



Enhanced recovery after spine surgeries (ERAS)

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Abstract

Protocols for enhanced recovery after surgery (ERAS) are a collection of measures taken before and during surgery to improve the likelihood of a patient's full recovery. They will aid the patient in recovering from surgery more quickly and with less negative side effects. It is well-established that ERAS is beneficial in a number of other surgical subspecialties. It was previously believed that spine surgery was too complicated to be able to use ERAS methods. This has all changed, though, in the past ten years, as (ERAS) protocols have become increasingly common in spine surgery. The lumbar spine was the only area where ERAS was initially studied in the context of spine surgery. But ERAS has grown to encompass anterior cervical procedures, spine deformities, malignancies, and senior spine surgery. Longer hospital stays, reduced overall hospital expenses, less opioid intake during perioperative and postoperative periods, and decreased complication rates in spine surgery have all been demonstrated by ERAS. In this narrative review, we cover a lot of ground with ERAS in spine surgery, from the advantages of the technique to the different parts of the protocol for preoperative, intraoperative, and postoperative measures.

Keywords: Enhanced recovery after surgery, spine surgeries

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A growing number of surgical subspecialties are embracing the concept of enhanced recovery after surgery (ERAS) or "fast track" procedures. The idea of ERAS is to include a number of postoperative and perioperative evidence-based interventions that can lessen the body's stress response to surgery, improve the patient's recovery, and decrease the risk of problems.^{1,2} ^{6,9} The lumbar spine was the original target of endoscopic retrograde angioplasty (ERAS), but the range of procedures that use this technique has grown to encompass surgeries on the cervical spine, deformities of the spine, malignancies of the spine, and even older patients having spine procedures done.^{9, 10, 11, 12}

Shorter hospital stays are the most often reported advantage of ERAS protocols for spine surgeries. According to many meta-analyses, ERAS protocols greatly shorten patients' hospital stays and make it easier for them to go out quickly.^{8,13,14} There is no evidence that fact track discharge or ERAS guidelines enhance the risk of complications. The complication rate is actually lower in ERAS groups, according to many research.^{8,14} Postoperative pain scores were found to be lower in the ERAS group compared to the conventional treatment group in several ERAS regimens.^{8,14,15}

Spine surgeons throughout the world are seeing an increasing problem with patients who continue to use opioids following their operation. After spinal surgery, many patients, particularly those who were already using opioids before the procedure, keep using them for a long time. In this respect, sixteen ERAS procedures have demonstrated efficacy. Patients following the ERAS protocol use much less opioids during the perioperative period compared to the control group, according to many studies.^{13,17} In their prospective cohort

study, Flanders et al. demonstrated that ERAS significantly reduced opioid use at 1, 3, and 6 months after surgery, highlighting the post-operative effects of ERAS on opioid use. Nearly 24% of ERAS patients were using opioids at 6-month follow-up, compared to 52% of non-ERAS patients.¹⁸

ERAS has demonstrated its efficacy in a variety of spinal operations. There was a considerable decrease in LOS and postoperative complications in the ERAS group, according to a recent systematic analysis on the use of ERAS in paediatric deformity correction procedures. There was no discernible rise in 30-day readmission rates, and they also found reduced pain scores on days 0 and 2.¹⁹ A meta-analysis relating to Adolescent idiopathic scoliosis (AIS) also found a reduced LOS in the ERAS group.¹⁰ Liu et al. in their RCT on 94 patients with intraspinal tumors noted a significant reduction in LOS, lower postoperative pain scores, decreased patient controlled analgesia use and opioid use, early removal of urinary catheter and higher satisfaction rates in the ERAS group. However, the complication rates were not different between the two groups.¹¹ A case matched study related to applicability of ERAS in the elderly population (>65 years) undergoing short lumbar fusion found that a significant reduction in LOS was seen in the ERAS group without an increase in complication rates.²⁰ A multivariate regression analysis revealed that comorbidities and implementation of ERAS protocols were the only two factors that correlated with length of hospital stay.²⁰ ERAS pathways have also been shown to reduce the postoperative use of opioids at one and three months in the elderly population.²¹ ERAS pathways are of benefit even in frail elderly patients, improving physiological function return and LOS. The results approximated outcomes of non-frail patients.¹² The applicability of ERAS has also been established for anterior cervical surgery. A retrospective case matched study in patients undergoing anterior cervical surgery on an ERAS pathway resulted in a significant decrease in LOS. There was no difference in the complication rate and readmission rates at one and 3 months.²² Leng et al. in their patients undergoing anterior cervical surgery noted a lower cost, higher patient satisfaction, and shorter LOS in hospital stay. The applicability of ERAS in multilevel disease ($n \geq 3$) was also established.⁹ The cost benefit of application of ERAS protocol has been noted by multiple authors across various types of spine surgeries.^{9,23} It leads to significant savings in hospital days and reduction in cost.²⁴ However, the initial cost of implementation and further maintenance of ERAS programs can be a costly affair.²⁵ The training of personnel and intraoperative costs account for the major expenses associated with the ERAS protocols.²⁵ Despite these higher initial costs ERAS has been found to be cost effective overall.²⁶ However this is likely to be affected by the volume of patients being operated in a centre.

