# Evidence Basis for Regional Anesthesia in Multidisciplinary Fast-Track Surgical Care Pathways

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**Abstract:** Fast-track programs have been developed with the aim to reduce perioperative surgical stress and facilitate patient's recovery after surgery. Potentially, regional anesthesia and analgesia techniques may offer physiological advantages to support fast-track methodologies in different type of surgeries. The aim of this article was to identify and discuss potential advantages offerred by regional anesthesia and analgesia techniques to fast-track programs.

In the first section, the impact of regional anesthesia on the main elements of fast-track surgery is addressed. In the second section, procedure-specific fast-track programs for colorectal, hernia, esophageal, cardiac, vascular, and orthopedic surgeries are presented. For each, regional anesthesia and analgesia techniques more frequently used are discussed. Furthermore, clinical studies, which included regional techniques as elements of fast-track methodologies, were identified. The impact of epidural and paravertebral blockade, spinal analgesia, peripheral nerve blocks, and new regional anesthesia techniques on main procedure-specific postoperative outcomes is discussed. Finally, in the last section, implementations required to improve the role of regional anesthesia in the context of fast-track programs are suggested, and issues not yet addressed are presented.

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## DEFINITIONS

"Fast-track surgery," also known as "accelerated or enhanced recovery," involves a coordinated perioperative approach, specific for each surgical procedure, which is aimed at modifying the factors implicated in the pathophysiology of surgical stress, thus facilitating early hospital discharge and fast return to daily activities with minimal morbidity. The major components of fast-track methodology that encompass the preoperative, intraoperative, and postoperative phases are listed in Table 1. Each of these components is well defined and has been shown to exert some positive influence in the trajectory of the surgical care pathways. Although each of them may have modest benefits when used in isolation, within the fast-track strategy they are combined into a coordinated effort that has a synergistic beneficial effect on surgical outcome. For example, laparoscopic approaches have been shown to reduce the incidence of wound infection; however, the impact on outcome has been negligible. In contrast, the synergistic effect of laparoscopic approach within a fast-track methodology has been shown to facilitate earlier hospital discharge and minimize morbidity. This has been evident in colorectal fast-track surgery, where an organized multidisciplinary surgical care pathway has been shown to have positive clinical advantages such as shorter hospital stay and earlier return to baseline functional activities without increasing the rate of readmission or complications.

In the field of perioperative medicine, various regional anesthesia and analgesia techniques could assume a role of increasing importance as each could indeed facilitate the recovery process. This article aims to expand on what has been written previously with regard to the role of anesthesia and analgesia in the context of fast-track surgical pathways,[1] to review critically the advantages and limitations of the regional anesthesia techniques, to draw the clinician's attention to what has been published in the field of regional anesthesia applied to specific surgical procedures, and to guide the anesthesiologist in the implementation of a fast-track program.

## PART 1. THE IMPACT OF REGIONAL ANESTHESIA AND ANALGESIA ON THE COMPONENTS OF FAST-TRACK METHODOLOGY

Regional anesthesia, whether conduction blockade or peripheral nerve block or infiltration of local anesthetics, has been shown to be associated with several recognized physiologic advantages (Fig. 1). These beneficial effects could, in principle, provide optimal conditions for a successful implementation of fast-track surgery. However, on a critical analysis, the literature is not always clear whether the influence of regional anesthesia techniques can always be positive or negative, and whether these physiologic benefits can be translated in facilitating the implementation of fast-track methods, thus accelerating surgical rehabilitation.[2,3]

On the basis of what has been reported with regard to the physiologic effects of regional anesthesia on various organ functions, the clinical impact of regional anesthesia techniques on some of the components of fast-track surgery has been summarized in Table 2. From the published literature, there is a strong indication that in most circumstances both central neural blockade and peripheral neural blockade have positive effect and therefore can contribute to an improved outcome. It might still be difficult to determine how a sole intervention such as regional anesthesia might have an impact on outcome; thus, it is necessary to consider regional anesthesia more as a therapeutic modality aimed at limiting organ dysfunction in the context

