Retroperitoneal versus transperitoneal approach for nephrectomy in children: Anesthetic implications

Introduction

Laparoscopic nephrectomy is a popular technique both in adults and children because of its advantages that include less postoperative pain, a shorter hospital stay, better cosmetic results and a quicker return to normal activities.[1] Laparoscopic nephrectomy in children utilizes both transperitoneal (TP) and retroperitoneal (RP) techniques with no clear cut advantage of one over the other.[2] The TP approach offers a large working space and natural orientation to the anatomic landmarks. RP approach offers quicker access to the hilum and is performed in lateral or prone position. However, both techniques have comparable surgical outcome in terms of risk of bowel injury and vascular injury.[3,4] Laparoscopic surgery usually involves abdominal insufflation with carbon dioxide, which has significant cardiovascular and respiratory effects like reduction in oxygen saturation, increase in end-tidal carbon dioxide ($ETCO_2$) and increase in peak airway pressure (PAP).[5] However, whether the type of surgical technique influences the cardiorespiratory parameters is debatable.

Effect of Pneumoperitoneum

Pneumoperitoneum affects the various organ systems by physical pressure on these systems and also due to the systemic absorption of carbon dioxide. The pressure effect depends on both the absolute intraperitoneal pressure and the length of time the pressure is applied. The diffusion of CO_2 across the peritoneum and into the bloodstream is governed by Fick's Law according to which the diffusion is proportional to the solubility of the gas and inversely proportional to the square root of the molecular weight as well as the thickness of the membrane. Hence, children will absorb a higher proportion of CO_2 as surface area: body mass is increased, and the peritoneal thickness is decreased.[6] The increased intra-abdominal pressure (IAP) results in splinting and a cephalad shift of the diaphragm leading to an absolute decrease in functional residual capacity, decrease in lung compliance; and an increase in V/Q mismatch in different parts of the lung with preferential ventilation of nondependent regions. The outcome is the development of hypoxia and hypercarbia.[7] Carbon dioxide absorption into the systemic circulation can lead to the development of respiratory acidosis. Increased IAP during insufflation leads to decrease in venous return, a decrease in preload and an increase in afterload. There is an increase in systemic vascular resistance and decrease in cardiac output, but blood pressure is maintained.

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Transperitoneal versus Retroperitoneal Approach Laparoscopy

Transperitoneal approach is commonly used for performing laparoscopy because of its familiarity, a larger working space and a natural orientation to the natural landmarks. However, it requires mobilization and reflection of the colon. Surgically retroperitoneal laparoscopy (RPL) might be advantageous over TP laparoscopy (TPL) due to safe port placement, visceral handling with a lesser risk of injury, more rapid access to the renal pedicle and easier renal artery control. Conversely, RPL may be technically more challenging because of the smaller working space and port proximity with resulting problematic ergonomy. Guillonneau *et al.* in a retrospective study found both RP and TP approaches to have similar rates of complications and length of hospital stay but that the RP approach had longer operative times.[2]

The TP and RP approaches may have implications for an anesthesiologist. These include amount of exposure to CO_2 in the TP and RP space, effect of positioning of the patient that may be prone or lateral for RP approach versus 60° for TP approach, the effect of pressure on one (RP) or both diaphragms (TP) and different analgesic requirement.[8]

Studies have shown that CO_2 absorption during RP and TP approach increases significantly during the first 30 min of surgery, followed by attainment of a steady-state and hemodynamic changes also occur alongwith. It is debatable which approach leads to a greater CO_2 absorption. Animal studies have shown similar CO_2 absorption with both the approaches. Ng *et al.* did not observe greater absorption of carbon dioxide in comparison with TPL, but Wolf *et al.* and Streich *et al.* found that carbon dioxide absorption was greater

in patients the RP approach was used for renal surgery than when the TP where approach.[9-11] RP space is different from the peritoneal cavity as it offers less barrier to CO_2 accumulation and absorption. Furthermore, the CO_2 levels may remain elevated up to the early postoperative period.

Lorenzo *et al*. investigated prospectively the effect of CO_2 insufflation in a pediatric population undergoing RP laparoscopic surgery.[12] The authors found significant changes in $ETCO_2$, PAP and mean arterial pressure (MAP). The RP space is a vascular space, contains areolar tissue, and offers less barrier to the diffusion of carbon dioxide. Therefore, the absorption of carbon dioxide is greater with RP technique when compared to TP approach. The increase in PAP may be related to the increased pressure in RP space, which translates into increased intrathoracic pressure, limited chest wall compliance, increased dead space and ventilation perfusion mismatch. These may be compounded by the position required during RP laparoscopy as flexion, elevation of the kidney rest and the lateral decubitus all have a role in further affecting chest wall mechanics and increasing the required ventilation pressures. This may be important in children with cardio-pulmonary compromise. Also, during RP surgery there may be a slight increase in MAP because of a temporary increase in systemic vascular resistance due to mechanical compression of vascular bed and/or catecholamine and renin release.[12]

Karsli *et al*. compared the cerebral and systemic hemodynamic effects of TP versus RP insufflation in children.[13] The authors found that TP laparoscopy is associated with a rapid increase and then a plateau in cerebral blood flow velocity and $ETCO_2$ in contrast to the slower and more gradual increase during RP laparoscopy. However, in most patients these changes are counteracted by the homeostatic mechanisms.

Some authors have found a difference in analgesic requirement in children undergoing RP and TP surgery with children undergoing TP surgery requiring more analgesics. This may be related to the colonic dissection and peritoneal irritation, which is required with the TP approach.[4,14]

Conclusion

Laparoscopic surgery in children can be accomplished by both RP and TP approaches. The selection of the type of procedure depends on the surgeon preference. RP approach may lead to more CO_2 absorption, elevated PAP, a gradual increase in cerebral blood flow velocity and less analgesic consumption. However, the effect of these changes may be relevant only in children with cardiorespiratory compromise and in children with central nervous system pathology.

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