ANESTHESIOLOGICAL MANAGEMENT IN ENDOUROLOGICAL SURGERY IN CHILDREN

Nizamov I.U.
Satvaldieva E.A.
Tashkent state medical university
https://doi.org/10.5281/zenodo.20590975

Relevance. Pediatric endourology represents one of the most dynamically evolving surgical disciplines, characterized by the progressive adoption of minimally invasive approaches that impose specific demands on anesthetic provision. The physiological immaturity of organ systems in children, their heightened sensitivity to volatile agents, and the unique cardiorespiratory challenges posed by pneumoperitoneum during laparoscopy necessitate a carefully individualized anesthetic strategy. Low-flow sevoflurane anesthesia has demonstrated favorable pharmacokinetic and hemodynamic properties in adult practice; however, comparative evidence regarding its safety and efficacy across laparoscopic versus open urological interventions in the pediatric population remains insufficient, particularly within the context of Central Asian clinical experience.

Aim. To evaluate the clinical efficacy, hemodynamic safety, and perioperative outcomes of low-flow sevoflurane anesthesia in children undergoing laparoscopic versus open endourological procedures.

Materials and Methods. A prospective comparative study was conducted at the Multidisciplinary Children's Clinic of Tashkent State Medical University during the period 2022–2024. A total of 102 pediatric patients aged 2 to 14 years were enrolled and stratified into two groups according to surgical access modality. Group I comprised 50 patients who underwent laparoscopic endourological interventions (nephrectomy, pyeloplasty, ureteroneocystostomy), and Group II comprised 52 patients who underwent equivalent procedures via open surgical approach. In both groups, general anesthesia was induced with propofol (2–3 mg/kg IV) combined with fentanyl (2 μg/kg IV) and maintained exclusively with sevoflurane delivered via a low-flow technique (fresh gas flow ≤1.0 L/min, target end-tidal sevoflurane concentration 2.0–2.5 vol%). Intraoperative monitoring included continuous ECG, pulse oximetry (SpO_2), non-invasive blood pressure, capnography ($EtCO_2$), and bispectral index (BIS). Postoperative parameters encompassed time to extubation, Aldrete recovery score, pain intensity assessed by the FLACC/NRS scale, and supplemental analgesic requirements. Statistical analysis was performed using SPSS v.26.0; intergroup differences were evaluated by Student's _t_test and Mann–Whitney U-test; significance threshold was set at $p < 0.05$.

Results: Intraoperative hemodynamic parameters remained within age-appropriate physiological ranges in both groups throughout the procedure. Mean arterial pressure in Group I was 68.4 ± 4.2 mmHg versus 71.1 ± 5.0 mmHg in Group II ($p = 0.09$), indicating comparable cardiovascular stability. Heart rate did not differ significantly between groups at any monitored time point (Group I: 98.3 ± 7.6 bpm; Group II: 101.4 ± 8.1 bpm; $p = 0.07$). SpO_2 was maintained at ≥98% in all patients; $EtCO_2$ values in Group I transiently peaked at 38.6 ± 2.9 mmHg during pneumoperitoneum but remained within acceptable limits throughout. BIS values were maintained in the target range of 40–60 in 94% of cases across both groups, confirming

adequate anesthetic depth. Total intraoperative blood loss was significantly lower in Group I (18.4 ± 6.3 mL) compared to Group II (74.7 ± 18.5 mL; $p < 0.001$). Sevoflurane consumption per unit time was 8.2 ± 1.1 mL/h in Group I and 8.6 ± 1.3 mL/h in Group II ($p = 0.18$), reflecting equivalent anesthetic depth, while low-flow delivery reduced total agent utilization by an estimated 36% relative to conventional flow techniques. Time to extubation was significantly shorter in Group I (8.3 ± 2.1 min) versus Group II (13.7 ± 3.4 min; $p < 0.001$). Achievement of Aldrete score ≥9 occurred at 18.5 ± 4.6 min postoperatively in Group I compared to 31.2 ± 6.8 min in Group II ($p < 0.001$). Postoperative pain scores at 2 hours were 2.1 ± 0.8 in Group I versus 4.6 ± 1.2 in Group II ($p < 0.001$), and the need for supplemental opioid analgesia within the first 24 hours was recorded in 18% of Group I patients versus 61.5% of Group II patients ($p < 0.001$). No clinically significant adverse events - including laryngospasm, bronchospasm, or severe cardiovascular depression - were registered in either group.

Conclusions: Low-flow sevoflurane anesthesia ensures reliable, titratable, and hemodynamically safe general anesthesia for pediatric endourological surgery regardless of the surgical access employed. The combination of laparoscopic technique with low-flow sevoflurane delivery demonstrated statistically significant superiority across all key perioperative indices - including intraoperative blood loss, time to extubation, speed of postoperative recovery, pain intensity, and supplemental analgesic demand - without compromising anesthetic depth or cardiorespiratory stability, thereby justifying its adoption as the preferred anesthesiological strategy for minimally invasive urological procedures in children.