

Gastroesophageal manometry and 24-hour double pH monitoring in neonates with birth asphyxia

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INTRODUCTION

Birth asphyxia may lead to disturbances of gastroenteric motility of newborn infants^[1,2]. The change of gut pressure and reflux are the major manifestations of the motor disturbance^[3-9]. To evaluate the effects of perinatal asphyxia on the gastroenteric motility, gastric and esophageal pressure and double pH were measured in a group of asphyxiated newborns. And, their pathophysiological and anatomical effects on gastroenteric function were discussed.

MATERIALS AND METHODS

Subjects

The neonates admitted to our neonatal intensive care unit of the Second Affiliated Hospital, China Medical University from August 1995 to March 1996 were studied. The criterion for asphyxia: Apgar score at birth (1 min) ≤ 7 , accompanied with hypoxia, acidosis and other organ damage caused by asphyxia^[10]. The asphyxia group consisted of 35 asphyxia neonates with a mean age of 3.3 d, gestational age 40 wk, and mean body weight of 3189 g. In the asphyxia group, there were 7 infants with severe asphyxia (1 min Apgar score ≤ 3). The control group included 17 normal infants, who were admitted for intensive care. These infants showed no symptoms of gastroenteric, neurological and respiratory diseases, with a mean age of 5.2 d, mean gestation age of 39.6 wk, and mean body weight of 3371 g. Two groups were fed with same formula. No prokinetic agent was administered.

Gastric and esophageal manometry

Multiple channel physiological recorder (RMP-6018, Japan), TP-400 pressure transmitter and Au-601G automatic drawing device were used in this study. The manometry was performed after 3h fasting. By the fluid transformation and synchronous device, the pressure within the stomach, lower esophageal sphincter (LESP), body of esophagus and upper esophageal

sphincter were measured respectively and the difference between LESP and gastric pressure was calculated. The distance between the nasal cavity and the LES was calculated as well.

Double pH monitoring technique

Crystal antimony double pH microelectrode (diameter 2.1 mm, type 90-0011, Synectics Medical, Sweden) was used in this study. Before each monitoring, pH calibration was performed. The esophageal electrode was introduced to 2 cm above LES and the distal electrode was advanced 15 cm apart. The infants' diet and activity were not limited during the test. The beginning and ending of each feeding, occurrence of vomiting and crying were written down. The pH signals were recorded during 24 h in a pocket pH meter. After that, the meter was connected with computer and the results were analyzed with a pH analysis software system (Esophogram 5.550 B3 improved edition, Gastrosoft Inc.).

Monitoring index

The indexes of acid gastroesophageal reflux (GER) (esophageal pH<4): acid reflux index (RI) (percentage of total time pH<4); number of reflux episodes; number of reflux episode >5 min; duration of longest episode pH<4 in minutes; total time of pH <4 in minutes; the area under pH<4 curve (pH \times min); and esophageal clearance time (min/reflux). The indexes of alkaline duodenogastric reflux (gastric pH>4): gastric alkaline index (AI): percentage of total time pH>4; number of gastric alkaline episodes; number of gastric alkaline episode >5 min; duration of longest episode pH>4 in minutes; total time of pH>4 in minutes; and the area under pH>4 curve (pH \times min).

Statistics

The data were expressed as $\bar{x} \pm S_{\bar{x}}$. Inter-group comparison was performed with *t* test. The results were considered statistically significant if *P* value <0.05.

RESULTS

Esophageal and gastric pressure

The gastric pressure of the study group was higher than that of control group (Table 1). The LESP, difference between LESP and gastric pressure, esophageal body pressure and UESP were lower than those of control group, but the differences were not significant (*P*>0.05). The gastric pressure of severe asphyxia group was significantly lower than that of mild asphyxia group (*P*<0.01).

24-h esophageal pH monitoring

The GER parameters of asphyxia group were all higher than those of control group (Table 2). The parameters were also higher than the consulting pathological GER diagnosis standard for the age group of <12 mo, i.e. reflux index >5%, number of reflux episodes >132, number of episodes over 5 min >1, duration of longest episode of pH<4 >13 minutes, the area under pH<4 curve >51. This pH analysis

system recommended a Boix-Ochoa value reflecting infant acid gastroesophageal reflux and a value less than 11.99 was considered normal statistically^[11]. In our current study, the asphyxia group had an average value of 37.1 whereas 6.4 in the control group.

24-h gastric pH monitoring

The difference in the parameters between the asphyxia and control groups was not statistically significant ($P>0.05$,

Table 3) and with no sensible tendency.

Double pH monitoring in infants with asphyxia of different degree

The acid GER in mild asphyxia group was more severe than that in severe asphyxia group (Tables 2,3). The gastric alkaline parameter was not significantly different between the asphyxia groups of different degree.

Table 1 Esophageal and gastric pressure in asphyxia infants ($\bar{x}\pm s_x$, kPa)

Groups	n	Gastric pressure	LESP	LESP-gastric pressure	Esophageal pressure	UESP
Asphyxia	35	0.89±0.07	3.22±0.14	2.33±0.13	-0.33±0.05	2.38±0.13
Mild	28	0.99±0.06	3.32±0.15	2.31±0.14	-0.34±0.05	2.34±0.15
Severe	7	0.49±0.20 ^b	2.90±0.33	2.42±0.36	-0.30±0.09	2.55±0.31
Control	17	0.86±0.07	3.37±0.29	2.47±0.29	-0.38±0.06	2.45±0.22

^b $P<0.01$, vs mild asphyxia group.

