

# Considerations for the Use of Local Anesthesia in the Frail Elderly: Current Perspectives

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**Abstract:** The frail, elderly population is at a high risk of postoperative complications. Besides perioperative rehabilitation techniques and management by geriatric teams, the least invasive techniques in anesthesia are required, making regional anesthesia very interesting in terms of benefit-risk ratio. Among them, local anesthesia is a simple, reproducible, inexpensive technique applied to many superficial or deep surgeries, which should make it a gold standard for the frail person. This review provides an update on the current possibilities for various surgeries and exclusion.

**Keywords:** local anesthesia, technique, surgery, frail population

## Introduction

Every year, over 250 million surgical interventions are performed worldwide and, despite the progress in surgery (minimally invasive) and anesthesia (safety), the 30-day postoperative mortality rate remains high (1 to 5%).<sup>1</sup> In the frail, elderly population, postoperative morbidity and mortality are higher and represent a major economic and social issue due to high management costs.<sup>2</sup> Several studies also suggest that frailty alone is a better predictor of mortality and morbidity than age, the American Society of Anesthesiologists (ASA) physical status classification, or comorbidities.<sup>2</sup> With cardiac and respiratory frailties, local anesthesia is a major asset as it does not affect these organs, unlike general anesthesia on the cardio-vascular (vasoplegia, hypotension, decreased cardiac output), respiratory (atelectasis, diaphragmatic dysfunction, alveolar hypoventilation) or cerebral (delirium, confusion) functions. In addition, frail people often have dehydration and impaired renal function which delay the elimination of general anesthesia drugs, whereas none of these problems occur with local anesthesia.

This review outlines the interest of the latest advances in local anesthesia which allow the most fragile patients to be managed in the best possible way.<sup>3</sup>

## Frail, Elderly Patients and Perioperative Considerations

Frailty is a multidimensional syndrome characterized by a decrease in physiological, physical, or psychosocial functional reserves. In the overall population, the prevalence of this syndrome rises exponentially with increasing age: from <10% in those aged 65 years to 50% and more in those aged 85 or over. In two papers assessing long-term mortality, frailty was associated with greater two-year mortality with an Odds Ratio of 4.01 and greater five-year mortality with an Odds Ratio of 3.6.<sup>8,9</sup> In addition to the finding of excess mortality in this population, this syndrome increases vulnerability in the perioperative period and decreases resistance to stress, increasing adverse postoperative outcomes.<sup>4</sup> From a pathophysiological point of view, in the perioperative period, frail patients have an inadequate response to surgical stress leading to an inability to increase oxygen supply to the cellular demand, promoting oxygen debt and cell apoptosis. This maladaptation is directly related to insufficient cardiac output (decreased myocardial contractility, frequent valvular diseases dysregulation of venous tone limiting venous return) and alveolar hypoventilation and insufficient coughing in the postoperative period (sarcopenia of the diaphragm and abdominal muscles).<sup>8,9</sup>

Also, evidence from recent cohort studies and meta-analyses has demonstrated strong associations between preoperative frailty and adverse perioperative outcomes after general surgery, and all the more so when surgery is major. To resume, patients deemed “frail”, as determined by an objective assessment tool, have a higher likelihood of experiencing mortality, morbidity (respiratory tract infection, myocardial infarction, acute renal failure and delirium: Odds Ratios ranging from 1.5 to 4.8), length of stay, readmission and long-term functional dependence regardless of surgery type.<sup>5–7,10,11</sup>

During the perioperative period, there are many reasons for increased frailty. In addition to the surgical procedure, anesthesia can play a major role, either due to the drugs used or invasive techniques (ie ventilation). Despite the use of short-acting agents, variations in pharmacodynamics and pharmacokinetics expose older patients to delayed, prolonged side effects (overdosing and delayed recovery). Recent studies have highlighted the fact that neurophysiological monitoring of the depth of anesthesia, perioperative hemodynamic optimization, prevention and treatment of hypotension and hypothermia, protective ventilation, prevention of transfusion and a restrictive transfusion strategy may reduce poor outcomes after surgery. However, there is consistent evidence that the best course of action may be to avoid general anesthesia altogether.<sup>12</sup>

## Local Anesthesia and Surgery: Anti-Inflammatory Response and Pain Relief

Among the anesthetic techniques, three main classes are described: general anesthesia, loco-regional anesthesia (spinal, epidural, perineural ie truncal and plexus nerve blocks) and local anesthesia. The use of local anesthesia in the frail population has increased tremendously over the last 10 years due to the simplicity of this low-cost technique. The main reasons for its use are that it is a simple, low cost, reproducible technique requiring no premedication. It leads to early recovery without perioperative hypothermia or hypotension and a reduction in airway and pulmonary complications, pro-inflammatory reaction and delirium. It also avoids the possible side effects and complications of sedation or general anesthesia, such as nausea.

