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Research Progress on the Clinical Application of Opioid-Free Anesthesia

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Abstract: Opioid-free anesthesia (OFA) is an innovative anesthetic strategy that minimizes intraoperative opioid use by employing multimodal analgesia, including regional techniques, non-opioid analgesics, and nerve blocks, while ensuring perioperative safety and effective pain control. Current studies suggest that OFA offers potential advantages in reducing opioid-related complications, improving long-term prognosis, and shortening postoperative recovery time. However, further research is needed to explore its long-term benefits and optimal patient populations. This article summarizes the classifications and indications of OFA and reviews its clinical value in gynecological, thoracic, orthopedic, and geriatric surgeries.

Keywords: Opioid-free anesthesia; Indications; Clinical value

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1. Introduction

Opioids have long been widely used for perioperative analgesia. However, their administration is often associated with complications such as respiratory depression, nausea and vomiting, urinary retention, and ileus, which compromise patient safety [1–3]. Moreover, prolonged postoperative opioid use increases the risk of dependence. With the growing adoption of enhanced recovery after surgery (ERAS) protocols and advancements in anesthetic techniques, OFA has gained increasing attention in clinical practice. OFA refers to the complete avoidance of opioids during the perioperative period, instead relying on regional blocks, nonsteroidal anti-inflammatory drugs (NSAIDs), α2-adrenergic agonists, and other analgesic techniques to achieve sufficient pain relief [4–6]. This article reviews the efficacy and clinical value of OFA across various surgical specialties, providing critical insights for anesthetic practice.

2. Classifications and indications of OFA

2.1. Classifications

Based on the techniques and drug combinations employed, OFA can be categorized into the following types: Regional anesthesia techniques, including peripheral nerve blocks, local infiltration anesthesia, and neuraxial anesthesia, which inhibit pain signal transmission. These are often combined with long-acting local anesthetics such as bupivacaine and ropivacaine [7,8]. Multimodal drug combinations, typically involving NSAIDs, ketamine, and dexmedetomidine, which synergistically target different pain pathways. General anesthesia with non-opioid adjuncts, where agents such as dexmedetomidine or propofol are used to enhance anesthetic depth and analgesic efficacy.

2.2. Indications

The indications for OFA continue to expand with its increasing adoption. It is particularly suitable for: Patients with contraindications to opioids. Those with a history of opioid abuse or addiction should minimize relapse risk. Short-duration and ambulatory surgeries, where pain is typically mild and rapid recovery is desired [9,10]. As techniques mature, OFA is gradually being applied to more complex surgical procedures, benefiting a broader patient population.

3. Clinical applications of OFA

3.1. Gynecological surgery

OFA is well-established in gynecological surgeries, particularly in breast cancer operations, where it may exert immunomodulatory effects that theoretically improve long-term oncological outcomes. Shi *et al.* [10] compared opioid-sparing and conventional anesthesia in 43 patients undergoing radical mastectomy and found that the opioid-sparing group required fewer analgesics, exhibited more stable intraoperative hemodynamics, and experienced faster recovery with fewer adverse reactions. Similarly, Chen *et al.* [11] demonstrated in 80 breast cancer patients that OFA provided better hemodynamic stability, reduced postoperative pain, and lowered the incidence of complications such as hematoma and pneumothorax. Liu *et al.* [12] further reported that 40 patients receiving OFA had shorter extubation times, reduced postoperative opioid consumption, and lower rates of nausea and vomiting, confirming its efficacy and safety.

3.2. Thoracic surgery

Traditionally considered opioid-intensive, thoracic surgery has seen progress in OFA application. Shi [13] compared OFA with conventional anesthesia in esophageal cancer resection and found that OFA patients had shorter awakening and extubation times, more stable intraoperative hemodynamics, and lower pain scores at 2 hours postoperatively. Liu *et al.* [14] studied 30 patients undergoing non-intubated thoracoscopic surgery with OFA and observed faster recovery, earlier ambulation, and fewer cardiovascular events and postoperative nausea and vomiting (PONV) at 6 hours, highlighting its safety benefits.

3.3. Orthopedic surgery

Although pain management in orthopedic surgery is challenging, preliminary evidence supports OFA's safety and efficacy, aligning with ERAS principles. Xu *et al.* [15] demonstrated that OFA combined with periarticular infiltration

in total hip arthroplasty improved hemodynamic stability, accelerated cognitive recovery, and reduced dizziness and PONV. Chen *et al.* [16] found comparable analgesia but fewer adverse events with OFA in calcaneal fracture surgery, underscoring its safety advantages. Given the high proportion of elderly patients in orthopedic procedures, who are more susceptible to opioid-related side effects, OFA holds particular value in this population.

3.4. Geriatric patients

Due to age-related physiological decline, elderly patients require meticulous anesthetic management. Zhou *et al.* [17] reported that esketamine-based OFA provided stable hemodynamics, adequate sedation, and reduced central sensitization, lowering the risk of chronic postoperative pain in geriatric surgical patients.

4. Conclusion

As a pivotal advancement in modern anesthesiology, OFA has demonstrated significant benefits across multiple surgical disciplines, including reduced adverse events, enhanced recovery, and decreased opioid dependence. However, challenges remain in major abdominal and thoracic surgeries where opioid avoidance may be difficult [18–20]. Future research should focus on developing safer, longer-acting local anesthetics, optimizing OFA protocols for different surgeries, and investigating their long-term outcomes and cost-effectiveness. With the rise of personalized anesthesia, OFA promises to be a superior choice for an increasing number of patients, ensuring both safety and satisfaction.

Disclosure statement

The author declares no conflict of interest.

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