Table 2 24-h esophageal pH monitoring in asphyxia ($\bar{x}\pm s_x$)

Groups	n	Acid reflux index	Reflux episodes	Episode >5 min	Duration of longest episode pH<4	Total time pH<4	Area under pH<4 curve	Esoph. clear time
Asphyxia	35	7.1±1.3 ^b	137±24 ^b	5.9±1.1 ^b	24.9±8.0 ^a	157±32 ^b	187±62 ^a	0.95±0.12 ^b
Mild	28	8.7±1.5	167±28	7.3±1.3	30.3±9.8	192±37	230±76	1.00±0.12
Severe	7	0.8±0.4 ^d	19±9 ^d	0.9±0.7 ^d	3.4±1.3 ^c	19±10 ^d	17±9 ^d	0.76±0.36
Control	17	1.3±0.5	29±11	0.7±0.5	4.2±1.7	20±10	20±9	0.39±0.09

^a $P<0.05$, ^b $P<0.01$, vs control; ^c $P<0.05$, ^d $P<0.01$, vs mild asphyxia.

Table 3 24-h pH monitoring of stomach in asphyxia ($\bar{x}\pm s_x$)

Group	n	Gastric index	Alkaline episodes	Episode >5 min	Duration of longest episode pH>4	Total time pH>4	Area under pH>4 curve
Asphyxia	35	21±6	111±17	10.1±1.7	243±59	554±79	1132±202
Mild	28	23±7	124±20	10.3±1.8	234±58	558±83	1102±188
Severe	7	15±13	56±24	9.3±5.3	281±196	539±230	1252±723
Control	17	20±7	80±17	8.7±2.1	388±96	802±124	1769±352

DISCUSSION

The pressure measurement of inside gut is a major index reflecting gastroenterol motility. LESP and UESP are important elements to resist GER^[12]. Our results showed that gastric pressure in asphyxia group was higher than that of control, LESP, esophageal body pressure and UESP were all lower than those of control group. Though the differences were not significant, it does partly contribute the pathophysiological and anatomical bases for GER^[13-16].

GER is a disorder of gastroenterol motility malfunction. Among many inspecting METHODS, continuous 24 h esophageal pH monitoring is regarded as "golden standard" to diagnose and manage GER^[17-22]. This study introduced this technique to the digestive tract motility research of asphyxia newborn babies. The acid GER parameters derived from the normal control group were similar with a large sample study (92 cases of same age) done by Vandenplas *et al*^[23] with the same technique, which suggests that this method has good stability, reliability and repetition^[24].

In children with impaired central nervous system, there is a tendency of more occurrence of GER^[25-29]. This is associated with the long-term supine position, uncoordinated or lack swallow movement, impaired function of esophageal movement, abnormal motility of gastric sinus or pylorus duodenum, increased abdominal pressure caused by swallowing too much air, convulsion and effects of some medicine. It has been

observed in animal that slight increase of intracranial pressure can cause obvious decrease of LESP^[26,27]. Prenatal asphyxia can easily cause temperate or permanent injury of central nervous system, it should be noted that prenatal asphyxia may play an important role in the mechanism of GER.

GER is not all pathological, so it has no feature of all-or-no. There are large laps between physiological and pathological GER^[30]. Normal physiological GER occurs when a baby is in a standing position, or in a state of wakening and post meal, whereas the pathological GER occurs when the baby is in supine position, or during sleep and before meal^[31]. In our study, the GER in asphyxia patients obviously belong to the pathological GER no matter using Boix-Ochoa Index or other diagnostic standards. So these patients can easily suffer from reflux, vomiting even without feeding, and complications^[32-35] such as problems of nutrition and respiratory system.

There is few research of alkaline GER in neonates^[36-39]. It is generally regarded that esophageal pH>7 can be called alkaline GER. Because this value is near to the normal esophageal pH (5.0-6.8), the single esophageal pH monitoring can not give an accurate judgment about alkaline GER. But the gastroesophageal continuous double pH monitoring has resolved this problem^[39]. It can help analyze the relevance of the changes of gastroesophageal pH and in the meantime it helps understand the pathological bases of the alkaline duodenal GER. However, the gastric alkaline parameter showed

nosignificant difference between the asphyxia group and normal control, mild and severe asphyxia infants. Furthermore, there was no relevance with the esophageal alkaline reflux.

To our surprise, severe asphyxiated infants showed obviously decreased gastric pressure, slighter acid GER and lower gastric alkaline than that of their mild asphyxia cohort. Combining with the clinical symptoms of feeding difficulty, gastric retention, abdominal distension, and constipation in severe asphyxiated infants, this result suggested that after severe asphyxia, a phenomenon similar with "gastropa resis" in adults, developed in newborn infants due to the multiple factors such as inhibition of central nervous system^[40,41] and ischemia-refilling injury.

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