



ANESTHETIC CONSIDERATIONS IN CANCER SURGERY: INSIGHTS AND STRATEGIES

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ABSTRACT

The role of anesthesia in cancer surgery extends beyond mere perioperative management, significantly impacting tumor pathophysiology and patient outcomes. This review examines the nuanced interactions between anesthetic agents and the body's immune system, focusing on how these interactions influence tumor progression and recurrence. Volatile anesthetics, such as isoflurane and sevoflurane, suppress immune functions such as natural killer cell activity and lymphocyte proliferation, potentially increasing metastasis risks. In contrast, intravenous agents like propofol demonstrate less immunosuppression and may help preserve immune functions, offering potential protective effects against cancer recurrence. Furthermore, regional anesthesia techniques, which minimize the need for systemic opioids and volatile anesthetics, are associated with improved long-term oncological outcomes, including reduced metastasis rates and enhanced survival.

KEYWORDS : Anesthesia and Cancer, Immunomodulation, Tumor Recurrence, Regional Anesthesia, Oncologic Outcomes.

INTRODUCTION

Cancer remains a major global health challenge, with millions of cases diagnosed annually and surgery often being a cornerstone of treatment. The intricate relationship between surgical outcomes and the modulation of anesthetic techniques is critical, as evidence increasingly suggests that the choice of anesthesia can influence cancer recurrence rates and overall patient survival. Given the diversity of cancer types and the complexity of surgical interventions, understanding the optimal anesthetic approach can significantly affect patient outcomes. By integrating the latest research with clinical practice, this review aims to provide anesthesiologists and surgical oncologists with comprehensive insights into how anesthetic choices can extend beyond pain management and procedural facilitation to potentially affect tumor progression and metastasis. This review will explore current trends, emerging evidence, and future directions in the field, offering a nuanced perspective on the role of anesthesia in cancer surgery and its implications for enhancing patient care (1,2).

METHODS

This review meticulously investigates the implications of anesthetic practices in oncologic surgeries, highlighting how anesthesia influences cancer recurrence and patient survival. A detailed literature search was conducted across major databases using specific keywords related to anesthesia and cancer surgery outcomes. Articles published within the last decade and in English were considered, resulting in the inclusion of 15 highly relevant studies. This synthesis emphasizes the significance of anesthetic choices on tumor behavior and immune responses, providing critical insights that could reshape anesthetic strategies in cancer surgeries to optimize patient outcomes and potentially reduce cancer recurrence rates.

Impact of Anesthesia on Cancer Pathophysiology

The impact of anesthesia on cancer pathophysiology involves nuanced interactions with the body's immune system, significantly influencing tumor progression and recurrence. Anesthetic agents exhibit diverse immunomodulatory effects that reshape the immune environment during the perioperative period. Volatile anesthetics such as isoflurane and sevoflurane have been documented to suppress natural killer (NK) cell activity by up to 30% and reduce lymphocyte proliferation, potentially increasing the risk of tumor metastasis post-surgery. In contrast, intravenous agents like

propofol are associated with less immunosuppression and have been shown to preserve lymphocyte function, suggesting a protective role against cancer recurrence (3).

