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Intraperitoneal microdialysis in the postoperative surveillance of infants undergoing surgery for congenital abdominal wall defect: A pilot study

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ABSTRACT

Purpose: This study aims to investigate the safety and clinical implication of intraperitoneal microdialysis (MD) in newborns operated on for congenital abdominal wall defect.
Patients and methods: 13 infants underwent intraperitoneal microdialysis (9 with gastroschisis and 4 with omphalocele). MD samples were collected every four hours and the concentrations of lactate, glycerol, glucose and pyruvate were measured. The results of MD were compared between the group of infants with gastroschisis and the group with omphalocele. The duration of parenteral nutrition and tube feeding were compared for high and low levels of intraperitoneal lactate, glycerol, and glucose and lactate/pyruvate ratio respectively. High and low levels were defined as above or below the median value on day one.
Results: Results from intraperitoneal MD showed a significantly higher mean lactate concentration in the group of infants with gastroschisis compared with the group of infants with omphalocele. The median values were 6.19 mmol/l and 2.19 mmol/l, respectively ($P = 0.006$). The results from MD in the six infants in the gastroschisis group who underwent secondary closure after Silo treatment were similar to those who underwent primary closure. None of the infants with omphalocele received parenteral nutrition whereas all of the infants with gastroschisis did. There was no significant difference in duration of parenteral nutrition or tube feeding, respectively, when comparing the gastroschisis children with high versus low intraperitoneal lactate values. Placement of the MD catheter in the intraperitoneal cavity was feasible and without any major complications.
Conclusion: Intraperitoneal MD is a safe procedure and an applicable method in surveillance of inflammatory changes in the peritoneal cavity in infants after operation for congenital abdominal wall defect. The true clinical value in infants with congenital wall defect remains unknown.

During the postoperative period after closure of congenital abdominal wall defects enteral nutrition is a challenge, especially in gastroschisis. This is because of the intestinal exposure to amniotic fluid during pregnancy causing visceral oedema, which may result in impaired intestinal motility and nutrient absorption. In addition the increased intraabdominal pressure after closure of the defect may aggravate the condition. The condition gradually improves over time but several infants do not tolerate immediate enteral feeding and are dependent on total or supplemental parenteral nutrition for longer periods of time. Presently there is no known paraclinical method to monitor the intestinal condition.

We hypothesize that changes in intraperitoneal concentration of lactate, glycerol, glucose and pyruvate achieved by intraperitoneal microdialysis (MD) in the first postoperative week will reflect the condition of the intestines.

MD is a minimally invasive technique based on diffusion principles that allows collection of substances from the extracellular fluid in different organs and compartments. The MD probe mimics the function of a capillary blood vessel. By perfusing a physiological solution through the MD catheter implanted into a tissue or body cavity it is possible to collect a representative sample of a variety of metabolites. MD allows continuous sampling for hours or days [1]. In several experimental studies and clinical studies in adults intraperitoneal MD has shown to be an applicable and safe tool to detect and monitor intestinal ischemia and intraperitoneal inflammation [1–4]. Intraperitoneal MD has been applied in a previous study in preterm babies operated for necrotizing enterocolitis [5]. The results showed that intraperitoneal MD was applicable in surveillance of the metabolic and inflammatory changes in the peritoneal cavity. To our knowledge no studies on intraperitoneal MD in infants with congenital abdominal wall defect have been published.

The objective of this study was to investigate the safety and clinical implications of intraperitoneal MD and to evaluate to what degree the levels of lactate, glycerol, glucose and pyruvate in microdialysate fluid would reflect the condition of the intestines in infants with gastroschisis and omphalocele. As a proxy for the condition of the intestine we also looked at the tolerance of enteral nutrition.

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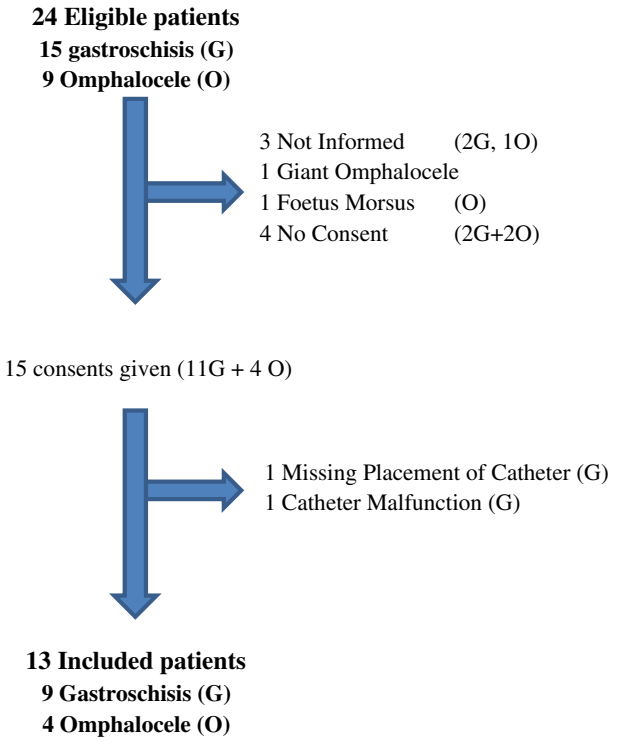

Fig. 1. Flowchart of the inclusion process.