On the other hand, several points need to be discussed with the patient and his/her family as local anesthesia requires patient cooperation. There may be intraoperative discomfort, limited to the surgical site so this is not possible in major surgery (eg cardiac or intra-abdominal). There may also be local anesthetic cardio and neurotoxicity (see above), and it is contra indicated when there is local sepsis.

During the perioperative period, surgery induces stress and inflammation which release numerous mediators and these can have general repercussions, regardless of the type of anesthesia. However, several studies have demonstrated that pro-inflammatory cytokine, interleukin or TNF levels in the plasma are higher with general anesthesia than with local anesthesia.<sup>13,14</sup> Using bupivacaine wound infusion, the authors demonstrated a significant decrease in interleukin 10 and an increase in substance P in wounds compared with saline infusion (area under the 24-hour concentration-time curve;  $P < 0.001$ ).<sup>13</sup> Moreover, clinical and basic scientific studies have demonstrated the anti-inflammatory properties of local anesthetics and their benefits on cancer recurrence after surgery.<sup>15</sup> Despite the molecular mechanisms by which regional anesthesia might inhibit or reduce cancer metastases, no clinical studies have ever demonstrated this beneficial effect in a large randomized controlled trial.

Pain relief after local anesthesia is well described in the literature. The duration of analgesia with short-acting agents (lidocaine, mepivacaine) is limited (2–3h) but prolonged with long-acting agents like bupivacaine or ropivacaine (12–16h). Depending on the agent and dose used, the duration does not exceed 24 hours and lifting the block should be anticipated when prolonged analgesia is required (adjuvant, catheter). Epinephrine (1/200 000) is the main adjuvant used with lidocaine because it reduces plasma concentration levels after initial injection (cardiotoxicity) and prolongs pain relief. However, the effect is limited (< 3h).

To date, there is no significant evidence to support a single best anesthetic plan for frail, elderly patients when major surgery (hip, abdominal) is performed. Several studies have found no difference in postoperative morbidity, re-hospitalization rates, in-patient mortality, or hospitalization costs in geriatric patients undergoing regional anesthesia (RA) or general anesthesia GA.<sup>2,3</sup> However, many studies have likened GA to spinal anesthesia as regional anesthesia

which induces severe hypotension. In fact, no studies have clearly compared GA to local anesthesia in the frail population. A pragmatic view would have positioned local anesthesia as the best choice.

## Local Anesthesia in Practice: Volume, Concentration and Type of Surgery

In the frail population, the dose of local anesthetic should not exceed the maximum dose and must be reduced, as elderly patients have greater sensitivity to local anesthetics. Toxicity is not only determined by the total dose of LA but also by its rate of absorption. This rate depends on the blood flow within the tissues, which is faster in the frail person due to the lack of vasoconstriction and reduced adipose tissue.<sup>26</sup> To reduce the blood flow at the injection site and, therefore, the absorption rate, vasoconstrictors are used (epinephrine 1:200,000). In addition, it seems logical to recommend reducing the volume and concentration of LA administered to the frail person to reduce resorption. Indeed, the sensory fibers need a lower dose to be blocked, as in diabetic patients for example. At equivalent doses, the duration of the block is reduced and prolonged, at a lower dose, the characteristics of the blocks are similar between healthy and frail patients.<sup>27</sup>

- For lidocaine, the maximum dose in the healthy adult population is 6–8 mg.kg<sup>-1</sup> and 8–10 mg.kg<sup>-1</sup> with epinephrine (1/100,000). In frail patients, the dose must be reduced to 4–5 mg.kg<sup>-1</sup> and the concentration should be 10 mg.mL<sup>-1</sup> (ie 1%) and not 20 mg.mL<sup>-1</sup>

- For ropivacaine and levobupivacaine: the maximum dose in the healthy adult population is 2.5 mg/kg for bupivacaine. In the frail population, this dose must be reduced to 1.5 to 2 mg.kg<sup>-1</sup>. With lidocaine the onset time is < 5–10 min and with ropivacaine or bupivacaine it is <10–20 min. The surgeon may choose the most appropriate local anesthetic based on the procedure to be undertaken and the postoperative requirements. Due to the lower cardiac and neurologic risk as compared with bupivacaine or ropivacaine, lidocaine should be used first. No studies have demonstrated that a mixture of short- and long-acting agents significantly improves postoperative pain relief. In addition, lidocaine with epinephrine is controversial for the extremities (penis, finger).