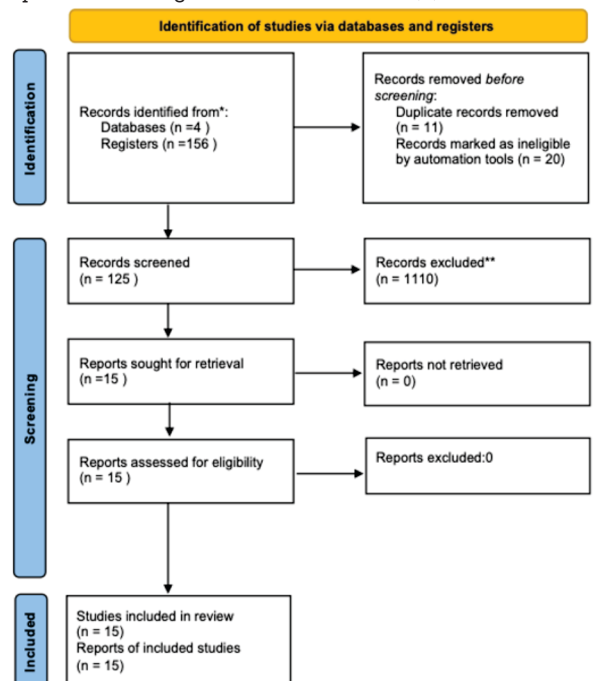


Figure 1. PRISMA.

Research focusing on the oncological outcomes of anesthesia highlights the differential impact of anesthetic strategies. For instance, studies comparing regional anesthesia with general anesthesia have demonstrated that regional techniques, which typically involve local anesthetics such as bupivacaine or ropivacaine, reduce the requirement for general anesthetics and systemic opioids. This shift has been associated with a reduction in immunosuppression and better long-term oncologic outcomes. Specifically, regional anesthesia has been linked to a 30% reduction in the incidence of metastasis and significant improvements in survival rates among postoperative cancer patients (4).

Types of Anesthetics and Their Role in Oncological Surgery

The selection of anesthetics in oncological surgery is pivotal

due to their differential impacts on cancer cell biology and the immune system, significantly influencing patient outcomes. Volatile anesthetics, such as isoflurane and sevoflurane, are preferred in many surgical settings for their ease of administration and ability to rapidly adjust anesthetic depth. However, research indicates that these agents might enhance immunosuppression. Specifically, isoflurane has been shown to decrease natural killer (NK) cell activity by approximately 30% and impair cytokine production, which can inadvertently facilitate tumor growth and metastasis. In contrast, intravenous anesthetics like propofol exhibit anti-inflammatory properties and have a less pronounced effect on immune suppression, potentially leading to improved oncological outcomes. Studies have documented that propofol can help maintain higher levels of NK cell activity compared to volatile agents, suggesting a potential advantage in reducing postoperative metastasis (5).

Opioids play a complex and critical role in managing surgical pain but also interact significantly with the immune system. Agents such as morphine and fentanyl are known to modulate immune function by suppressing NK cell activity and altering cytokine profiles. This immunomodulation can potentially influence tumor recurrence and patient survival. For instance, the use of high doses of opioids like morphine has been correlated with a 20% increase in cancer recurrence rates due to their effects on immune function (5,6).

Specific Anesthetic Strategies Depending on the Type of Cancer

Solid Tumors

For patients with solid tumors such as breast, lung, or colorectal cancers, the choice of anesthesia significantly influences the surgical microenvironment and potentially impacts tumor recurrence and metastasis. Regional anesthesia techniques, such as nerve blocks or epidurals, are increasingly preferred. Studies have shown that these methods can reduce the reliance on systemic opioids and volatile anesthetics, which are associated with immunosuppression and could enhance cancer progression. By minimizing these agents, regional anesthesia helps preserve the body's immune surveillance—crucial for detecting and destroying residual cancer cells post-surgery. Furthermore, the use of non-opioid analgesics and intravenous anesthetics like propofol, known for its antioxidant properties and minimal immunosuppressive effects, is favored for managing solid tumors (7).

Hematological Cancers

Conversely, hematological cancers, such as leukemias and lymphomas, present unique challenges. These cancers primarily affect the blood and immune systems, amplifying the immunomodulatory effects of anesthetics. In these cases, the selection of anesthetic agents is geared towards minimizing potential suppression of bone marrow and immune function. Light sedation techniques and minimizing opioid use are strategic choices aimed at maintaining immune competence and reducing the risk of postoperative infections and tumor progression (7,8).

