

SHORT REPORT

Gastric tonometry after gastroschisis repair

R J Thompson, B Jaffray

Arch Dis Child 2002;87:339-340

Gastric tonometry and intravesical pressure measurement were performed on eight babies born with gastroschisis for 72 hours after abdominal closure. Intravesical pressure was not high. The gastric mucosal $p\text{CO}_2$ and gastric mucosal pH remained stable and closely matched arterial values. Tonometry may be a useful technique to monitor these babies.

Mortality in gastroschisis is caused by intestinal atresia, or bowel or renal ischaemia.¹ Because recognising intestinal ischaemia after abdominal closure is difficult, measurement of intragastric,² or intravesical pressure³ have been proposed as monitoring techniques.

Gastric tonometry measures the mucosal concentration of CO_2 in the stomach, which rises as perfusion falls. Thus it may provide a better method of monitoring than pressure techniques. Tonometry can predict the development of the abdominal compartment syndrome (ACS) after trauma or surgery.⁴ It is not known whether uncomplicated closure of the abdomen of a baby with gastroschisis causes changes in gastric perfusion. The aims of this study were to determine the values of gastric tonometry for 72 hours after repair of gastroschisis while measuring intra-abdominal pressure.

PATIENTS AND METHODS

Eight consecutive babies diagnosed antenatally with gastroschisis and delivered in one institution were recruited.

Average gestation and birth weight were 37 weeks and 2.5 kg respectively. Surgery was performed under general anaesthesia with full muscle relaxation. Babies were ventilated for the duration of this study.

Tonometry was performed using a Datex TC-200 Tonocap monitor (Tonometrics Division, Instrumentarium Corp., Helsinki, Finland). Tonometry measures the CO_2 concentration in the gastric lumen. It is assumed that this is in equilibrium with the CO_2 concentration in the mucosa, termed the regional $p\text{CO}_2$ ($p\text{rco}_2$). It is further assumed that the mucosal concentration varies as a result of production (metabolism), or removal (blood flow); finally it is assumed that local metabolism is constant and therefore alterations in CO_2 concentration reflect changes in blood flow. Knowing the variables of $p\text{rco}_2$ and arterial bicarbonate concentration allows the gastric intramucosal (intracellular, not intraluminal) pH (pHi) to be calculated from the Henderson Hasselbalch equation.⁵ The CO_2 gap is the difference between gastric mucosal and arterial concentrations.

$p\text{rco}_2$, pHi , intravesical pressure, and arterial gas tensions were measured prior to fascial closure, after closure, and six hourly for 72 hours. The decision to close the abdomen primarily, or in stages, or to reopen the abdomen was made independently of this study.

Abbreviations: ACS, abdominal compartment syndrome; IAH, intra-abdominal hypertension

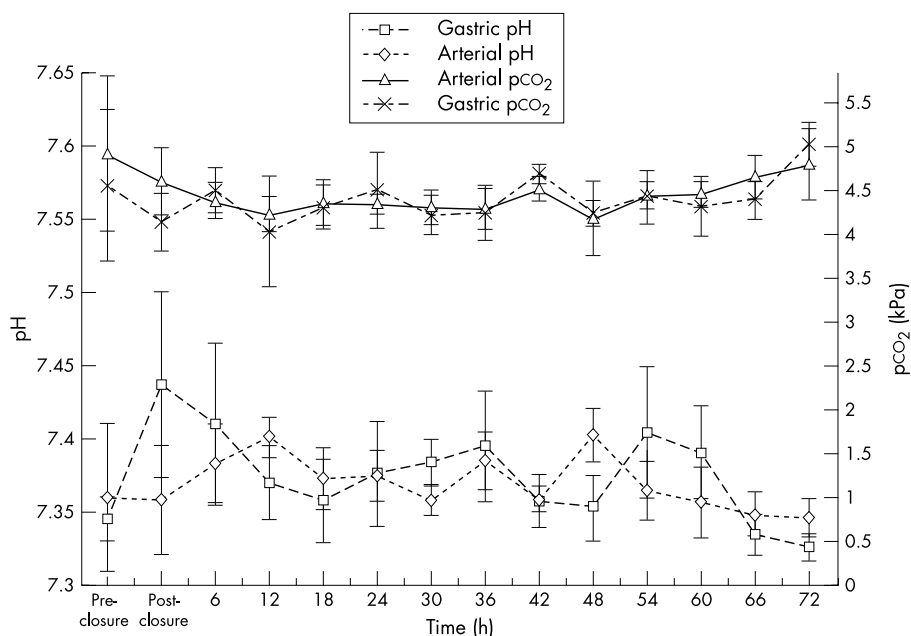


Figure 1 Gastric mucosal and arterial $p\text{CO}_2$, and gastric mucosal and arterial pH during the 72 hours after closure of the abdomen. Mean and SEM.