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**TABLE 1.** Evidence-Based Elements of Fast-Track Programs

| |
|---|
| Preoperative preparation |
| Patient information and explanation of fast-track modalities |
| Optimization of medical and physical conditions |
| Smoking cessation (4–6 wk before surgery) |
| Stop alcohol intake |
| Carbohydrate loading from the night before surgery |
| No mechanical bowel preparation |
| Intraoperative care |
| Antibiotic prophylaxis |
| Attenuation of stress response |
| Avoidance of fluid excess |
| Maintenance of normothermia |
| Use of short-acting opioids and muscle relaxants |
| Maintenance of tissue oxygenation |
| Deep vein thrombosis prophylaxis |
| Postoperative care |
| Optimize multimodal analgesia (opioid sparing) |
| Avoid fluid and sodium excess |
| Control of nausea and vomiting |
| Control of ileus |
| Early oral nutrition |
| Early ambulation |
| Early removal of catheters, drains, and tubes |

of surgical stress. However, we wish to emphasize that other components associated with traditional anesthesia and surgical practice have to be revised to facilitate the positive effects of regional anesthesia and the components of enhanced rehabilitation. For example, the revised practice of preoperative fasting,[24] bowel cleansing,[25] and the earlier removal urinary catheters[26,27] and drains[28] has been shown to have a positive impact on patient outcome.

## PART 2. UPDATE ON THE IMPLEMENTATION OF REGIONAL ANESTHESIA AND ANALGESIA FOR PROCEDURE-SPECIFIC FAST-TRACK SURGICAL PATHWAYS

Clinical pathways have been developed with the intent to improve patient well-being, and traditional approaches to surgical care have been replaced with evidence-based practices.[29–31] For example, the ERAS (Enhanced Recovery After Abdominal Surgery) pathway, based on the work of Kehlet et al,[32] was designed to include many interventions aimed at accelerating the recovery following colorectal surgery. Another initiative, the PROSPECT (evidence-based, procedure-specific postoperative pain management), was also developed to make recommendations on pain management for specific surgical procedures.

In this section, an update is provided on the application, when possible, of regional anesthesia techniques to some of the most common fast-track procedures (Table 3). The order proposed to analyze surgical interventions is based on the published evidence accumulated over the last years and how successful the fast-track strategy has been in its implementation. However, for some of the surgical procedures, it remains difficult to identify the key elements that might impact on the implementation of fast-track care.

### COLORECTAL SURGERY

The fast-track multimodal program for colorectal surgery is the most studied and evaluated for over a decade. There is ample published evidence to support multimodal enhanced rehabilitation programs following colorectal resection, resulting in a significantly reduced hospital stay (from an average of 10 to about 3 days) and no change in readmission rate.[64,65] Furthermore, the postoperative period of rehabilitation has been characterized not only by less hospitalization but also by less fatigue and earlier return to baseline functional capacity and reduced medical morbidity.[66,67]

#### Epidural Blockade

The use of thoracic epidural analgesia (TEA) has been recommended as one of the key elements of fast-track pathway[68] for colorectal surgery. Technical considerations to optimize management of epidural analgesia include epidural needle insertion and catheter placement to correlate with level of surgical incision. Most of the vertical midline and paramedian incisions are supraumbilical or infraumbilical requiring positioning of the epidural catheter at the same level of midpoint of the surgical incision. The thoracic route is the preferred one because high thoracic epidural has extensive caudad and minimal cephalad spread of local anesthetic.[69] It is suggested to insert the epidural needle at T7-T9 for colon surgery and T10-T11 for rectal surgery. The lumbar approach is discouraged because of insufficient upper sensory block covering the surgical incision, lack of blockade of sympathetic fibers innervating the gut, and risk of lower limb motor block and bladder dysfunction. Epidural infusion of a mixture of low-dose local anesthetics and opioids