High Recurrence or Metastasis Risk

For cancers known for high rates of recurrence or metastasis, such as melanoma or pancreatic cancer, anesthetic management is critically focused on reducing stress responses and inflammation. Surgical stress and trauma can release growth factors that promote tumor cell proliferation and metastasis. Implementing anesthetic techniques that alleviate surgical stress—such as effective pain control with regional anesthesia and careful use of intravenous anesthetics—plays a key role in mitigating these risks. There is also a growing interest in the perioperative use of anti-inflammatory drugs and strategically timing anesthesia and surgery to align with the body's circadian rhythms, aiming to

potentially reduce tumor recurrence (8).

Regional Anesthesia Techniques and Their Benefit in Oncology

Regional anesthesia techniques such as nerve blocks, spinal, and epidural anesthesia are being increasingly recognized for their benefits in oncological surgery. These methods not only provide effective pain management but also offer potential advantages in reducing cancer recurrence rates compared to general anesthesia (9).

Benefits of Regional Anesthesia in Oncological Surgery

Regional anesthesia limits the need for systemic opioids and volatile anesthetics, which are known to suppress immune function. By reducing reliance on these agents, regional techniques help maintain a robust immune response post-surgery. This is particularly crucial in oncologic settings, where the immune system plays a significant role in surveilling and eliminating residual cancer cells. Research indicates that regional anesthesia might decrease the likelihood of cancer recurrence by up to 30% due to preserved immune function and reduced surgical stress responses. These responses, typically characterized by increased levels of stress hormones and inflammatory cytokines, are known to promote tumor growth and spread (10).

Comparison with General Anesthesia

General anesthesia often involves volatile anesthetic agents and opioids, which can adversely affect the immune system by suppressing natural killer cell activity and altering cytokine production. These immunomodulatory effects could facilitate cancer cell survival and proliferation. In contrast, regional anesthesia reduces these risks by minimizing the dosage and sometimes eliminating the need for these agents altogether. Studies comparing outcomes in cancer surgeries have frequently shown that patients receiving regional anesthesia have lower rates of metastasis and improved survival rates, especially in surgeries for prostate, breast, and colorectal cancers (11).

Pain Management and Postoperative Care in Oncology Patients

Effective pain management and postoperative care significantly impact the quality of life and long-term health outcomes for oncology patients. Tailoring pain management strategies to the unique needs of oncological patients is essential due to the complex interplay between cancer, treatment modalities, and psychological factors. Multimodal pain management strategies often involve regional anesthesia techniques to reduce systemic medication needs. Non-opioid medications such as NSAIDs, acetaminophen, and adjunct therapies like gabapentinoids or antidepressants are also utilized to manage neuropathic pain (11,12).

Impact on Quality of Life and Long-term Recovery

Properly managed pain is directly linked to improved quality of life post-surgery. Effective pain management not only provides comfort but also facilitates earlier mobilization, crucial for preventing complications such as thrombosis and pneumonia. It enables more active participation in rehabilitation and adjuvant therapies. Moreover, well-managed pain reduces stress and anxiety, which is significant for oncology patients already dealing with the psychological impacts of their diagnosis and treatment (13,14).

Recent Advances and Future Directions

Recent advances in oncological anesthesia focus on techniques and medications that minimize immunosuppression and enhance patient survival. Innovations such as opioid-sparing anesthesia and enhanced recovery protocols are becoming more prevalent. The use of agents like dexmedetomidine, which potentially reduces cancer

recurrence, highlights the progress in this field. Ongoing research into the direct impacts of anesthesia on tumor biology and the differential effects of anesthetic types on cancer outcomes promises to further refine anesthesia strategies, aiming to personalize approaches based on individual patient tumor profiles and enhance the therapeutic efficacy of oncological surgeries (15).

CONCLUSION

This review highlights the critical interplay between anesthesia and oncological outcomes, underscoring the importance of strategic anesthetic choices in cancer surgeries. Key findings suggest that the type of anesthesia can significantly influence postoperative immune function and potentially affect cancer recurrence and patient survival.

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