MULTIMODAL APPROACH TO POSTOPERATIVE ANALGESIA IN NEONATES UNDERGOING THORACIC SURGERY

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Abstract

Postoperative pain syndrome in neonates undergoing thoracic surgical interventions remains one of the most significant challenges in neonatal intensive care and pediatric anesthesiology. Inadequately controlled postoperative pain may lead to respiratory dysfunction, hemodynamic instability, activation of stress responses, and adverse effects on the central nervous system. Therefore, the implementation of effective and safe analgesic strategies during the postoperative period is of considerable clinical importance.

The present study evaluated the clinical efficacy of a multimodal analgesic approach based on a combination of opioid analgesics and regional anesthesia in neonates who underwent thoracic surgery. Pain intensity was assessed using validated neonatal pain assessment systems, while heart rate, respiratory rate, arterial oxygen saturation, and other physiological parameters were continuously monitored. The obtained results demonstrated that multimodal analgesia significantly reduced postoperative pain intensity, improved physiological stability, and decreased the need for additional analgesic medications. Furthermore, the multimodal approach was associated with a lower incidence of respiratory complications and excessive sedation.

Keywords: neonatal surgery, thoracic surgery, postoperative pain, multimodal analgesia, regional anesthesia, opioid analgesics, neonates.

Introduction

In recent years, the increasing number of thoracic surgical procedures performed in neonates has emphasized the importance of postoperative intensive care and pain management. Neonates possess well-developed anatomical and physiological pathways for pain perception, and nociceptive impulses are rapidly transmitted to the central nervous system. At the same time, inhibitory antinociceptive mechanisms remain insufficiently developed during the neonatal period, making neonates particularly vulnerable to the harmful effects of pain.

Thoracic surgical interventions are considered highly traumatic procedures and are commonly associated with severe postoperative pain syndrome. Postoperative pain may result in shallow breathing, impaired pulmonary ventilation, hypoxemia, and significant hemodynamic disturbances. In addition, prolonged pain exposure stimulates the release of stress hormones, contributing to metabolic imbalance, immunosuppression, and delayed postoperative recovery.

Although opioid analgesics remain highly effective for the management of severe postoperative pain, their use in neonatal practice is limited by the risk of respiratory depression, arterial hypotension, bradycardia, and excessive sedation. Consequently, modern pediatric anesthesiology increasingly focuses on the concept of multimodal analgesia. This strategy involves the simultaneous use of analgesic methods with different mechanisms of action to achieve superior pain control while minimizing opioid consumption and associated adverse effects.

Regional anesthesia combined with systemic opioid therapy is currently regarded as one of the most promising approaches for postoperative pain management in neonatal thoracic surgery. Effective analgesia contributes not only to patient

comfort but also to improved respiratory function, stabilization of hemodynamic parameters, and reduction of postoperative complications.

The aim of this study was to evaluate the clinical efficacy of multimodal analgesia in neonates undergoing thoracic surgical procedures.

Materials and methods.

This prospective observational study was conducted in the departments of pediatric surgery and neonatal intensive care. Thirty neonates who underwent thoracic surgical procedures were included in the study. The enrolled patients underwent surgery for congenital esophageal atresia, congenital diaphragmatic hernia, pulmonary malformations, and mediastinal pathologies.

The patients were divided into two groups:

- Group I included neonates receiving conventional postoperative opioid analgesia;
- Group II included neonates managed with multimodal analgesia consisting of opioid analgesics combined with regional anesthesia techniques.

Postoperative pain intensity was assessed using validated neonatal pain assessment scales specifically designed for newborn patients. Pain evaluations were performed during the first, sixth, twelfth, and twenty-fourth postoperative hours.

Continuous monitoring included heart rate, respiratory rate, arterial oxygen saturation, arterial blood pressure, and overall hemodynamic status. Additional requirements for analgesic medications, respiratory complications, episodes of apnea, and excessive sedation were also documented throughout the observation period.

The obtained data were statistically analyzed, and intergroup differences were evaluated to determine clinical significance.

Results

The study results demonstrated significantly lower postoperative pain intensity in neonates who received multimodal analgesia. During the first twenty-four postoperative hours, pain assessment scores remained consistently lower in Group II compared with Group I.

Neonates treated with conventional opioid analgesia exhibited more pronounced physiological disturbances, including tachycardia, increased respiratory rate, and decreased arterial oxygen saturation. In contrast, patients managed with multimodal analgesia maintained more stable hemodynamic and respiratory parameters throughout the postoperative period.

The requirement for additional opioid analgesics was substantially reduced in the multimodal analgesia group. Moreover, the incidence of respiratory depression, apnea episodes, and excessive sedation was lower among neonates receiving combined analgesic therapy. Effective blockade of nociceptive impulses through regional anesthesia contributed to faster stabilization of the general postoperative condition.

In addition, neonates in Group II demonstrated shorter durations of mechanical ventilation and reduced length of stay in the intensive care unit. These findings indicate not only the clinical but also the potential economic benefits of multimodal postoperative pain management.

Discussion

Inadequately controlled pain during the neonatal period negatively affects virtually all physiological systems. Following thoracic surgery, severe postoperative pain may significantly restrict respiratory movements, resulting in impaired pulmonary ventilation and increased risk of respiratory insufficiency. Consequently, hypoxemia, carbon dioxide retention, and postoperative pulmonary complications may develop.

The findings of the present study confirm the clinical advantages of multimodal analgesia in neonatal practice. The combination of regional anesthesia with systemic opioid therapy allows nociceptive transmission to be blocked at multiple levels of the

pain pathway. As a result, effective analgesia can be achieved with lower opioid doses, thereby reducing the frequency and severity of opioid-related adverse effects.

According to contemporary scientific literature, multimodal analgesia is considered one of the safest and most effective strategies for pain management in neonatal intensive care. In thoracic surgery, regional anesthesia techniques are particularly valuable because they facilitate earlier recovery of respiratory function and improve postoperative adaptation.

The results of this study are consistent with previously published international data and further support the clinical efficacy of multimodal postoperative analgesia in neonates undergoing thoracic surgery.

Conclusion

1. Multimodal analgesia effectively reduces postoperative pain intensity in neonates undergoing thoracic surgical procedures.
2. The combination of opioid analgesics and regional anesthesia contributes to improved stability of physiological parameters.
3. Multimodal pain management decreases the requirement for additional analgesic medications.
4. The incidence of respiratory depression, apnea, and excessive sedation is significantly reduced.
5. The implementation of multimodal analgesia in neonatal thoracic surgery should be considered an essential component of modern postoperative management protocols.

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