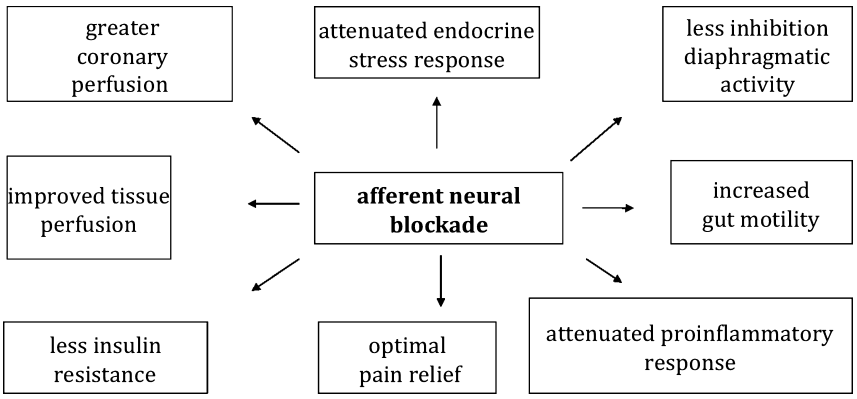


**FIGURE 1.** Physiological advantages of afferent neural blockade.

**TABLE 2.** Impact of Regional Anesthesia on Fast-Track Elements

| Elements of the Fast-track Strategy | Positive Impact of Regional Anesthesia and Analgesia | Minimal or Negative Impact of Regional Anesthesia and Analgesia |
|---|---|---|
| Attenuation of the endocrine and metabolic response to surgical stress | In open surgery, neural blockade needs to be established before the surgical incision and lasting at least for a 48-hr duration[4] | In presence of minimally invasive surgery, the magnitude of modulation of stress response by regional anesthesia might be reduced |
| Modulation of inflammatory changes | Effect of local anesthetics on inflammatory markers, C-reactive protein, interleukin6[5] | Minimal effects when regional techniques are used[6] |
| Goal-directed intravenous fluid balance | | Arterial hypotension as a result of neural blockade might lead to a risk of intravenous fluid overloading |
| Maintenance of normothermia | Neural blockade attenuates the shivering response in the deafferented part of the body. With application of external heat in the vasodilated area, hypothermia can be corrected[7,8] | Sympathetic blockade favors loss of heat from the body resulting in hypothermia[7] |
| Earlier awakening from general anesthesia | With appropriate segmental neural blockade, the requirement of inhalational and induction agents is decreased.[9] Decreased need of muscle relaxants[10] | |
| Maintenance of good tissue perfusion and tissue oxygenation | Increased peripheral vasodilatation and enhanced superficial and deep tissues perfusion[11] | |
| | Less diaphragm inhibition with better chest expansion[12] | |
| | Decreased V/Q mismatch[13] | |
| Multimodal analgesia | Synergistic effect and enhanced analgesia on ambulation[14,15] | |
| Deep vein thrombosis prophylaxis | Conduction blockade causes vasodilatation and tissue perfusion[16,17] | Risk of spinal hematoma with conduction blockade can occur. Need for surveillance for possible change in neurological status[18] |
| Earlier return of bowel function | Gut motility facilitated by either direct afferent neural blockade or anti-inflammatory effects of local anesthetics[5,19] | |
| Earlier oral feeding | Preservation of gut mucosa perfusion[20] | |
| | By opioid-sparing effect of local anesthetics, oral intake is facilitated[19] | |
| | Facilitate glucose utilization by decreasing insulin resistance[4] | |
| Control of postoperative nausea and vomiting | Less opioid requirement is associated with less nausea and vomiting[21] | |
| Earlier mobilization | Neural blockade at thoracic level or wound local anesthetic infiltration/infusion spares motor block of limbs[22,23] | |

(fentanyl, morphine, hydromorphone) enhances the analgesic effect and reduces the adverse effects associated with each component. Patient-controlled epidural analgesia also provides adequate quality of analgesia with fewer adverse effects, although not studied specifically in fast-track surgery.

Once the epidural analgesia is discontinued (48 hrs), nonsteroidal anti-inflammatory drugs or cyclooxygenase 2 inhibitors and acetaminophen can be used successfully, with opioids only as rescue analgesia. Epidural analgesia for laparoscopic colon resection might not be necessary in the context of fast-track program.[70]

## Abdominal Wall Block

Transversus abdominis plane (TAP) block has been reported to be quite effective for lower-abdominal wall analgesia,[71,72] including patients undergoing major abdominal surgery.[73] Recently, it has been studied in patients undergoing laparoscopic colorectal surgery within an enhanced recovery program. The TAP block decreased opioid consumption and shortened the length of stay (LOS) of 1 day.[33] More work needs to be done to identify potential benefits of this technique (eg, recovery of bowel function, time spent out of bed or ambulating, etc) beyond its analgesic properties and its impact on length of hospital stay in patients following fast-track programs. Furthermore, more studies comparing the TAP block with epidural analgesia are warranted.

## Infiltration of Local Anesthetic in the Surgical Incision

The efficacy of wound infusion with local anesthetic as a postoperative pain technique has been proven in different surgical procedures.[74] Nevertheless, the results of some studies comparing the efficacy of continuous infusion of local anesthetic with systemic opioid administration failed to demonstrate improved pain relief and less opioid consumption. Inconsistent results might have been due to several factors such as the type, concentration and dose of local anesthetic, type of catheters,

