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TECHNICAL NOTE

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Semicontinuous intra-abdominal pressure measurement using an intragastric Compliance catheter

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Abstract *Objective:* To compare intra-abdominal pressure (IAP) measurements obtained from an intragastric Compliance catheter with the pressure measured directly in the abdominal cavity. *Design and setting:* Prospective cohort study in an operating room of the Ghent University Hospital *Patients:* Seven patients undergoing elective laparoscopic cholecystectomy. *Interventions:* IAP was obtained from both an intragastric catheter and directly from the peritoneal cavity at 1-minute intervals in patients undergoing elective cholecystectomy and compared using Bland-Altman analysis. *Measurements and results:* In 156 paired measurements obtained from 7 patients the mean difference between $IAP_{gastric}$ and IAP_{ref} was 0.12 ± 0.70 mmHg (95% CI 0.01–0.23). *Conclusions:* IAP measured using an intragastric Compliance catheter reliably reflects the reference IAP in patients undergoing laparoscopic cholecystectomy.

Keywords Intra-abdominal pressure · Intra-abdominal hypertension · Abdominal compartment syndrome · Surgery · Trauma · Critically ill patients

Introduction

In critically ill patients, intra-abdominal hypertension (IAH) and abdominal compartment syndrome are increasingly appreciated [1] and intra-abdominal pressure (IAP) monitoring is becoming routine in these patients. Several techniques have been described for the measurement of IAP. Currently the transvesical route remains the most popular one [2]. The use of an intragastric balloon catheter may be an interesting alternative for the transvesical route as it makes continuous IAP measurement possible. Previously we found in a laboratory experiment that a balloon-tipped catheter filled with 1–3 ml air accurately transduces pressures [3]. Other balloon-tipped catheters have been reported to give reliable and reproducible IAP measurements [4, 5]. During laparoscopic procedures IAP is maintained at 10–15 mmHg using carbon dioxide to create a pneumoperitoneum. The pressure is set at a predefined level and remains constant. Because the pressure is constant during a laparoscopic procedure this

creates an ideal setting for evaluating new devices for IAP measurement. In addition, the reference pressure is easily measured and the IAP during a laparoscopic procedure usually is at a clinically relevant level (10–20 mmHg). Several studies evaluating methods for IAP measurement have been performed using this setup [6– 9].

This study compared pressure measurements obtained from an intragastric Compliance catheter with the pressure measured directly in the abdominal cavity during laparoscopic cholecystectomy. Findings have been presented previously at the annual meeting of the European Society of Intensive Care Medicine in Amsterdam, 10–13 October 2005.

Methods

The study included seven patients undergoing elective laparoscopic cholecystectomy (four men, 3 women; mean age 46 years). It was conducted in the operating theater of Ghent University Hospital and was approved by the hospital's ethics committee; written informed consent was obtained from the patients before the operation.

After induction of anesthesia a Compliance catheter (International Medical Systems, Zutphen, The Netherlands; Fig. 1) was introduced under direct vision in the esophagus and into the stomach. The balloon was filled with 3 ml air, and the catheter was attached to a pressure transducer connected to the patient monitoring system. After the pneumoperitoneum was established, a rigid pressure line was connected to one of the laparoscopic ports in direct connection with the peritoneal space. This pressure line was also connected to a transducer and recorded the reference pressure (IAP_{ref}). The position of the balloon was checked by comparing the pressure tracings from the two pressure lines and by manipulation of the stomach by the surgeon. Pressures from both pressure lines were obtained at 1-min intervals except during periods of insufflation of CO_2 into the abdomen, as this caused substantial fluctuations in IAP. When the gallbladder was extracted from the abdomen, the measurements were stopped. A total of 156 paired measurements were obtained from the seven patients; for each patient between 16 and 27 paired measurements were available for analysis (median 24). The IAP_{ref} ranged from 6 to 18 mmHg.

The pressure obtained from the Compliance catheter ($IAP_{gastric}$) and the IAP_{ref} (the pressure directly measured in the abdominal cavity) were compared using Bland and Altman [10] analysis. The mean ± SD difference between $IAP_{gastric}$ and IAP_{ref} was calculated, including a 95% confidence interval (CI). We considered the balloon to be acceptable for clinical use if the mean difference was 1 mmHg or less, and if the standard deviation was lower than 1 mmHg. Analyses were carried out using Medcalc 8.1 (Medcalc, Mariakerke, Belgium). Differences at the level of $p \leq 0.05$ were considered statistically significant.

