**Effect of pneumoperitoneum on intracranial pressure during supratentorial craniotomy: a case report**

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**Abstract**: Laparoscopic surgery has become the method of choice for many procedures previously performed by open techniques. However, its use in patients with a potentially decreased intracranial compliance warrants caution. We report a case of combined glioma excision and laparoscopic cholecystectomy procedures with evaluation of the effects of pneumoperitoneum on ICP and operative field. The clinical implications, safety and recommendations of conducting laparoscopic surgeries in neurosurgical patients are discussed. Performing pneumoperitoneum in patients with marginal intracranial compliance needs interdisciplinary discussions and ICP monitoring is mandatory.

**INTRODUCTION**

Laparoscopic surgery has become the method of choice for many procedures previously performed by open techniques. Smaller surgical incisions improve cosmetic result, decrease postoperative pain and allow an earlier return to preoperative activities. These benefits made laparoscopy popular (1). Pneumoperitoneum in patients with a potentially decreased intracranial compliance warrants caution due to the potential for excessive increase in intracranial pressure (ICP). We report the anaesthetic management of a patient with left temporal glioma and symptomatic cholelithiasis and submitted to combined glioma surgery and laparoscopic cholecystectomy, with measurement of the effects of pneumoperitoneum on ICP.

**CASE SUMMARY**

A 30 year old female patient weighing 65 kilograms had a history of recurrent episodes of fainting attacks during pregnancy associated with heaviness of head. Her peripartum period was uneventful with normal vaginal delivery at term. The patient had recurring vertigo and heaviness of head in the post partum period. She developed absence seizures in the second week of puerperium which was associated with loss of consciousness for about an hour. The patient was prescribed oral carbamazepine 300 mg twice daily and clobazam 5 mg twice daily. Neuroimaging studies revealed a space occupying lesion in the left temporal region, suggestive of glioma. There were no features suggestive of raised ICP. Apart from this, patient had recurrent epigastric pain since 3 months which was diagnosed as cholelithiasis.

The preanesthetic evaluation of this patient including ophthalmic fundus examination was unremarkable. Though various surgical options were contemplated, the patient insisted on craniotomy and laparoscopic cholecystectomy in a single setting. She wanted to avoid two hospital admissions during lactation and early motherhood period. A comprehensive peroperative management plan was worked out and discussed with the patient. A written and informed consent was obtained from the patient for the following peroperative plan. First a ventricular catheter allowing ICP measurement was inserted before dura opening after craniotomy, which permitted record of ICP change occurring with abdominal gas insufflation by attaching the device to a pressure transducer system. Relationship between intra abdominal pressure (IAP) and ICP were noted along with safe limits of abdominal pressure. It was followed by glioma excision and later by laparoscopic cholecystectomy without closing the dura and keeping the IAP within the safe limits. Any alarming increase in ICP would have led to abandoning of laparoscopic...
cholecystectomy and proceed with excision of glioma alone.

Standard monitors were attached to the patient before induction. Invasive arterial blood pressure, neuromuscular function and bispectral index (BIS) were additionally monitored. Induction was done with intravenous morphine and propofol while neuromuscular blockade was achieved with vecuronium to facilitate endotracheal intubation. Anesthesia was maintained with propofol/nitrous oxide and intermittent boluses of vecuronium to maintain a train of four count of zero throughout the surgery. Mannitol 0.25 g/kg was infused prior to craniotomy. Patient was placed in the supine 25-30° head up position throughout the surgery with a slight head tilt to right side making sure no extreme flexion or compression of neck veins occurred. To facilitate cholecystectomy, the table was tilted to left side.

After reflecting the bone flap, a ventricular drain was inserted through the intact dura and connected to the pressure transducer system observing aseptic precautions. The whole pressure transducer system was zeroed to the level of glabella since the head was placed in a slight rightward tilt to facilitate temporal craniotomy. The ICP waveform was identified and initial ICP of 4 mm Hg was noted (Fig. 1a). The initial arterial blood gas analysis, end tidal carbondioxide (EtCO₂) and hemodynamics were normal. Abdomen was slowly insufflated with CO2 (at flow rate of 1.5 L/min) with a watch on ICP, blood pressure, EtCO₂ and brain conditions. The ventilation was adjusted to maintain an EtCO₂ between 32 and 35 mm Hg and limit airway pressure. Real-time analysis of relationship between IAP and ICP revealed that ICP gradually increased with IAP till 7.37 mm Hg (10 cm H₂O) of IAP. Beyond 7.38 mm Hg of IAP, ICP increased rapidly i.e. 1 mmHg ICP raise for every 0.73 mm Hg (1 cm H₂O) rise in IAP. Mean arterial blood pressure increased from a baseline level of 99 mmHg to a maximum of 106 mm Hg with a corresponding increase in ICP from 4 mm Hg to 15 mm Hg. The IAP was maintained for 10 minutes at 15 mm Hg with no further increase in ICP measurements. The surgical field was tense to the extent requiring ventricular drainage when IAP was more than 7.38 mm Hg (10 cm H₂O). Intraoperative arterial blood gases did not reveal acidosis, hypoxia or hypercarbia. The dura was then opened and glioma excised. Although the surgeon noted a tense surgical field during glioma excision, there was no further need for ventricular drainage or an increased surgical bleeding so as to necessitate any additional haemostatic measures. After haemostasis, laparoscopic cholecystectomy was started with the dura left open. The laparoscopic procedure was started with a target IAP of 10-11 cm of H₂O as observed in the initial evaluation period. Dura was closed after completing cholecystectomy. The anesthetic agents were tapered off at the end of the surgical procedure and the residual neuromuscular blockade was reversed. The patient was extubated once she was able to respond to commands. Post operative period and further hospital course were uneventful.