**TABLE 3.** Published Fast-Track Surgical Programs That Include Regional Anesthesia Techniques

| Type of Surgery | Access | Regional Anesthesia Techniques Used | LOS | References |
|---|---|---|---|---|
| Colorectal resection | Laparotomy, laparoscopy | TEA<br>Wound infusion of local anesthetic<br>IV lidocaine<br>TAP block | 2–4 d | 33–45 |
| Hernia repair | Open | Local infiltration, INB | 2–4 hrs | 46,47 |
| Thoracic surgery | Thoracotomy | TEA | 1–4 d | 48–50 |
| Esophageal surgery | Laparotomy | TEA | 3–5 d | 51–54 |
| Open aortic surgery | Laparotomy | TEA | 3–5 d | 55–57 |
| Nephrectomy | Laparotomy, laparoscopy | TEA | 2–4 d | 58 |
| Hip and knee arthroplasty | Surgical incision | CPNB (femoral and sciatic), periarticular infiltration | 1–3 d | 59–63 |

IV indicates intravenous; INB, ilioinguinal nerve block.

mode of delivery, anatomic location, and possible dislodgment of the catheter during patient mobilization. However, in a recent study in patients undergoing colorectal surgery, a significant opioid-sparing effect and reduction of hospital stay were demonstrated when local anesthetic was infused through a catheter positioned between the fascia and the peritoneum.[75]

### Continuous Intravenous Infusion of Local Anesthetic

Intravenous lidocaine has been shown to have analgesic and anti-inflammatory properties and reduces the incidence of secondary hyperalgesia. In a recent meta-analysis, intravenously administered lidocaine was shown to decrease postoperative pain, opioid consumption, and adverse effects; speed the return of bowel function; and decrease the length of hospital stay in patients undergoing abdominal surgery.[76] These findings would suggest that, when epidural anesthesia is contraindicated, intravenous infusion of lidocaine could be an effective alternative. Preliminary results in nonaccelerated programs are encouraging, but they need to be confirmed in fast-track studies.[77]

### Summary

Epidural anesthesia and analgesia remain a key element of fast-track program, particularly for open colon resection. Recently, other techniques such as abdominal wall block, wound infiltration of local anesthetics, and continuous intravenous infusion of lidocaine have been assessed and are promising alternatives to epidural blockade. However, before adopting these techniques into full clinical practice, they need to be tested in the context of fast-track surgery. The use of epidural analgesia for laparoscopic colectomy remains questionable, particularly when fast-track modality is implemented and multimodal analgesia is administered.

## HERNIA REPAIR

Several series using infiltration of local anesthetics have reported very low morbidity and no urinary retention and good patient satisfaction.[46,47] Combining ilioinguinal nerve block with wound infiltration of local anesthetics prolongs and improves the quality of the block.[78] Spinal anesthesia is not recommended for hernia surgery because of slow recovery and high incidence of urinary retention.[79]

## THORACIC SURGERY

Fast-track thoracic surgery pathways have been adopted to address the need for increased cost-effectiveness while improving quality of care and are largely designed for the management of the patient undergoing lung resection either as open thoracotomy or video-assisted thoracoscopic surgery (VATS). Early studies of "managed clinical care pathways" in thoracic surgery were conducted in the late 1990s, and the median LOS following lobectomy was between 6 and 7.5 days. Cerfolio et al[48] showed that a streamlined care pathway could reduce the median day of discharge to day 3 or 4. Length of stay following pulmonary resection is determined by the presence of air leaks, timing of pleural drain removal, and the incidence of complications (eg, atrial fibrillation, myocardial infarction, pneumonia).

The introduction of regional anesthesia for lung surgery has been shown to have an impact on postoperative outcome. Published recommendations include the use of either thoracic epidural blockade or continuous paravertebral block (PVB),[80] but their contribution to fast-track thoracic surgical care is still unknown. Alternative techniques such as intrathecal opioids and/or intercostal nerve block may be useful when the former techniques are contraindicated.

### Thoracic Epidural Anesthesia

The thoracic epidural has been considered the criterion standard for thoracic surgical regional anesthesia. The catheter should be sited "mid–incision dermatomes," between T5 and T8 interspaces to achieve a successful sensory block. The most consistent analgesia with the fewest adverse effects is achieved using a combination of low-dose local anesthetic (bupivacaine or ropivacaine) and low-dose opioid such as morphine, hydromorphone, diamorphine, or fentanyl, maintained for a minimal period of 2 days to confer maximal advantage. The epidural infusion is usually maintained until after chest drain removal. Lower incidence of pneumonia (odds ratio, 0.54) and decreased need for prolonged ventilation or reintubation have been confirmed in an evaluation of epidural analgesia as a component of a fast-track care strategy, where its use was associated with a reduction in the risk of pulmonary complications from 35% to 6.6% among patients undergoing lung resection[49] and in patients with chronic obstructive pulmonary disease undergoing pulmonary resection for malignancy and have an $FEV_1$ (forced expiratory volume in 1 sec) of less than 60% predicted.