1. Material and methods

In the period from January 1st 2012 until August 31st 2014 a total of 24 children underwent surgical repair for congenital abdominal wall defect (15 with gastroschisis and 9 with omphalocele) and thus were eligible for the study. Informed consent preterm was obtained from parents of 15 patients (11 with gastroschisis and 4 with omphalocele). Of these 15 patients two were excluded — one child because of malfunction of the MD catheter and one because the MD catheter was not inserted. Thus, the calculations are based upon 13 patients (Fig. 1).

Prior to abdominal closure an MD catheter (71 High Cutoff MD Catheter, 60/30 from M Dialysis AB, Sweden) was placed intraperitoneally. The MD catheter has a concentric double lumen with an outer diameter of 1 mm with a 30 mm long tubular semipermeable membrane with a 100 kDa pore size. The catheter was introduced in the left hypochondrium via a splittable cannula (Splittable Introducer SI-2 from M Dialysis AB, Sweden). The tip of the catheter was placed in the lower part of the abdomen and the catheter was secured to the skin by a transparent plastic film (Suprasorb®F from Lohmann-Rauscher, Germany) or by a suture. Using a perfusion pump (106 Microdialysis Pump from M Dialysis AB, Sweden) the catheter (Fig. 2) was continuously perfused with Voluven® (Fresenius Kabi) at a rate of 0.3 μl/min and samples were collected in microvials changed every four hours for an intended period of 7 days.

Samples were analyzed for the concentration of lactate, glycerol, glucose and pyruvate in an ISCUS flex Microdialysis Analyser (M Dialysis AB, Sweden).

Every morning (8 a.m.) capillary blood samples were analyzed for the concentration of glucose and lactate. Body weight was measured together with the number of stool passings and the type and amount of nutrition and the gastric aspiration during the preceding 24 hours.

All infants received enteral feeding, either breast milk or a mixture of breast milk and amino acid-based formula. The amount of enteral nutrition was individual. Based on observation of the infant's weight and feeding tolerance enteral nutrition was increased up to the maximum quantity tolerated by the infant. Every day the balance between enteral feeding and parenteral nutrition was clinically evaluated. Clinical evaluation and treatment of the infants followed the usual department guidelines without inclusion of the results from the MD.

The study was approved by the Regional committee of Biomedical Ethics (Project-ID: S-20110145).

1.1. Statistics

Data are quoted as medians and were analyzed using Stata (Version IC 13.1) and Microsoft Excel 2010.

The results of MD were compared between the group of infants with gastroschisis versus the group of infants with omphalocele. The two-sample Wilcoxon rank-sum (Mann–Whitney) test was used.

The duration of parenteral nutrition and tube feeding were compared for high and low levels of intraperitoneal lactate, glucose, glycerol and lactate/pyruvate ratio, respectively. High and low levels were defined as above or below the median value on day one. Both the Wilcoxon rank-sum test and the Fisher's exact test were used.

2. Results

2.1. Clinical course

Thirteen infants underwent MD of which nine were born with gastroschisis and four with minor omphalocele. The median gestational age was 36 (32–39) weeks and the median weight at birth 2700 g (1700 g–3855 g). Among the nine infants with gastroschisis primary closure was performed in three infants, and secondary closure was performed in six infants. Age at final abdominal closure was median 2 (1–73) days. Median duration of enteral tube feeding was 35 (11–60) days for children with gastroschisis and 8 (5–22) days for children with omphalocele. Median duration of microdialysis was 160 (84–192) hours with no difference between gastroschisis and omphalocele. All children were discharged alive from hospital. A summary of the clinical features of the included infants is illustrated in Table 1.

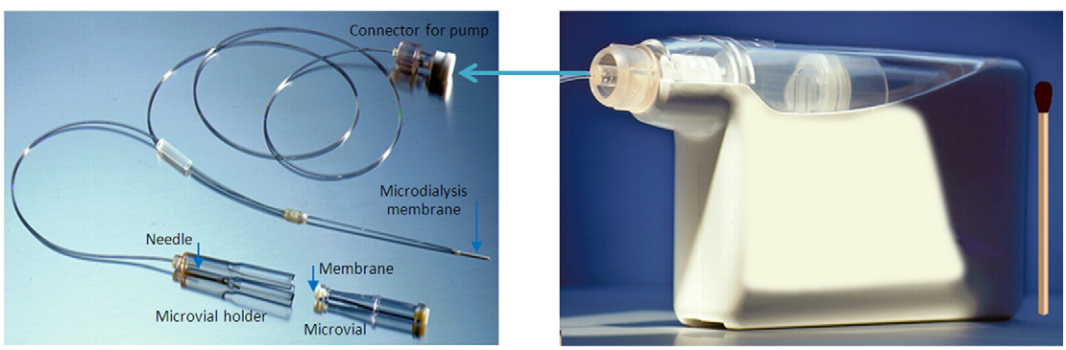

Fig. 2. Microdialysis catheter and pump. The pump and the catheter are joined by the *connector for pump*. The *microdialysis membrane* is placed intraperitoneal, and samples of microdialysate are collected from the *microvial* placed in the *microvial holder* (with courtesy of M Dialysis AB, Sweden).