Editorials

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Adverse cardiovascular changes induced by positive pressure pneumoperitoneum

Possible solutions to a problem

This and upcoming issues of *Surgical Endoscopy: Ultrasound and Interventional Techniques* contain a number of articles that document the adverse consequences of a positive pressure pneumoperitoneum. Jakimowicz et al. [1] report a pressure-related substantial reduction of portal flow in patients; Knolmayer et al. [2], reduction of gastric blood flow in pigs; Taura et al. [3], a significant lactic acidosis in patients undergoing laparoscopic sigmoid colectomy with high intraabdominal pressure (15 mmHg); and Horvath et al. [4], in a comparative experimental study; a lower incidence of metabolic and hemodynamic effects with abdominal wall lift (AWL). This is confirmed by Nimomiya et al. [5] for patients in whom it was observed that cardiac function and renal hemodynamics were not altered by AWL. Most of these observations on the pathophysiology of a positive pressure CO_2 pneumoperitoneum had been reported by others.

Extent and nature of the problem

In essence, a positive pressure pneumoperitoneum induces adverse changes, which, to a large extent, can be circumvented by the careful monitoring and appropriate general anaesthetic technique during laparoscopic surgery; thus the adverse changes are of limited consequence for the majority of patients. Some of the changes are aggravated by changes in the position of the patient during surgery. There is, however, concern about the use of positive-pressure pneumoperitoneum in high-risk patients with cardiorespiratory compromise [6].

As indicated by some of the articles in the present issue, the adverse effects are largely pressure-related, but some are also a result of the absorption of CO_2. Indeed, one randomized study has shown that postoperative drowsiness is prolonged in patients undergoing laparoscopic cholecystectomy with a positive-pressure pneumoperitoneum and is relatd to the amount of CO_2 used [7]. The cardiovascular changes, including reduction in tissue perfusion, altered renal hemodynamics and renal tubular damage, and the neuroendocrine response caused by a positive-pressure pneumoperitoneum, are remarkably similar to those encountered in congestive cardiac, and this observation (made to me by Professor A. Struthers at Ninewells [8] opens therapeutic possibilities.

Solutions to the problem

The CO_2 positive-pressure pneumoperitoneum approach remains the gold standard and undoubtedly provides the best laparoscopic exposure. There does not appear to be any material advantages to using inert gases and, indeed, because of their reduced solubility; these pose greater risks from gas embolism. One practical and simple measure is to operate with the lowest possible intraabdominal pressure that gives adequate exposure, and in many patients 10 mmHg is sufficient. The advantage of this policy is demonstrated by the Barcelona study in the present issue of *Surgical Endoscopy* [3]. In high-risk patients, the use of the abdominal wall sling first reported by our group [9] permits excellent exposure with a pneumoperitoneum of 4–6 mmHg. Our experience with this approach in high-risk cases over the past eight years has been entirely favorable, with virtual abrogation of the adverse cardiovascular changes, and this has been confirmed by prospective studies from the Finnish group [10–12].

Another possible solution to the problem that emanates from the observation of Professor Struthers is the medication of high-risk patients with vasodilators since this is known to alleviate the severe cardiovascular changes of congestive heart failure and could thus prevent the adverse changes of a positive-pressure pneumoperitoneum. Experimental and clinical studies investigating this hypothesis are in progress at Ninewells Hospital and Medical School.

A mechanical approach using active cycled anterograde pneumatic compression of the legs during the period of positive pressure pneumoperitoneum is being developed and evaluated by Dr. Amitai Bickel (Western Galilee Hospital, Nahariya, Israel). The technology for this has been developed in Israel and the system is currently undergoing clinical evaluation.

Retractor abdominal wall lift systems

The obvious advantages of retractor abdominal wall-lift systems is that they dispense entirely with the use of gas in-

sufflation and thus remove the problem. The first generation in current, established usage provides intraperitoneal lift. The device has been shown in randomized studies to be associated with inconsequential minor changes in cardiorespiratory parameters, tissue perfusion, and neuroendocrine response [9–12]. The problem concerns the exposure provided by the intraperitoneal retractor. This is less than optimal because of the tenting effect. Another disadvantage, which has been largely overlooked, is the ischemic injury to the anterior parietal peritoneum and to the subjacent abdominal wall that the retractor causes during long procedures and prolonged AWL. Will this pressure-induced ischemic injury increase the rate of intraabdominal adhesions, and what are its implications with respect to tumor implantation in patients undergoing laparoscopic excisional surgery for cancer?

The second generation of AWL devices, which are operated by lifting the anterior abdominal wall through the subcutaneous plane by means of specially designed curvilinear "pluriplan" needles. These needles, apart from avoiding pressure damage to the parietal pneumoperitoneum, reduce the tenting effect and thus provide better laparoscopic exposure. The LaparoTensor (LT snc Lucini & Co., Milan, Italy) is such a system and is being investigated against positive pressure pneumoperitoneum in a prospective randomized trial.

Conclusions

Although likely to remain the gold standard, CO_2 pneumoperitoneum may pose major problems in high-risk cases. Use of the lowest intraabdominal pressure possible is a sensible policy in all patients. Vasodilator medication of high-risk patients may protect against the adverse consequences of raised intraabdominal pressure, but the benefit of this approach has yet to be established. More efficient and less traumatic AWL devices may replace positive-pressure pneumoperitoneum in the future.

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