### Paravertebral Block

This technique has lately seen resurgence in popularity as it provides consistent analgesia with limited adverse effects. Systematic review of the evidence has shown that a PVB with local anesthetic alone, or combined with opioid, provides a significant benefit in analgesia and in reducing postoperative pulmonary

complications. A meta-analysis comparing PVB catheter with TEA catheter demonstrated no difference in pain scores at any time during the postoperative period. Moreover, the incidence of pulmonary complications (presence of atelectasis or pneumonia) was significantly lower in the PVB group (odds ratio, 0.36), and peak expiratory flow rate or $FEV_1$ at 24 hrs improved. The principal characteristics that differentiate PVB from TEA are its safety profile[81] and fewer adverse effects,[82] thus favoring PVB for a fast-track program.

### Intercostal Nerve Block and Subpleural Infusions

Most of the evidence points to the conclusion that only where TEA or PVB is not feasible or has failed, intercostal blockade may be an alternative. However, analgesia is not comparable with PVB or TEA.[80] Intrapleural local anesthetics are not recommended.[80]

The role of epidural anesthesia or PVBs for VATS is still debatable as it depends on the extent of resection and the duration of chest draining.

### Summary

The role of epidural anesthesia or PVBs for VATS is still debatable as it depends on the extent of resection and the duration of chest draining. Both thoracic epidural and paravertebral nerve blocks are essential elements to facilitate recovery after thoracic surgery. In addition, minimal invasive approach (VATS) contributes to reduce surgical stress. Nevertheless, a substantial revision of current surgical practice is required to speed up the fast-track process.

## ESOPHAGEAL SURGERY

Esophagectomy has traditionally been a high-morbidity and high-mortality procedure. Indeed from a pathophysiologic perspective, components of the surgery including large abdominal and thoracic incisions, manipulation of gut and pulmonary tissues, and prolonged operating time place these patients at high risk for postoperative pain, large fluid shifts and blood loss, an increased likelihood of prolonged mechanical ventilation, and pulmonary and gastrointestinal complications. Anesthetic management of esophagectomy patients is based on the following objectives:

1. Intraoperative fluid restriction. A reasonable, but unproven, goal is maintaining a urine output of 0.5 mL/kg per hr with a total intraoperative fluid replacement of 4.1 ± 1.3 L over an average 6-hr operative time.
2. Extubation in the operating room, a goal that is facilitated by shorter surgical times, avoidance of fluid excess, and minimal blood loss.
3. Pain control. Thoracic epidural blockade is the main analgesic technique used. However, if a cervical approach is required, systemic administration of opioid is required.

### Thoracic Epidural Analgesia

Insertion of epidural catheter at the level of T6 intervertebral space covers the thoracic incision and the insertion of chest drain. Patient-controlled epidural analgesia modality is used to accomplish the goals of providing superior analgesia and facilitating early extubation, mobilization, and return of gastrointestinal function.

With regard to complications and adverse effects, postoperative respiratory complications can be minimized by early extubation and ambulation. The latter milestones, which are essential elements of a fast-track program, are achievable when an effective anesthetic block is in place. Esophagectomy is particularly amenable to a multidisciplinary approach to standardized clinical pathways. Mounting evidence further suggests that intraoperative and early postoperative fluid restriction reduces the incidence of postoperative pulmonary and gastrointestinal complications in surgical patients undergoing major intracavitary procedures and esophagectomy in particular.[51–54,83]

### Summary

At present, thoracic epidural blockade remains the best analgesic technique suitable for fast-track esophageal surgery.

## CARDIAC SURGERY

Fast-track cardiac anesthesia was introduced in the early 1900s in many centers worldwide with the intent to accelerate the extubation time, thus resulting in less resource utilization and intensive care costs while providing comparable safety.[84] Several reviews are even showing significant potential benefits, but not a major impact on patient outcome in comparison with conventional care. Neuraxial anesthesia, besides its physiologic benefits on cardiac function, ensures hemodynamic and respiratory stability, excellent analgesia, and adequate muscle tone, thus facilitating earlier extubation and recovery.

### High Thoracic Epidural Anesthesia

High thoracic epidural blockade has been shown to provide superior analgesia, early extubation, reduction of perioperative myocardial ischemia, superior stress protection, and possible reduction of arrhythmias, but no change in LOS. Despite these potential benefits, data using a comprehensive approach to fast-track perioperative care are missing. The more widespread use of high thoracic epidural has been inhibited by the fear of the risk of epidural hematoma, and the increasing use of aggressive anticoagulation strategies in modern perioperative cardiac treatment regimens has limited its use and adoption by many anesthesiologists. However, a recent risk assessment did not rate the risk of epidural hematoma formation in cardiac surgery higher than in thoracic or vascular surgery.[85] Well-conducted controlled studies where thoracic epidural is part of a well-structured clinical pathway aimed at enhancing rehabilitation are still awaited.[86,87]

### Spinal Analgesia

Spinal analgesia with intrathecal opioids can be safely performed in patients undergoing cardiac surgery; however, the time course of its action limits its efficacy to provide prolonged analgesia after surgery.[88] In the context of fast-tracking anesthetic techniques, cardiac surgery spinal analgesia may not have a role in the future.