In frail patients, all distal surgery should be performed under local anesthesia, especially orthopedic surgery (finger, wrist, foot, tendon repairs ...), ophthalmology (cataract) and abdominal surgery (groin or umbilical repair):<sup>16–20</sup>

- For distal orthopedic surgery, the wide-awake local anesthesia procedure (tumescent local anesthesia involving an injection of lidocaine and epinephrine) allows surgeons to assess and adjust the pressure for tendon transfers, check the integrity of tendon repairs, and look for gapping with active motion following flexor tendon repair. For distal surgery, the volume of LA administered ranges from 5 to 20 mL. Several studies have clearly demonstrated a significant reduction in costs and length of stay when Wide-awake Local Anesthesia with No Tourniquet (WALANT) is used for distal upper or lower surgery.<sup>17</sup>
- For groin hernia surgery, recent international guidelines have highlighted the interest of local anesthesia: “Local anesthesia in open repair has many advantages, and its use is recommended provided the surgeon is experienced in this technique”.<sup>19</sup> For this surgery, the volume of LA administered ranges from 20 to 30 mL. Also, to reduce toxicity, lidocaine 10 mg.mL<sup>-1</sup> should be used, due to the large volume required. For umbilical repair in the frail population, several studies have highlighted a reduction in postoperative complications compared to GA (86% lower complication rate:OR 0.14, 95% CI 0.03–0.72) for frail patients.<sup>21</sup>
- Similarly, for breast surgery, local infiltration and anesthesia can be used for tumorectomy and mastectomy.<sup>22,23</sup> With this surgery, as very large volumes of LA are administered (20 to 40 mL), lidocaine 10 mg.mL<sup>-1</sup> or diluted at 5 mg.mL<sup>-1</sup> should be used to reduce systemic toxicity (resorption). In a case series, Nadeem et al demonstrated the efficacy of local anesthesia in 71 patients with breast cancer who underwent surgery: “65 (91.5%) had dual technique sentinel lymph node biopsy as a day case and 6 (8.5%) patients had axillary clearance. All patients had “0” pain score and no postoperative analgesia was required in recovery”.<sup>23</sup>
- In thoracic surgery, local anesthesia combined with regional anesthesia (paravertebral block or epidural) is proposed to enhance intraoperative and postoperative outcomes.<sup>1–3</sup> The ventilatory repercussions (hypoventilation) of epidural or paravertebral blocks are often a limitation in the frail person who may present respiratory distress intraoperatively, requiring conversion to general anesthesia.
- For vascular surgery, local infiltration for critical lower limb ischemia has been suggested.<sup>24</sup>

In addition, local analgesia may be used for all surgery as infiltration, including neck, thoracic and orthopedic surgery.<sup>20</sup> After major knee replacement, the authors noted that multivariate regression analysis showed that infiltration (40 to 60 mL of 2% ropivacaine) was associated with significantly lower opioid consumption on both days and less pain on postoperative Day 0.<sup>20</sup> Combination treatment was associated with significantly lower pain and opioid consumption on both days.<sup>20</sup> For breast surgery, local infiltration and anesthesia can be used in tumorectomy and mastectomy.<sup>22,23</sup>

The team's experience of performing long, complex surgery may be also analyzed. In one recent study (neurosurgical operations), Oh et al showed that, when surgery was performed under local anesthesia, poor pain control (severe pain, VAS>6.8) altered outcomes.<sup>25</sup> In their study, they demonstrated that control of blood glucose levels and pain management during local anesthesia and in the immediate postoperative period could reduce unexpected postoperative delirium and help prevent unexpected medico-legal problems.<sup>25</sup>

In conclusion, for the operative period, local anesthesia (or analgesia) should be the first choice whenever possible for frail elderly patients. In this context, the concentrations of local anesthetics and the volumes administered should be reduced in order to lessen the risk of systemic toxicity. With lidocaine, the optimal concentration is probably 10 mg.mL<sup>-1</sup> without exceeding the dose of 4–5 mg.kg<sup>-1</sup>. In these conditions, many surgeries can be performed under local anesthesia thus limiting the risk of postoperative decompensation.

## Author Contributions

PC, JYL and YG:

- All made a significant contribution to the work reported, either in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas.
- Wrote and reviewed the article.
- Agreed on the journal to which the article has been submitted.
- Reviewed and agreed on all versions of the article before submission, during revision, the final version accepted for publication, and any significant changes introduced at the proofing stage.
- Agree to take responsibility and be accountable for the contents of the article.

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