The protocol Component: ⁸⁴

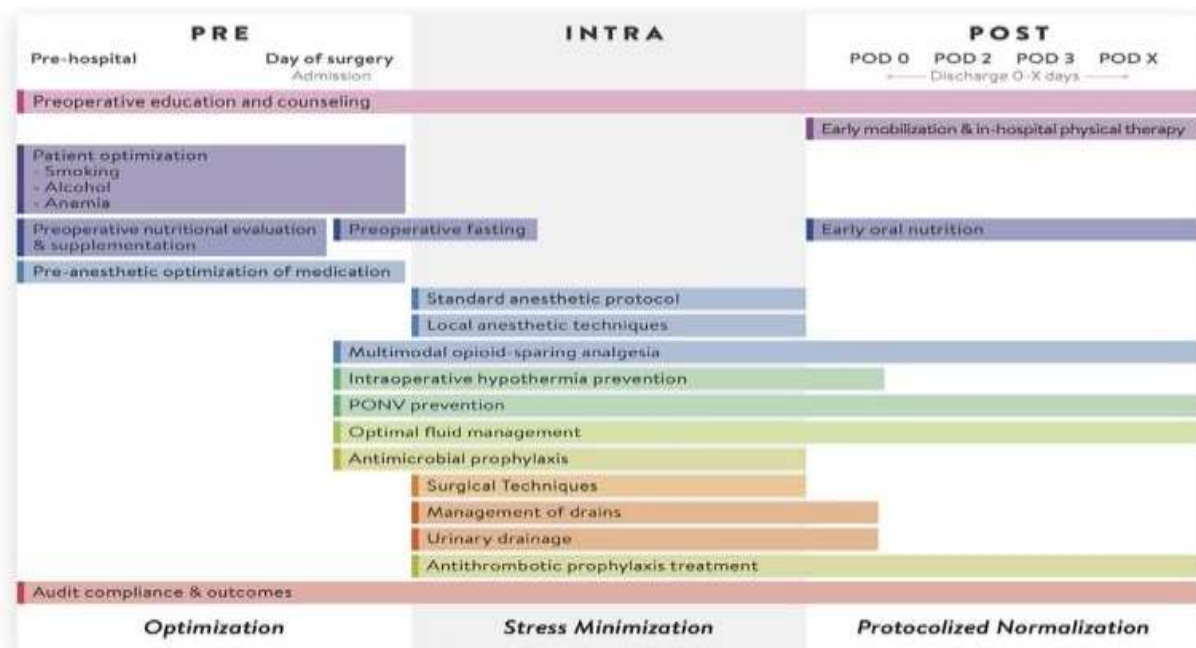


Fig. 1. Summary of recommended perioperative topics for ERAS and lumbar fusion. ⁸⁴

ERAS pathway is a set of evidence based interventions that are carried out in the perioperative period that leads to a faster recovery of patients. There are many protocols described in the literature and these can vary to great extent in their components.^{27,28} Despite these variations, the goal of ERAS remains to improve patient outcomes by preoperative optimization, pre-emptive analgesia, opioid sparing multimodal anesthesia, early mobilization and nutrition etc. in an attempt to prevent catabolism and immune dysfunction. The interventions can be divided into preoperative, intraoperative and postoperative measures. The major components in each of periods are described below. The list is non-exhaustive and components can vary across protocols.