### Midsternal Infusion of Local Anesthetics

There are only 3 randomized controlled trial (RCT) that have assessed the effectiveness of this technique but without accelerating programs.[89–91] Two of 3 have reported 30% decrease in opioid requirements and shorter length of hospital stay.[90,91]

### Summary

Maximal benefits of regional anesthetic techniques for cardiac surgery can be achieved only when perioperative medical and surgical care principles are adjusted to the principle of fast-track surgery.[1,87,92] Such an approach requires extensive revision of the current practice of perioperative management in cardiac surgery starting from the preoperative assessment and treatment to hospital discharge and further rehabilitation.

## OPEN AORTIC SURGERY

Two retrospective reports[55,56] and a RCT[57] using fast-track methodology and epidural anesthesia have demonstrated a

significant reduction in postoperative complications and duration of staying in intensive care in elective aortic aneurysm surgery. The results reported by the 2 retrospective studies were much more impressive (LOS, 2–3 days) than those of the trial, and it can be explained by a more comprehensive approach in the former, where also the abdominal incision was horizontal, the intraoperative epidural block was denser, and the patients were nourished earlier and mobilized much faster. In contrast, the results of the only RCT showed that despite positive results in the fast-track group, patients left the hospital 10 days after surgery.

Thoracic epidural analgesia still remains the only regional anesthesia technique successfully used in patients undergoing open aortic abdominal fast-track surgery. More work is needed to be optimize the surgical component of fast track.

## TOTAL HIP AND KNEE ARTHROPLASTY

Observational and randomized studies have demonstrated that reorganization of orthopedic surgical care involving patient preparation for surgery and more integration of different aspects of perioperative care have a significant reduction on hospital LOS and time to rehabilitate. However, these studies have not mentioned the type of anesthesia and analgesia used; therefore, the potential impact of regional anesthesia was not evaluated. Advances in surgical technology in conjunction with application of multimodal analgesic techniques (regional analgesia in the form of peripheral nerve blocks, wound infiltration, and oral nonopioid analgesics) have allowed more patients to undergo increasingly complex lower limb procedures in the ambulatory setting and facilitate earlier hospital discharge and rehabilitation. Regional anesthesia for fast-track lower-limb surgery is used frequently because the entire limb can be efficiently anesthetized with significant short-term benefits including decreased time to home readiness, decreased visual analog scale pain scores, decreased opioid consumption, decreased time to ambulation, improved satisfaction, and decreased nausea and vomiting.

The most effective regional anesthesia-analgesia techniques for total knee arthroplasty (TKA) and total hip arthroplasty (THA) are central neuraxial anesthesia (in the form spinal anesthesia) and peripheral regional anesthesia (in the form of continuous peripheral nerve blocks (CPNBs) of the lumbar plexus, femoral nerve, and, occasionally, the sciatic nerve.[93,94]

### Continuous Peripheral Nerve Blocks

Over the last decade, the use of continuous lumbar epidural analgesia has progressively been replaced by CPNB because of the concerns of an increased risk of neuraxial hematoma in the setting of aggressive perioperative venous thromboembolic prophylaxis and the increased incidence of minor complications, such as urinary retention, hypotension, and motor block of the nonoperated extremity and catheter malfunction associated with the former technique. Continuous peripheral nerve blocks have been shown to decrease the time to meet 3 specific discharge criteria (adequate analgesia, independence from intravenous opioids, and sufficient ambulation) after TKA and THA.[59,95] Although the use of this technique by these authors contributed to optimize the quality of postoperative analgesia, other elements required to accelerate the recovery process were not put in place, thus keeping patients in the hospital for an unnecessary long period. Additionally, the appropriate subset of patients and incidence of complications associated with ambulatory CPNBs after lower extremity major joint arthroplasty have yet to be defined.