Results

The mean overall difference between $IAP_{gastric}$ and IAP_{ref} was 0.12 ± 0.70 mmHg (95% CI 0.01–0.23; Fig. 2). There was no evidence of bias at the extremes of the pressure range studied. In individual patients the mean difference was also within acceptable limits: the mean difference ranged from –0.48 to 0.63 mmHg and SD from 0 to 0.99 mmHg (Table 1). No clinical complications related to the introduction of the pressure catheter were seen.

Fig. 1 Compliance catheter (International Medical Systems, Zutphen, The Netherlands)

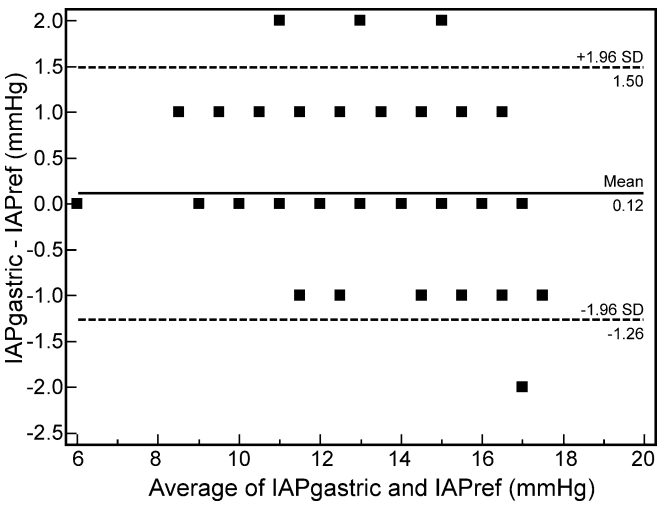

Fig. 2 Relationship between intra-abdominal pressure obtained from an intragastric Compliance catheter ($IAP_{gastric}$) and reference intra-abdominal pressure (IAP_{ref})

Table 1 Overview of the mean difference and standard deviation in individual patients

Patient no.	Number of measurements obtained	Mean difference (mmHg)	Standard deviation (mmHg)
1	25	0	0.65
2	24	0.12	0.99
3	27	0.63	0.63
4	16	0.13	0.34
5	17	0.53	0.51
6	22	0	0
7	25	−0.48	0.59

Discussion

This study found that the intragastric Compliance catheter accurately measures IAP and therefore is a potential alternative to other available methods for continuous IAP measurement. The mean difference between IAP measured using the intragastric Compliance catheter and that measured directly was 0.12 mmHg, was well within the limits determined before starting the experiment. Continuous IAP measurement seems advisable in selected critically ill patients as there is evidence that IAP may fluctuate considerably over time. This requires frequent measurements by the nursing staff, which is time consuming in often critically ill patients. Apart from this the abdominal perfusion pressure (mean arterial pressure minus IAP) has been proposed as a potential target for resuscitation. The use of this parameter as a target also obviates the need for continuous IAP assessment.

Balloon tipped catheters have been tested before, both in vitro [4] and in vivo [5], and have been found to be easy to use. IAP values obtained through these catheters are highly reproducible and seem to be a promising technique for continuous or semicontinuous IAP measurement. Also other techniques for continuous have been introduced: Balogh et al. [11] reported their experience with an elegant system for continuous IAP measurement using the transvesical route and found this technique to be very reliable. The use of the transgastric route for IAP measurement is not new. A laboratory experiment found the intragastric pressure to be well correlated with the pressure measured directly in the abdomen [12], a finding confirmed in another laboratory setting using this specific setup [3]. The transgastric route has also been used to measure the IAP in critically ill patients [13], and several automated techniques have recently become commercially available.

The advantages of using an intragastric Compliance catheter in critically ill patients are numerous. First, the catheter can be connected to the monitoring equipment used in the unit, solving the problem of the availability of a limited number of dedicated devices. The catheter is relatively cheap (€ 12, approx. US $14) and easy to use. It overcomes the problem of overestimation of IAP when using transvesical techniques in patients with compartment syndrome limited to the pelvis in localized hematomas, and it provides a method for IAP measurement in patients without bladder catheters. Possible drawbacks are the need for an additional catheter and the possible interference with peristalsis, medication, and enteral nutrition. These issues should be addressed when studying the clinical applicability in ICU patients.

In conclusion, IAP measured using an intragastric Compliance catheter reliably reflects the reference IAP in patients undergoing laparoscopic cholecystectomy and is an alternative for continuous IAP measurement in patients at risk for IAH.

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