Preoperative measures

Preoperative education and counselling

The ERAS pathway begins right at the start when the patient is counselled for surgery. It has been seen that patients with adequate preoperative information regarding the surgery and expected outcomes have higher satisfaction scores post-surgery than those with inadequate information.²⁹ A recent systematic review based on seven RCT's related to preoperative education and counselling in spine surgery noted that it not only improved postoperative pain and reduced length of hospital stay (LOS) but also improved psychological and economic outcomes.³⁰

Preoperative optimization of patient

Malnutrition has been shown to be an independent risk factor for the risk of perioperative complications, increased length of hospital stay and 30 day readmission rates in various studies across lumbar and cervical spine.^{31,32} Serum albumin levels have been shown to be an effective marker for gauging the nutritional status of the patients.^{31,32} The serum albumin level greater than 3.5 gm/dl are considered optimal before surgery. Patients with poor nutritional status benefit greatly from optimization before surgery. Xu et al. in an RCT noted that multimodal nutritional management involving protein carbohydrates and nutritional supplements in the preoperative and perioperative period in patients with poor nutritional status reduced LOS, decreased incidence of electrolyte disturbances, and resulted in higher postoperative albumin levels compared to controls.³³

Preoperative anaemia is another modifiable risk factor that has a huge bearing on surgical outcomes. A study based on a National surgical quality improvement program database noted that preoperative anaemia of all levels (mild, moderate and severe) is associated with increased LOS, risk of perioperative complications and higher 30 day mortality rate than nonanemic patients. It was also worth noting that this association was not affected by the intra and postoperative transfusions.³⁴ Preoperative screening in outpatient departments, use of iron (oral or intravenous), erythropoietin injections and cell saver techniques can be used as effective techniques to reduce the need for allogeneic blood transfusions across various spine surgeries including paediatric deformity correction.^{35,36}

Preoperative smokers have been shown to be at higher risk of postoperative complications including increased risk of wound issues, surgical site infections, respiratory complications, delirium and pseudoarthrosis and need for intensive care.^{37,38} A systematic review noted that cessation of smoking resulted in a decrease of total complication rates and decreased the wound healing and pulmonary complications. It was also seen that each week of cessation resulted in a 19% increase in magnitude effect. The cessation time of at least 4 weeks resulted in more benefit than shorter trials.³⁹ Counselling of patient and nicotine replacement therapy are effective strategies which for smoking cessation that should be implemented with the help of deaddiction clinic referrals.⁴⁰

Alcohol consumption has been related to increased risk of post-operative complications like infection, pseudoarthrosis, cardiac and respiratory complications, delirium, ileus and deep vein thrombosis.⁴¹ It has also been suggested that daily consumption of more than two alcohol units increases the risk of complications in spine surgery with effects being less obvious for lesser quantities.⁴¹ A recent Cochrane review suggested that cessation of alcohol for 4–8 weeks before surgery was effective in decreasing the risk of postoperative complications.⁴²

Pre-emptive analgesia

Pre-emptive analgesia is a single or a group of medications that are given before surgery in an attempt to reduce the effects of upcoming painful stimuli. The drugs used in various protocols are varied.⁴³ However, the commonly used drugs mostly in combination of two or more in this regard include acetaminophen, non-steroidal anti-inflammatory drugs and gabapentinoids (gabapentin or pregabalin). Low dose local anaesthetics like ropivacaine and bupivacaine and opioids like oxycodone and tramadol have also been used.^{28,43} It has been shown that pre-emptive analgesia is effective in improving postoperative pain scores, decreasing total morphine equivalent consumption, and reducing LOS without increasing the risk of complications.⁴³ Another meta-analysis assessing the use of gabapentin as pre-emptive analgesia in spine surgery noted significantly lower total morphine consumption and better VAS scores in the first 24 h postoperatively. They also noted a significant decrease in postoperative complications like vomiting, pruritus and urinary retention (opioid related complications) with the use of gabapentin.⁴⁴

Intraoperative measures

Prophylactic antibiotics and surgical preparation

Multiple RCT's have demonstrated that prophylactic administration of antibiotics leads to decreased rates of surgical site infections in patients undergoing instrumented spinal fusion.⁴⁵ Both chlorhexidine or iodine preparations have been shown to be effective for adequate skin preparation before surgery.⁴¹

Standardized anesthesia protocol and multimodal analgesia

Anesthesia protocols can vary widely in spine surgery. However, ERAS pathways through multimodal analgesia (MMA) use a variety of interventions to decrease the use of opioids intraoperatively and postoperatively, decrease postoperative complications associated with anesthesia and achieve better perioperative pain control. A number of modifications and interventions have been described in this regard to enhance postoperative recovery. Soffin et al. in their study described the feasibility an opioid free anesthesia protocol which included the use of total intravenous anesthesia with MAC for inhalational agents maintained below 0.5. They noted that the perioperative requirement of opioids was significantly less compared to the traditional group with similar pain scores in both the groups.⁴⁶ Such protocols have been supported by other studies as well.⁷

