The role of lidocaine in perioperative pain and recovery management

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Abstract

Pain control is crucial in surgical patients, being an essential part of enhanced recovery after surgery protocols. Lidocaine, an amide local anesthetic, was primarily used as an antiarrhythmic. It has analgesic, antihyperalgesic and anti-inflammatory effects, with various actions on cardiovascular, respiratory, and digestive systems. Lidocaine has been shown to also have antithrombotic, antimicrobial, and antitumoral effects. Numerous studies have reported its safe profile and role in managing perioperative pain after breast cancer, abdominal, genitourinary, gynecologic, obstetric, orthopedic, cardiothoracic, spine, thyroid, and upper airway surgery. Lidocaine, as part of multimodal analgesia, also shows promising results in ambulatory surgery. Therefore, the use of intravenous lidocaine in the perioperative period is mainly associated with better pain control, reduced opioid use, diminished incidence of postoperative nausea, vomiting, and ileus, and exhibits antithrombotic effects.

Keywords: surgery, acute pain, intravenous lidocaine, lidocaine’s sides effects

INTRODUCTION

Proper pain control during the perioperative period is a major cornerstone in surgical patients’ management, being a part of enhanced recovery after surgery protocols [1]. In order to obtain that, various studies have shown that lidocaine infusion has a safe profile, and it is useful in pain control and opioid decrease in the perioperative period [2].

Besides pain control, due to its numerous pharmacological effects, lidocaine, as a short-acting amide local anesthetic, can prevent the occurrence of various complications in the postoperative period [3,4]. Over time, perioperative lidocaine administration has demonstrated its effectiveness in enhancing the recovery after surgery and reducing the complication rate. It also has an important role in controlling postoperative pain, shortening the hospital stay, and therefore the costs of medical care, and appears to increase surgical patient satisfaction and comfort after surgery [5,6].

KEY PHARMACOLOGICAL PROPERTIES OF LIDOCAINE

The molecular effect of lidocaine depends on its concentration [7]. Its effects are manifested through
sodium and potassium channel blocking [8], interaction with acetylcholine receptor, 5-hydroxytryptamine (5HT-3 receptor) [9], blockage of calcium channels, and N-methyl-D-aspartate receptor [7]. It is an amide local anesthetic and was first used as an antiarrhythmic drug [10]. The beneficial effects of lidocaine in the perioperative period are obtained through intravenous infusion, which mimics the effects acquired when it is administered at the epidural level [11].

A. Analgesic and antihyperalgesic effects

The exact mechanism of lidocaine pain control during the perioperative period is not fully understood, and it seems to extend above sodium channel blocking [7]. Studies have shown the peripheral and central analgesic effects of lidocaine and its ability to suppress hyperalgesia [12-14].

B. Anti-inflammatory effects

Being an amide local anesthetic, at the injury site, lidocaine has the ability to suppress the activation and adhesion of leukocytes [15], inhibits the release of superoxide anions and interleukin 1 (IL-1) through neutrophils priming blocking [16,17], reduce neutrophil adhesion, endothelial hyperpermeability and therefore, the endothelial fluid leakage [18,19].

C. Cardiovascular effects

Lidocaine is used as an antiarrhythmic agent [10]. In doses used for an analgesic purpose, it has a minor cardiac effect, slightly decreasing the heart rate [20].

D. Respiratory effects

It is a weak respiratory depressant, with a peak effect of moderate magnitude at 2.5-3 minutes after bolus infusion [21]. Doses of 1-2 mg/kg of lidocaine are effective in laryngospasm prevention in case of general anesthesia and reduce the risk of fentanyl-induced cough appearance [22,23].

E. Digestive tract effects

Over time, intravenous lidocaine has shown an important role in favoring the resolution of postoperative ileus [24].

F. Antithrombotic, antimicrobial, and antitumoral effects

Like any local anesthetic, lidocaine inhibits platelet aggregation [25]. It also has some antimicrobial [26] and antitumoral properties [27].

### MAJOR SIDE EFFECTS OF LIDOCAINE

Lidocaine, as a local anesthetic, which acts through blocking sodium and potassium channels, is associated with the potential risk of inducing so-called LAST (local anesthetic systemic toxicity). The main clinical manifestations in the case of LAST development are presented in Figure 1 [28-30]. It is considered that it is a molecule with greater safety margins and that neurological side effects are seen at doses of 8 mg/kg (plasma value of 15 μg/mL) and cardiac toxicity develops at plasma values > 21 μg/mL [10, 31].

![Figure 1. Local Anesthetic Systemic Toxicity](image)

**WEWEBEL ET AL.** showed in a systemic review that the administration of intravenous lidocaine to control perioperative pain is not associated with major adverse events [32].

