 9.93	30.77 ± 5.55	20.03 ± 3.05	11.61 ± 1.86
F value		F_{time} = 1735.992, F_{group} = 41.112, $F_{interaction}$ = 4.628			
P value		P_{time} < 0.001, P_{group} < 0.001, $P_{interaction}$ = 0.035			

Note: Comparison was conducted using multivariate analysis of variance. Compared with the preoperative values within the same group, *P < 0.05.

Table 6. Comparison of clinical efficacy evaluated by modified MacNab criteria between the ERAS group and the control group (cases)

Group	Excellent	Good	Fair	Poor	Excellent-good rate (%)
ERAS group	29	2	1	0	96.9
Control group	26	2	3	0	90.3

Note: The excellent and good rate was calculated as (Excellent + Good) / Total number of cases × 100%. Comparison between the two groups was conducted using Fisher's exact test, with $P = 0.355$ (two-tailed).

4. Discussion

The study results indicate that, among elderly patients with lumbar spinal stenosis, perioperative management based on the ERAS concept combined with the Wiltse intermuscular approach for TLIF significantly reduces intraoperative blood loss and shortens hospital stays compared to traditional perioperative management combined with the posterior midline approach for TLIF. This approach also lowers the incidence of complications, improves early postoperative pain and mid-term functional recovery, and achieves a higher excellent and good rate according to the MacNab criteria at the last follow-up. These findings suggest that combining surgical trauma control with comprehensive perioperative optimization offers significant clinical advantages in the surgical treatment of elderly patients with lumbar spinal stenosis.

Traditional posterior approaches often lead to denervation and ischemic changes in the paraspinal muscles, whereas the Wiltse approach [4] preserves the innervation and blood supply of some muscles, reducing the occurrence of chronic postoperative low back pain. The preservation of the paraspinal muscles and posterior ligamentous complex via the Wiltse approach may influence the postoperative recovery process through multiple mechanisms [5]. First, reducing muscle dissection and retraction can decrease local inflammatory responses and ischemia-reperfusion injury, creating favorable conditions for early postoperative mobilization. Second, maintaining the integrity of the muscle-ligament complex may help preserve spinal dynamic stability, thereby alleviating early postoperative mechanical pain. This hypothesis aligns with the improvement in early postoperative VAS scores observed in our study patients, but further validation through imaging and biomechanical studies is needed. Research has shown [6] that the Wiltse approach preserves approximately 70% of paraspinal muscle function, which may be a key reason for faster postoperative recovery.

Notably, the accelerated functional recovery observed in the ERAS group in this study suggests that reduced surgical trauma may alter the kinetics of postoperative recovery. Traditional views [7] hold that postoperative recovery in elderly patients is primarily limited by underlying diseases and physiological reserves. However, our study results indicate that these limitations can be partially overcome by optimizing surgical techniques and perioperative management. This finding has significant implications for geriatric spine surgery, suggesting that elderly patients should not be simply regarded as a "high-risk group" with lowered treatment goals. Instead, their prognosis can be improved through technological innovation and management optimization. In terms of complication prevention, our study results support the concept of "prevention is better than treatment." The lower complication rate in the ERAS group may be related to multiple factors: multimodal analgesia in the ERAS protocol (e.g., local infiltration anesthesia, NSAIDs) reduces the need for opioids, thereby decreasing the risk of postoperative delirium, ileus, and other complications; early mobilization reduces pulmonary complications; and nutritional support promotes wound healing and improves immune function. Reduced intraoperative blood loss lowers the need for blood transfusions and associated risks; these factors collectively create a virtuous cycle, particularly beneficial for elderly patients with limited physiological reserves.

However, several aspects of this study's design require cautious interpretation. First, combining the surgical approach with perioperative strategies as a single intervention makes it impossible to distinguish their individual contributions. Second, a 6-month follow-up period is clearly insufficient for evaluating long-term outcomes such as fusion rates and adjacent segment degeneration. Third, the lack of objective muscle function assessments and inflammatory marker measurements limits the interpretation of underlying mechanisms. Future studies will adopt a multicenter design, extend follow-up periods, and incorporate more objective indicators to comprehensively evaluate the value of this comprehensive intervention. From a clinical practice perspective, our study results suggest that combining minimally invasive surgical techniques with the ERAS concept may yield superior clinical outcomes compared to traditional methods for elderly patients with lumbar spinal stenosis.

5. Conclusion

In summary, this study provides new insights into the treatment of elderly patients with lumbar spinal stenosis, but the relevant conclusions require further validation in larger, more rigorously designed studies. Future research directions should include comparing the benefits of different technical combinations, evaluating long-term functional outcomes, conducting cost-effectiveness analyses, and optimizing individualized protocols guided by biomarkers.

Funding

Key Research and Development Program of Linfen Science and Technology Bureau (Grant No. 2329)

Disclosure statement

The authors declare no conflict of interest.

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