Regional and local anaesthetic techniques like regional blocks, infiltration of wound, spinal and epidural analgesia can not only improve postoperative pain but also decrease the opioid requirement. Intrathecal morphine has been evaluated for use in lumbar spine surgery. Its use has been shown to effectively decrease pain scores and opioid consumption in the post-operative period.⁴⁷ Some respiratory depression is associated with its use, but it did not require any intervention or treatment.⁴⁷ The combination of naloxone and morphine for intrathecal use has been shown to further increase efficacy and reduce complications compared to intrathecal morphine alone.⁴⁸ Besides morphine the intrathecal use of fentanyl has also been shown to be effective in decreasing pain and opioid requirements with minimal respiratory depression requiring no intervention.⁴⁹ Epidural analgesia (EA) using long acting local anaesthetics with or without opioids have also been shown to be effective in reducing postoperative pain and decreasing opioid requirement.⁵⁰ It is recommended to start EA early in the procedure to for optimal results.⁵¹

Regional plane blocks like erector spinae (ESP) block, thoracolumbar interfascial plane block [TLIP] block, and quadratus lumborum block have gained popularity over the years as effective and safe strategies for postoperative pain management. A recent meta-analysis of 9 RCT's of the use of TLIP block in lumbar spine surgery noted lower VAS scores at all time points on first postoperative day. The frequency and overall use of patient controlled analgesia was also lower in the TLIP group.⁵² Goel et al. in their prospective study utilizing ultrasound guided ESP in single level lumbar fusion noted a lower opioid consumption, muscle relaxant requirement, operative blood loss, better pain scores and higher satisfaction rates than the control group.⁵³ Infiltration of long acting local anaesthetics like ropivacaine and bupivacaine at the local wound site at the time of closure have been very effective in decreasing postoperative pain scores and opioid requirement.⁵⁴ Recently the addition of alpha-2 agonists like dexmedetomidine and clonidine have been shown to improve the efficacy of long acting anaesthetics compared to when they are used alone.⁵⁵

Spinal anesthesia (SA) instead of general anesthesia (GA) has also been proposed by some for use in lumbar discectomies and lumbar spine fusion.^{56,57} Sekerak et al. in their retrospective comparative study between SA and GA in 1 and 2 level lumbar TLIF surgeries noted that SA significantly reduced the time in operating room, postoperative recovery room time, and time under anesthesia. Postoperative pain scores and opioid requirement was also less in the SA group. The complications and operative cost were not different between the two groups. Spinal and regional anesthesia protocols combined with ERAS principles has led to awake spinal fusion gaining popularity in the last few years.⁵⁸ The evidence for this new concept at present is limited and further large scale studies are needed in this field.

Maintenance of normothermia and euvolemia

Hypothermia during surgery increases the risk of blood loss, cardiac complications, long LOS and even surgical site infections.⁵⁹ Strategies such as warmed intravenous fluids, prewarming of patient and warming blankets along with continuous monitoring can effectively prevent hypothermia and its adverse effects.⁶⁰

Maintenance of euvolemia is an important component of ERAS as both hypo and hypervolemia have been associated with compromised cellular oxygen supply, especially in patients with poor cardiac and renal reserve.⁴¹ Goal directed fluid therapy has been shown to result in less crystalloid administration, fewer blood transfusions, and improved diuresis when applied to scoliosis surgery.⁶¹ Debeono et al. in their evidence based ERAS guidelines recommended goal directed fluid therapy for patients with comorbidities undergoing lumbar fusion.⁴¹

Use of MIS techniques

ERAS pathways often employ the use of minimally invasive surgery (MIS) techniques where possible, though the former works well in traditional open surgeries as well.⁶² The use of MIS techniques along with ERAS has been a natural progression, as MIS surgery also aims at minimizing tissue trauma, blood loss, faster rehabilitation and reduction of postoperative pain which are in line with the goals of ERAS.⁶² The effectiveness of minimally invasive techniques in terms of decreasing blood loss and length of stay has been seen in lumbar fusions.^{63,64} However steep learning curve and more radiation exposure during surgery for patient and surgeon and still major concerns.⁶²

Urinary catheters and wound drains

Urinary catheters are often used during surgery as they help in monitoring urine output, a marker of hemodynamic stability and prevent bladder distension.⁶⁵ However, delayed removal of urinary catheters is associated with increased risk of not only urinary tract and surgical site infections but also postoperative urinary retention (POUR) which in turn increases the risk of sepsis, hospital cost and LOS.⁶⁶ It also acts as a deterrent to early mobilization in the postoperative period. ERAS pathway recommends limited use urinary catheters to avoid complications. It has been shown that short elective spinal surgeries including lumbar spinal fusions can be managed without the use of urinary catheters.⁷ However, if they are used early removal within few hours of surgery with monitoring for POUR should be the goal.