### PERIOPERATIVE USE OF LIDOCAINE

The main beneficial effects of intravenous lidocaine use in surgical patients are pain control, opioid consumption reduction, the reduction in postoperative nausea, vomiting, and postoperative ileus incidence [33-35]. It appears that using lidocaine, as part of multimodal analgesia control, leads to a reduction in hospital stay length [36].

Currently recommended dosage targets the administration of an initial bolus of 1.5-2 mg/kg 10 minutes prior to anesthesia induction, followed by the infusion of 1.5-2 mg/kg/hr for 24 hours in the postoperative period [28,37].

A. Breast surgery

It is well known that high-risk operations, like breast cancer surgery, can lead to chronic postoperative pain development in 10% of cases, further decreasing the life of this subgroup of patients [38]. Grigoras et al. reported that the perioperative use of intravenous lidocaine has a safe profile and decreases the incidence of chronic or persistent postsurgical pain (PPSP) [39]. Another trial, including 148 patients, showed that perioperative lidocaine infusion for patients with mastectomy is associated with decreased incidence of postoperative pain at 3 and 6 months follow-ups [40].

A meta-analysis written by Chang et al. presented that the intravenous lidocaine use in patients undergoing breast surgery is not associated with acute pain control in the first 3 days after surgery, but with the reduction in total analgesic consumption at 72 hours and subjects exhibited a lower risk of developing chronic pain (3-6 months after surgery) [41].

B. Abdominal surgery

Dai et al. published a report about 115 patients undergoing gastrointestinal tumor surgery and showed that intravenous lidocaine administration in the perioperative period is associated with reduced acute postoperative pain and increased patient comfort. At the same time, it accelerated the gastrointestinal function recovery [7].

An important meta-analysis by Marret et al. highlighted that lidocaine use in patients with abdominal
surgery reduces the pain 24 hours after surgery, reduces the postoperative ileus duration and the nausea and vomiting episodes incidence, shortening the hospital stay length [42]. In another analysis, Venthom et al. showed that, after laparoscopic surgery, lidocaine infusion is associated with decreased opioid requirements, improved postoperative pain scores in the first 24 hours, lower incidence of nausea or vomiting, and the patients were able to resume oral feeding more rapidly [43].

C. Genitourinary surgery
In the case of radical prostatectomy, studies have shown that the intravenous administration of lidocaine reduces the pain scores in the postoperative period, decreases opioid consumption, and reduces general hospitalization [36].

A study regarding the use of lidocaine in 64 subjects undergoing laparoscopic renal surgery reported no benefits for this intervention [44].

D. Gynecologic and Obstetric surgery
There are various reports that do not support the perioperative use of intravenous lidocaine in needing total abdominal hysterectomy due to the lack of evidence supporting the benefits of this intervention [45, 46].

E. Orthopedic surgery
Perioperative intravenous lidocaine appears to better control the acute pain in case of ankle dislocation [47].

A study by Martin et al. showed no benefits of perioperative lidocaine infusion in terms of superior pain control or rapid recovery after total hip arthroplasty [48].

F. Thoracic and upper airway surgery
A recent study published by Wang et al. showed that intravenous infusion of lidocaine (2 mg/kg within 10 minutes before starting anesthesia + 2 mg/kg/hr until the end of the surgery) can improve the perioperative recovery status and pain scores, reduce intraoperative opioid use, and decrease the risk of postoperative nausea and vomiting development. It also favours the rapid postoperative recovery of patients undergoing upper airway surgery [47].

Cui et al. showed that perioperative intravenous lidocaine use is associated with improved pain scores and reduced opioid consumption 6 hours after surgery [48].

G. Spine and thyroid surgery
In a study reported by Farag et al., including 160 adult patients undergoing spinal surgery, the infusion of lidocaine 2 mg/kg/hr showed good outcomes regarding postoperative pain control [49].

Apparently, in subjects with thyroid surgery, the intravenous administration of lidocaine only controls the pain in the first 4 hours after surgery, but decreases the opioid consumption and reduces the levels of systemic C-reactive protein [50].

H. Ambulatory surgery
In the first 24 hours after ambulatory surgical procedures performance (plastics, urology, gynecology, general surgery, minor orthopedics), the infusion of lidocaine reduces the opioid consumption and decreases the pain scores, but has no influence on nausea and vomiting incidence, nor on discharge time [51].

CONCLUSIONS
This article offers a brief overview of key pharmacological properties of lidocaine, its analgesic and systemic effects, the major side effects of intravenous administration, and the perioperative use of this molecule in controlling pain in various types of surgical interventions. There are various reports about the safety and efficacy of lidocaine infusion in multimodal analgesic management of surgical patients, along with other beneficial systemic effects. Numerous current clinical trials aim to study the role of this molecule in acute and chronic pain, highlighting its importance.

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