**DISCUSSION**

The conduct of neurosurgery and laparoscopic surgery in a single setting is an anesthetic challenge. Whereas laparoscopic surgery after neurosurgery may increase the risk of bleeding during the postoperative period secondary to vasodilatation and hypertension, laparoscopic procedure before neurosurgery has the risk of increasing ICP to dangerous levels with brain matter herniation. Combined surgeries in a single setting may have the advantage of treating the two pathologies during the same anesthetic setting, avoiding repeated anaesthesia exposure. Moreover, the patient may insist on getting rid of both pathologies in a single setting for personal convenience or cost saving benefit. The surgical options contemplated include tumour excision followed by laparoscopic cholecystectomy at a later date, open cholecystectomy and glioma excision in a single setting, and, finally, tumor excision and cholecystectomy in a single setting. The risks, benefits and plan of surgery for each option was discussed. Abandoning the laparoscopic procedure if it appeared unsafe intraoperatively was communicated to the patient preoperatively. The conduct of
Laparoscopic procedures mandates higher vigilance and monitoring than open procedures due to the CNS effects of laparoscopy. Various animal studies indicate that laparoscopic CO2 insufflation significantly increases ICP independently of arterial pH, oxygenation or mean arterial pressure (2, 3). The increase in ICP is seen even at low (8 mmHg) abdominal pressures and pronounced in animals with baseline elevated ICP (4, 5).

The definition of intracranial hypertension depends on the specific pathology and age, although ICP more than 15 mm Hg is generally considered being abnormal (6). ICP is not evenly distributed in pathologic states and assumption of one, uniform, ICP is therefore questionable (6). The exact mechanism by which IAP affects ICP is unknown and appears to be multifactorial. Apart from IAP, positive pressure ventilation itself increases ICP by impeding venous drainage due to increased intrathoracic pressure. The use of nitrous oxide could dangerously elevate ICP, although not probable in the present case due to the presence of ventricular drain. Various investigators have evaluated the safety of laparoscopic surgery in patients at risk of decreased cerebral compliance and have proposed that an increase in intraabdominal and intrathoracic pressure as well as impaired CSF absorption during insufflation impedes drainage of the lumbar venous plexus, inducing an increase in the vascular compartment resulting in increased ICP (2-7). Additionally, peritoneal absorption of carbon dioxide may induce vasodilatation, thus exacerbating intracranial hypertension. Also, a rapid increase in abdominal pressure may result in a transient increase in CVP as blood is forced out of the splanchnic circulation and inferior vena cava resulting in sudden increases in ICP (7). There is evidence that diagnostic laparoscopic procedure in head injured patients has shown to be detrimental (8). Similarly, in patients with ventriculo-peritoneal shunts, intraabdominal insufflation causes a rapid and sustained increase in ICP, which may result in hindbrain herniation (9).

The present case is probably the first to report the effect of pneumoperitoneum on operative field and ICP after craniotomy. Combined surgeries are not new to anesthetic practice (10, 11). However, we opted for observations of changes in ICP and operative field sequentially followed by glioma excision and cholecystectomy separately to decrease the risk of combined surgeries. Anesthetic implications of combined conduct of both surgeries lack clear guidelines due to the rarity of such cases. Conduct of such cases often compels anesthesiologists to choose the priority as cerebral dynamic in our case. Such surgeries are better done in centers where adequate monitoring facilities and trained neuroanesthesiologists are available. The increase in ICP following CO2 insufflation was lesser in our report as compared to those noted in other studies (Fig. 1) (7-9). Also, the increases in ICP did not significantly hamper cerebral perfusion pressure (CPP) (Fig. 2). This can be due to the measurement of ICP after craniotomy. The ICP measured in a closed cranial vault most probably will be higher than that measured after craniotomy with intact dura. But still, the increase in ICP in our case was highly significant from 4 mm Hg to 15 mm Hg. Moreover, the observation of a tense surgical field with bulging of dura necessitating CSF drainage indicates the inherent risks posed by pneumoperitoneum. As governed by Munro-Kelly doctrine, the increases in ICP in patients with intracranial mass lesions or increased ICP with decreased cerebral compliance may hamper cerebral blood supply or cause brain matter herniation with untoward consequences. Although normocarbica and normal CPP was ensured in our case, the effect CO2 insufflation on cerebral blood flow needs further study. Safety of conducting combined surgeries especially in neurosurgical patients is yet to be determined. As of now, the conduct of combined surgeries involving alterations in cerebral homeostasis in patients with intracranial pathology cannot be recommended till further safety of these procedures are proved.

References


