Diagnostic and therapeutic laparoscopy has emerged as an alternative to trauma laparotomy. Laparoscopy is used to control hemorrhage and repair the diaphragm, stomach, bowel, and bladder during colectomy, pancreatectomy, and splenectomy in blunt and penetrating trauma.1-5 Therapeutically, laparoscopy is less morbid than laparotomy, and diagnostically it can obviate the need for a laparotomy.1-5

Unfortunately, abdominal and head trauma can coexist, and increasing intra-abdominal pressure increases intracranial pressure (ICP).6-8 Results of animal studies have shown that laparoscopy increases ICP.9-12 Various mechanisms have been proposed, including compression of the lumbar venous plexus, hypercarbia causing cerebral vasodilation due to carbon dioxide (CO2) insufflation, and inferior vena cava compression inhibiting cerebral venous drainage.10,11 Abdominal decompression may relieve elevated ICP. 13,14 These data belie the lack of human data on the effects of laparoscopy on ICP.

The laparoscopy-assisted ventriculoperitoneal shunt (VPS) placement is ideal for examining the effects of abdominal insufflation for laparoscopy on ICP. At Beth Israel Deaconess Medical Center, ICP has been measured during this operation. We conducted a retrospective review of sequential laparoscopic VPS placement to examine the effect of laparoscopy on ICP.

**Methods**

**Data Collection**

Approval of the Beth Israel Deaconess Medical Center institutional review board was obtained. Retrospective medical record review was performed for sequential patients who underwent laparoscopy-assisted VPS placement from January 1, 2008, through December 31, 2011. Nine patients had ICP recorded on operative reports by the preference of the general surgeon or the neurosurgeon. Three neurosurgeons (including E.P.) and 4 general surgeons (including B.E.S.) were involved in the operations. Sixteen measurements were recorded with abdominal insufflation with CO2 at pressures ranging from 8 to 15 mm Hg. Intracranial pressure was measured through the ventricular catheter using a manometer with insufflation and desufflation. Baseline data obtained included age, sex, the presence of hypertension, the presence of cancer, weight, and prior abdominal or cranial surgery.

**Statistical Analysis**

When ICP was recorded as a range, we used the mean value in analysis. We performed a paired $t$ test on ICP measurements between insufflation and desufflation. Linear regression and the correlation coefficient were calculated to correlate intraperitoneal pressure with ICP.
Results

Fifty-five patients underwent laparoscopic VPS placement during the study period; in 9, ICP and intraperitoneal pressures were included in the operative report. Sixteen ICP measurements were obtained on these patients with intraperitoneal pressures ranging from 8 to 15 mm Hg. All patients had ICPs recorded with 15-mm Hg insufflation; 3, with 10- and 12-mm Hg insufflation; and 1, with 8-mm Hg insufflation. All patients received propofol and an inhaled anesthetic agent (sevoflurane or desflurane). The mean age was 65.1 (range, 34-82) years. Indications for VPS placement included normal-pressure hydrocephalus (5 patients), traumatic subdural hematoma (2 patients), meningioma (1 patient), and metastatic melanoma (1 patient). Four patients were men and 5 were women. No baseline data significantly affected ICP change.

Intracranial pressure ranged from 0 to 18 cm H$_2$O with desufflation and from 8 to 25 cm H$_2$O with 15-mm Hg insufflation. The highest recorded ICP was 25 cm H$_2$O. Mean ICP increase correlated significantly with insufflation pressure. The mean increase in ICP was 7.2 (95% CI, 5.4-9.1) cm H$_2$O with 15-mm Hg insufflation ($P < .001$), 6.3 (0.6-12.1) cm H$_2$O with 12-mm Hg insufflation ($P = .04$), and 4.8 (1.0-8.6) cm H$_2$O with 10-mm Hg insufflation ($P = .03$). Increasing insufflation pressure correlated with increased ICP ($P = .04$) (Figure).

Discussion

Elevated ICP is associated with cerebral ischemia and is predictive of deterioration after head trauma; decreasing ICP to less than 20 cm H$_2$O and keeping cerebral perfusion pressure (CPP) at greater than 50 mm Hg is the priority in patients with head injury according to the Brain Trauma Foundation. The maximum ICP measured in our study was a potentially dangerous 25 cm H$_2$O. In patients with head injuries after trauma, an elevated ICP for the duration of a therapeutic or even a diagnostic laparoscopy could cause irreparable brain damage.

In our study, the ICP increase correlated linearly with the abdominal insufflation pressure. This finding is consistent with the previous animal data and suggests that this increase may be due to the effect of increased abdominal pressure on central venous pressure, as suggested by Rosenthal et al. Although a wide range of ICPs were noted during insufflation and desufflation—likely owing in part to the primary brain disease necessitating placement of the VPS—a strong correlation was shown between insufflation pressure and ICP. Unfortunately, we had only a small number of patients and were unable to evaluate the response in different brain diseases. Because of the limitations of the laparoscopic VPS procedure and anesthesia record, we were unable to measure ICP at the onset and close of the procedure or to correlate end-tidal CO$_2$ levels with insufflation and thus could not determine the effect of longer CO$_2$ insufflation and potential subsequent hypercarbia on ICP, as suggested by Schöb et al. This potential for CO$_2$ absorption might make laparoscopy even more dangerous in patients with already elevated ICP because ICP may continue to rise throughout the operation. Furthermore, laparoscopic operations may aggravate the multiple compartment syndrome—a combination of elevated intra-abdominal and intrathoracic pressures and ICP—owing to the combination of abdominal insufflation and positive pressure ventilation. The linear relationship in our study between ICP and insufflation pressure suggests that any increase in abdominal pressure can be harmful in the patient with head injury. If laparoscopy is to be performed, a lower-than-standard insufflation pressure may be safer, although future study is necessary to determine its safety and feasibility.

Because our study was retrospective and limited by the anesthesia record, we were unable to correlate blood pressures with insufflation and thus could not measure the CPP. However, if the CPP were greater than 60 mm Hg, CPP may have less bearing than ICP on the prognosis of patients with head injury. Further studies will need to determine the correlation between insufflation pressure and CPP in human patients. Another potential concern is the small size of our study. Despite the small number of patients, the impact of laparoscopy was still striking enough to afford a significant $P$ value. However, a larger study might determine which factors place a patient at higher risk of a larger, potentially devastating rise in ICP with laparoscopy.

Conclusions

In patients undergoing laparoscopic VPS placement, ICP is significantly increased with abdominal insufflation for laparoscopy, and sequentially increased insufflation pressures significantly correlate with increased ICP. More research is needed to determine the effect of laparoscopy on CPP. These data suggest that laparoscopy should be used cautiously, if at all, in patients with a baseline elevated ICP or with head trauma.
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REFERENCES