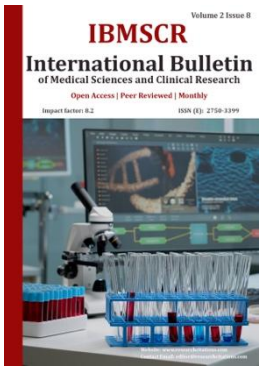

STRESS HORMONAL RESPONSE AND METABOLIC ADAPTATION UNDER LOW-FLOW SEVOFLURANE ANESTHESIA IN CHILDREN UNDERGOING LAPAROSCOPIC VERSUS OPEN ENDOUROLOGICAL SURGERY: A PROSPECTIVE COMPARATIVE STUDY

Nizamov I.U.
Satvaldieva E.A.
Tashkent state medical university
https://doi.org/10.5281/zenodo.20590921

Relevance. The magnitude of the surgical stress response in pediatric patients constitutes a critical determinant of perioperative morbidity, metabolic homeostasis, and postoperative recovery quality. Neuroendocrine activation elicited by surgical trauma manifests primarily through hypothalamic–pituitary–adrenal axis stimulation, resulting in measurable elevations of serum cortisol, secondary disruption of pancreatic insulin secretion, and peripheral tissue hypoperfusion reflected in elevated blood lactate concentrations. Children are particularly susceptible to stress-mediated hormonal dysregulation owing to the relative immaturity of hypothalamic regulatory mechanisms and limited glycogen reserves. Whereas minimally invasive endourological techniques are presumed to attenuate the magnitude of this neuroendocrine response compared to open surgery, objective biochemical evidence in the pediatric population under standardized low-flow volatile anesthesia remains sparse. Characterizing the dynamics of cortisol, insulin, and lactate across surgical modalities is therefore of direct clinical and scientific importance.

Aim: To comparatively assess the dynamics of serum cortisol, insulin, and blood lactate as objective biomarkers of surgical stress response in children undergoing laparoscopic versus open endourological interventions under low-flow sevoflurane anesthesia.

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. Group I comprised 50 patients who underwent laparoscopic endourological procedures (nephrectomy, pyeloplasty, ureteroneocystostomy), and Group II comprised 52 patients who underwent equivalent interventions via open surgical approach. In both groups, anesthesia was induced with propofol (2–3 mg/kg IV) and fentanyl (2 μg/kg IV) and maintained with sevoflurane administered by a low-flow technique (fresh gas flow ≤1.0 L/min; target end-tidal concentration 2.0–2.5 vol%). Serum cortisol (μmol/L) and insulin (μIU/mL) were determined by enzyme-linked immunosorbent assay (ELISA), and whole-blood lactate (mmol/L) was measured by electrochemical analyzer at three standardized time points: T1 -preoperative baseline (30 min prior to induction); T2 -intraoperative peak (60 min after skin incision); T3 -postoperative (24 hours following surgery). Statistical analysis was performed in SPSS v.26.0; intergroup comparisons were made by Student's _t_test and Mann–Whitney U-test; intragroup dynamics were assessed by repeated-measures ANOVA; statistical significance was defined as $p < 0.05$.

Results: Cortisol. Baseline (T1) values were comparable between groups: 284.6 ± 21.3 nmol/L in Group I and 291.4 ± 19.8 nmol/L in Group II ($p = 0.14$). At T2, a significant intergroup divergence was observed: cortisol rose to 376.2 ± 28.4 nmol/L in Group I versus 524.8 ± 34.1

nmol/L in Group II ($p < 0.001$), indicating a markedly attenuated hypothalamic–pituitary–adrenal response in laparoscopic patients. At T3, values declined in both groups but remained significantly elevated in Group II (402.5 ± 30.6 nmol/L) compared to Group I (308.3 ± 22.7 nmol/L; $p < 0.001$), reflecting more prolonged adrenocortical activation following open surgery. Insulin. Preoperative insulin levels did not differ between groups (Group I: 9.2 ± 1.4 μIU/mL; Group II: 9.6 ± 1.6 μIU/mL; $p = 0.21$). Intraoperative values at T2 revealed a moderate elevation in Group I (12.8 ± 2.1 μIU/mL) but a substantially greater increase in Group II (19.4 ± 2.8 μIU/mL; $p < 0.001$), consistent with a more intense counter-regulatory hormonal response in open-access surgery. By T3, Group I approached baseline (10.4 ± 1.7 μIU/mL), whereas Group II remained significantly elevated (15.9 ± 2.3 μIU/mL; $p < 0.001$). Lactate. Baseline lactate was within physiological range in both groups (Group I: 1.08 ± 0.21 mmol/L; Group II: 1.12 ± 0.19 mmol/L; $p = 0.36$). At T2, lactate increased to 1.74 ± 0.31 mmol/L in Group I and 2.68 ± 0.42 mmol/L in Group II ($p < 0.001$), demonstrating significantly greater tissue metabolic stress during open surgical access despite comparable anesthetic depth. At T3, levels normalized more rapidly in Group I (1.19 ± 0.24 mmol/L) than in Group II (1.98 ± 0.33 mmol/L; $p < 0.001$). No patient in either group exceeded a lactate threshold of 4.0 mmol/L, excluding clinically significant hypoperfusion. BIS values were maintained within the target range of 40–60 in 94% of all cases, confirming that differences in biochemical stress markers reflected surgical rather than anesthetic depth variation.

Conclusions. Low-flow sevoflurane anesthesia provides effective and physiologically protective anesthetic coverage in pediatric endourological surgery; however, the magnitude of the stress hormonal and metabolic response is substantially determined by the surgical access modality. Laparoscopic intervention was associated with statistically significantly lower intraoperative and postoperative elevations of cortisol, insulin, and blood lactate compared to open surgery, confirming the biochemical superiority of minimally invasive technique in attenuating neuroendocrine activation, preserving insulin regulatory balance, and maintaining peripheral tissue oxygenation -collectively supporting the combined use of laparoscopic access and low-flow sevoflurane anesthesia as the optimal perioperative strategy for urological procedures in the pediatric population.