To facilitate a fast-track program, continuous blocks of femoral and/or sciatic nerves, achieved with low-dose infusion of dilute concentrations of local anesthetics and supplemented by incorporating multimodal nonopioid analgesia, must be actively managed to minimize the motor block of both the quadriceps and hamstring muscle groups and the associated risk of falls while facilitating ambulation and knee range of motion. The guidelines published by the PROSPECT initiative recommend the following:

1. For THA: Intraoperatively, the use of either spinal anesthesia with intratechal morphine, or continuous lumbar epidural analgesia local anesthetic and opioids, or general anesthesia combined with a lumbar plexus block; postoperatively, either single-shot or continuous femoral or lumbar plexus block, or multimodal analgesia with strong opioids if high intensity of pain is expected.[93]
2. For TKA: Intraoperative use of femoral block together with either spinal or GA, followed by continuous femoral block and multimodal analgesia with opioids if high intensity of pain is expected.[94]

### Periarticular Infiltration of High Doses of Local Anesthetics

There has been a recent interest in continuous intraarticular and periarticular infiltration of local anesthetics for TKA with positive findings. The potential advantage of this technique is that it maintains quadriceps strength, thus facilitating early ambulation. However, chondrolysis has been reported. The results from single centers where this technique has been incorporated in the fast-track strategy together with revised surgical care and using large patient populations are encouraging.[60] Hospital stay has been reduced to 1 to 3 days. The success of this novel analgesic intervention has been possible when an integrated approach to perioperative care has been put in place, and surgical practice revised.[61,96]

### Summary

Although CPNBs remain potentially useful for optimizing fast-track care because of the quality of analgesia provided and decreased complications compared with continuous lumbar epidural analgesia; nevertheless, the results of the published studies have not shown significant reduction of length of hospital stay. Wound infiltration of local anesthetic used in the context of fast-track care has further accelerated hospital discharge. These promising results need to be verified in large prospective RCTs.

## PART 3. IMPLEMENTATION AND CHALLENGES OF FAST-TRACK PROGRAMS

The concept of integrating regional anesthesia within a multimodal, evidence-based program requires collaboration from the anesthesiologist, with particular attention to each surgical procedure.[1] This can be achieved if there is a process by which members of the medical and nursing team address all aspects of care starting from the preoperative preparation and continuing after surgery. During the last decade, efforts have been made to provide scientific evidence for the fast-track concept, with the intent to improve patient outcome and contain health-related costs. Fast-track surgery represents an extension of the clinical pathway, integrating new modalities in surgery, anesthesia, and nutrition, enforcing early mobilization and oral feeding, with an emphasis on reduction of the surgical stress response. This strategy is designed not only to improve efficiency by reducing hospital stay and variability, like any standardized protocol, but also to decrease the physiologic impact of major surgery and thereby reduce organ dysfunction and recovery time. Guidelines and multimodal programs have been published, and regional anesthesia and multimodal analgesia

techniques specific for some surgical procedures have been included.[31,97] Nevertheless, there are several publications on fast-track where anesthesia and analgesia are briefly mentioned, indicating the absence of an anesthesiologist as part of the perioperative team. This demonstrates that there is more work to be done to determine how the anesthetic and surgical interventions can integrate appropriately. Several elements seem relatively consistent between fast-track centers, at least in colorectal surgery (eg, thoracic epidural, philosophy to feed and ambulate early), whereas several others are more variable (eg, use of bowel preparation, feeding protocol, preoperative carbohydrate, specific anesthesia protocol). With time, large multi-institutional studies are undertaken, and the results become reproducible and generalizable. From the review of the present literature, it is clear that there is a need to expand the knowledge on how to optimize the existing regional anesthesia techniques and develop new ones within the context of fast-track procedures. This is particularly true with the continuous advances in surgical technology and the minimally invasive surgery. To achieve such a goal, it is necessary to set up a multidisciplinary systematic approach, and examples such as ERAS and PROSPECT are worthy attempts in this direction.

## SYSTEMATIC APPROACH

The task of setting up a fast-track protocol requires determination and collaboration. This can be achieved by identifying enthusiastic individual "champions" who wish initially to take up the challenge to initiate the process and lead it within the institution.[31] Either a surgeon or anesthesiologist can lead this effort, with their counterpart and a dedicated nurse as part of the core group, which will then expand to include a physiotherapist, a nutritionist, and a pharmacist.

The implementation process has been described by Kehlet and Wilmore[97] and can be summarized in Table 4. Once the protocol is introduced, there is an adjustment and learning period for the medical and nursing personnel.