The use of wound drains in spine surgery is a common practice which has been promoted by advantages such as low cost and belief that they lead to decreased risk of surgical site infection (SSI) and epidural hematoma formation. However, the rates of SSI, epidural hematoma formation and other complications have been found to be same irrespective of whether or not drain is used in various cervical and lumbar surgeries.^{67,68} The use of wound drains should be limited and if used, used should be removed early to facilitate mobilization.

Postoperative measures

Postoperative analgesia

Postoperative pain is one of the major concerns in spine surgery. Adequate pain control is not only helpful in improving functional outcomes and facilitating early mobilization and discharge but also prevents development of chronic pain.⁶⁹ It has been estimated that over half of the patients undergoing spine surgery experience poor pain control especially in the first 24 h post-surgery.⁷⁰ ERAS pathways improve postoperative pain with anticipation of pain, early intervention and multimodal analgesic strategies as discussed earlier being the key.⁷¹ Acetaminophen, NSAID's and selective COX-2 inhibitors alone or in combination have been shown to very effectively reduce postoperative pain and are the pillars of opioid

sparing multimodal analgesia followed in ERAS pathways.^{71,72} Opioids should be used sparingly as rescue analgesics only.

Post-operative nausea and vomiting care

Post-operative nausea and vomiting (PONV) is a common concern post-surgery and affects nearly one third of all surgical patients.⁷³ Risk factors for PONV include females, non-smokers, and patients with history of motion sickness or PONV.^{74,75} Opioid and nitrous oxide use perioperatively also increase the risk of PONV.⁷⁴ It results in dehydration, delay in nutrition, increased LOS and hospital charges.⁷³ Preoperative risk assessment and adequate prophylaxis is an important part of ERAS. First line drugs for prophylaxis and treatment include serotonin (5HT3) antagonists, dopamine (D2) antagonists and steroids.⁷³

Early mobilization

Prolonged recumbency is associated with multiple issues like insulin resistance, atrophy of muscles, decreased pulmonary function and tissue oxygenation and risk of deep vein and pulmonary thromboembolism.⁷⁶ Hence, early mobilization is an important component of ERAS pathways. There are multiple studies that have shown that early mobilization is associated with reduced LOS and decreased morbidity.^{77,78} The mobilization should be goal directed with progressive goals on each postoperative day. Goals like independent transfer in and out of bed and the ability to climb the stairs should be aimed at before discharge.⁷⁸ The importance of team work and early involvement of physiotherapist to achieve these goals especially in geriatric population cannot be overstated.

Designing of ERAS protocols may sound easy, but its implementation in actual practice can be a challenging task. Studies from gastrointestinal surgery in this regard have shown that compliance with the ERAS protocol components can be highly variable with very poor to excellent compliance rates being reported.^{79,80} It is important to appreciate that ERAS pathways often require multidisciplinary teams including surgeons, anaesthetics, nurses, physiotherapist and other speciality personal for successful implementation of a protocol.⁸¹ It has been seen that hospital personnel though positive about ERAS pathway, often find the process difficult.⁸¹ It requires effort and constant reinforcement to switch practices being followed earlier and change over to evidence based ERAS guidelines to improve the standard of healthcare.⁸² All the stakeholders should be involved early during the planning phase of a protocol, so as to enhance compliance. Regular meetings and audits for appraisal of practical challenges faced and incorporation of suggestions is equally important. Periodic monitoring, feedback of processes and measuring outcomes are essential so that successful implementation of ERAS protocols can be done.⁸³

Conclusion

ERAS protocols have gained prominence over the last decade in spine surgery. They have been shown to reduce length of hospital stay, decrease hospital costs and lower opioid requirement as compared to traditional protocols. Their applicability and reproducibility of results across various types of surgeries in the spine including lumbar, anterior cervical, deformity correction and spinal tumors reinstates the fact that they are here to stay. It is important to appreciate that the protocols can vary between different centres. They can often be dictated by hospital setups and resource constraint. However, preoperative optimization of patient, use of multimodal analgesia, and minimizing surgical trauma and early mobilization remain the cornerstones of nearly all ERAS protocols.

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