Informed consent was obtained from parents, and the regional ethics committee approved the protocol.

RESULTS

Two cases were incomplete because of kinking of the catheter in one and loss of the arterial line in another. All had fascial closure within six hours of birth. None required re-exploration, and all had an uneventful subsequent course.

The mean intravesical pressure was 10.3 mm Hg (95% confidence interval (CI) 9.4 to 11.2). The highest pressure was 20 mm Hg.

The gastric mucosal $p\text{CO}_2$ and arterial $p\text{CO}_2$ were not significantly different (see fig 1). The mean gastric mucosal $p\text{CO}_2$ was 4.37 (95% CI 4.2 to 4.5). The mean arterial $p\text{CO}_2$ was 4.42 (95% CI 4.3 to 4.6). The mean $p\text{CO}_2$ gap was 0.067 (95% CI -0.06 to 0.19).

The mean pHi and arterial pH were identical at 7.37 (95% CI: gastric pH 7.35 to 7.39; arterial pH 7.35 to 7.38). There was no correlation between intravesical pressure and either gastric $p\text{CO}_2$ ($r = -0.05$) or gastric mucosal pH ($r = 0.11$).

DISCUSSION

Closure of the abdomen in babies with gastroschisis risks intestinal and renal ischaemia¹ because of intra-abdominal hypertension (IAH), causing ACS. Tonometry is used to monitor for the development of ACS after trauma,⁴ and in severe sepsis where impaired splanchnic perfusion is significant.⁶

The absence of data regarding expected values of tonometry variables prevents its application to babies undergoing abdominal closure. We report a series without IAH. For tonometry to be of use, such cases should show close approximation between gastric $p\text{CO}_2$ and arterial $p\text{CO}_2$, and between gastric mucosal pH and arterial pH. It was unknown whether deterioration in mucosal perfusion could be expected. We have shown that where there is no rise in intra-abdominal pressure, there is very close approximation of gastric mucosal $p\text{CO}_2$ and arterial $p\text{CO}_2$, and between gastric mucosal pH and arterial pH.

Whether tonometry will prove more sensitive than clinical suspicion, or conventional pressure monitoring in detecting impaired gut or renal perfusion will require a larger study to

recruit babies who show a rise in intra-abdominal pressure, or in whom the clinical concern is such that the question of staged closure or reopening the abdomen after primary closure occurs. This study provides data on babies who did not develop complications related to closure to allow such a large study.

ACKNOWLEDGEMENTS

The gastric tonometer and catheters were purchased with the financial support of the Newcastle University Hospitals Special Trusts. The authors acknowledge the support and cooperation of the staff of the neonatal surgical unit.

Authors' affiliations

R J Thompson, B Jaffray, Department of Child Health, Sir James Spence Building, University of Newcastle upon Tyne, UK

Correspondence to: Mr B Jaffray, Senior Lecturer in Paediatric Surgery, Department of Child Health, Sir James Spence Building, University of Newcastle upon Tyne, Queen Victoria Road, Newcastle upon Tyne NE1 4LP, UK; bruce.jaffray@ncl.ac.uk

Accepted 11 June 2002

REFERENCES

- 1 **Fonkalsrud EW**, Smith MD, Shaw KS, *et al*. Selective management of gastroschisis according to the degree of viscerobdominal disproportion. *Ann Surg* 1993;**218**:742-7.
- 2 **Yaster M**, Scherer TL, Stone MM, *et al*. Prediction of successful primary closure of congenital abdominal wall defects using intraoperative measurements. *J Pediatr Surg* 1989;**24**:1217-20.
- 3 **Rizzo A**, Davis PC, Hamm CR, *et al*. Intraoperative vesical pressure measurements as a guide in the closure of abdominal wall defects. *Am Surg* 1996;**62**:192-6.
- 4 **Ivatury RR**, Porter JM, Simon RJ, *et al*. Intra-abdominal hypertension after life-threatening penetrating abdominal trauma: prophylaxis, incidence, and clinical relevance to gastric mucosal pH and abdominal compartment syndrome. *J Trauma* 1998;**44**:1016-21.
- 5 **Russell JA**. Gastric tonometry: does it work. *Intensive Care Med* 1997;**23**:3-6.
- 6 **Hatherill M**, Tibby SM, Evans R, *et al*. Gastric tonometry in septic shock. *Arch Dis Child* 1998;**78**:155-8.