To be viable, this group has to receive the support of the institution and colleagues. Time has to be allocated for regular meetings and literature search; consultation with an epidemiologist to analyze results has to be provided, and institutional approval of clinical pathways has to be facilitated. The fast-track group needs to identify first those surgical procedures that are easily amenable to changes (eg, an enthusiastic anesthesiologist or surgeon, published data on a specific procedure) and start working with the perioperative care group (surgeons, anesthesiologists, nursing working in the preoperative clinic, operating room, postanesthesia care unit, and surgical ward). A team of surgeons, anesthesiologists, and nurses with expertise on a specific surgical procedure would be preferable, but, if not possible, a dedicated leader with the capacity to coordinate the implementation of the pathway can be acceptable. Templates of clinical pathways must include elements that can be justified based on published evidence when possible. All those involved must agree with all the elements included before starting.

**TABLE 4.** Steps to Be Followed in the Implementation of Fast-Track Surgical Pathways

| |
|---|
| 1. Assemble a multidisciplinary team including surgeon, anesthesiologist, surgical nurse, dietitian, and physiotherapist |
| 2. Examine published evidence for all the components of perioperative care for specific surgical procedures |
| 3. Interpret evidence in light of local experience, patient population, resources, etc |
| 4. Write, circulate, and revise protocol |
| 5. Implement plan |
| 6. Measure outcomes with timely feedback such as length of hospital stay, quality of pain, readmission to hospital, incidence of postoperative complications, and patient satisfaction |
| 7. Revise protocol in light of outcomes |

With regard to regional anesthesia techniques, the success of their implementation depends in part on the skills of the operator and the organization of the acute pain service. Failure to achieve satisfactory postoperative analgesia with epidural has been reported between 5% and 15% (primary and technical failure), and the results can be disastrous for the implementation of fast-track program. This is where the acute pain service must promptly intervene to address the problem with either resiting the epidural block or providing an alternative method. Regional techniques might at times be contraindicated as they might slow down the process of rehabilitation, for example, quadriceps weakness impacting rehabilitation after TKA, or leg, weakness impacting ambulation after abdominal surgery. Therefore, adjustments need to be implemented with the consensus of the team.

The anesthesiologist, as a perioperative physician, must be aware of the continuous innovation in perioperative care and if necessary adjust the anesthesia and analgesia practice to facilitate the implementation of a fast-track program. For example, if changes occur that laparoscopic approach to colon resection is accompanied by revision of surgical practice, such as absence of nasogastric tube, removal of urinary catheter soon after surgery, wound infiltration of local anesthetics, anti postoperative nausea and vomiting prophylaxis, and early implementation of feeding and out-of-bed mobilization, then the anesthesiologist would have to revise the use of epidural analgesia accordingly and administer other types of regional analgesia such as TAP block, wound infiltration, and infusion of lidocaine.

## CHALLENGES TO THE IMPLEMENTATION OF FAST-TRACK PROGRAM

Although there have been several publications in the surgical literature on the positive impact of fast-track programs on outcome,[31] studies to assess the specific role of regional anesthesia techniques in the context of fast-track surgery and assess the impact on outcome have been few, as shown in Table 2. Some explanations can be proposed: the lack of awareness of advances in fast-track surgery among the anesthesia community, the lack of interest in accessing surgical literature, issues of liability in initiating something new, the realization that the process of implementation is too long with many barriers, the belief that fast-track is a surgical and not anesthetic issue, and finally resistance to new ideas.[97] Even introduction of innovations based on published evidence is a long process that requires education and unbiased information. To address these issues, collaboration with surgical teams needs to be strengthened, views on various aspects of perioperative care exchanged, and scientific articles on the impact of anesthesia on fast-track surgery published.

Another challenge facing the anesthesiologist is how to assess the impact of anesthetic techniques on outcome in the context of fast track. Hospital stay is the most common outcome measure used to assess the success of fast-track program, but this measure is confounded by nonphysiologic parameters that are more related to administrative and organizational issues. In fact, even within fast-track programs, a minority of patients are discharged on the day of functional recovery.[98] Nevertheless, if length of hospital stay reflects how well patients reach the criteria for discharge, then it can be a valuable indicator assuming that

patient can return home to step into a rehabilitation program. As yet, little research has been undertaken to better describe the process of recovery, and currently there is no accepted outcome measure to define the length of clinical recovery. Other clinical outcomes often used are readmission rate and complication rate.[34] Although both are useful indicators of recovery progress, there is a need to define whether the complication is directly related to the surgical technique per se or trauma-induced organ dysfunction. Assessment of the effectiveness of regional anesthesia techniques can be based on the assumption that these interventions have an immediate direct impact on pain, mobilization, and oral feeding as a result of their physiologic effect and hopefully on the process of rehabilitation.

In summary, the future may be bright for regional anesthesia, provided that the positive effect on perioperative pathophysiology is used when combined with the fast-track methodology.

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