The Effect of Body Positioning on Gastroesophageal Reflux in Premature Infants: Evaluation by Combined Impedance and pH Monitoring

Luigi Corvaglia, MD, Raffaella Rotatori, MD, Marianna Ferlini, MD, Arianna Aceti, MD, Gina Ancora, MD, and Giacomo Faldella, MD

Objective To evaluate the pattern of acid and nonacid gastroesophageal reflux (GER) in different body positions in preterm infants with reflux symptoms by a combined multichannel intraluminal impedance (MII)–pH monitoring, which identifies both acid and nonacid GER.

Study design Premature infants with frequent regurgitation and postprandial desaturation (n = 22) underwent a 24-hour recording of MII-pH. In a within-subjects design, reflux indexes were analyzed with the infants in 4 different positions: supine (S), prone (P), on the right side (RS), and on the left side (LS).

Results All infants were analyzed for 20 hours. The mean number of recorded GER episodes was 109.7. The mean esophageal exposure to acid and nonacid GER was lower in positions P (4.4% and 0.3%, respectively) and LS (7.5% and 0.7%, respectively) than in positions RS (21.4% and 1.2%, respectively) and S (17.6% and 1.3%, respectively). The number of postprandial nonacid GER episodes decreased but the number of acid GER episodes increased over time. The LS position showed the lowest esophageal acid exposure (0.8%) in the early postprandial period, and the P position showed the lowest esophageal acid exposure (5.1%) in the late postprandial period.

Conclusion Placing premature infants in the prone or left lateral position in the postprandial period is a simple intervention to limit GER. *(J Pediatr 2007;151:591-6)*

Gastroesophageal reflux (GER) is common in premature infants. Because it may be linked to serious clinical consequences, it is cause for concern in neonatologists and parents and necessitates prolongation of hospitalization.[1,2] As in term infants,[3] a conservative approach based on postural treatment has been suggested in preterm infants with GER.[1] However, few studies have been performed to investigate the best body position for this approach to GER treatment in premature infants, and results are not conclusive. Using pH monitoring, Ewer et al[4] found that prone and left lateral positioning was more effective in preventing GER. Omari et al,[5] using combined manometry and multichannel intraluminal impedance (MII) recording in preterm infants asymptomatic for GER, found that left lateral positioning was more advantageous than right lateral positioning. These authors analyzed the mechanisms triggering GER and observed an increased number of transient lower esophageal sphincter relaxations (TLESRs) in the right lateral position, despite a gastric emptying rate twice that in the left lateral position. Despite these important findings, this study was unable to differentiate acid and nonacid GER.[5]

The effect of positioning is predictable based on previous work, but it is important to describe this effect using the current state-of-the-art methods for GER measurement. Consequently, the aim of our study was to evaluate the affect of body position on GER in symptomatic premature infants using combining intraluminal impedance and pH monitoring.

MII is based on the intraluminal electrical impedance changes occurring during the passage of a bolus through the esophagus. It is measured by electrodes incorporated along a catheter. Impedance is decreased if the bolus is liquid and is increased if it is air. The direction of the bolus is determined by evaluating changes in intraluminal impedance at various levels over time.[6] MII can detect gas, mixed, and

See editorial, p 560 and related article, p 585

From the Institute of Preventive Pediatrics and Neonatology, St. Orsola Malpighi General Hospital, University of Bologna, Bologna, Italy (L.C., R.R., M.F., A.A., G.A., G.F.).

Submitted for publication Feb 1, 2007; last revision received Apr 27, 2007; accepted Jun 6, 2007.

Reprint requests: Luigi Corvaglia, MD, Istituto di Pediatria Preventiva e Neonatologia, Via Massarenti 11, 40138 Bologna, Italy. E-mail: luicorva@almadns.unibo.it.

0022-3476/$ - see front matter

10.1016/j.jpeds.2007.06.014

BEI	Bolus exposure index	P	Prone
GER	Gastroesophageal reflux	RIpH	Reflux index
LES	Lower esophageal sphincter	RS	Right side
LS	Left side	S	Supine
MACT	Mean acidic clearing time	TLESR	Transient lower esophageal sphincter relaxation
MII	Multichannel intraluminal impedance		

liquid GER episodes but cannot differentiate acid and non-acid episodes; for this reason, it is essential to combine MII and pH monitoring to evaluate the role of acid and nonacid GER episodes.

METHODS

A total of 22 (16 male) symptomatic premature infants with a median gestational age at birth of 31 weeks (range, 24 to 32 weeks) and a median birth weight of 1220 g (range, 630 to 2250 g) were enrolled in the study at a median age of 29 days (range, 12 to 83 days) and a median weight of 1747 g (range, 1150 to 3215 g). The infants exhibited frequent regurgitation and postprandial desaturation; in addition, 7 infants had postprandial apnea, 4 had failure to thrive, 1 had bradycardia, and 1 had both postprandial apnea and bradycardia. All were otherwise healthy at the time of examination. None had malformation or major gastrointestinal problems or was taking drugs influencing gastrointestinal motility or gastric acidity. Seven infants were fed extracted human milk fortified with 3% FM85 (Nestlé, Vevey, Switzerland), 3 were fed a standard preterm formula, and the remaining 12 received both. All 22 infants tolerated at least 100 ml/kg per day of milk.

The effect of postural intervention on GER was evaluated in a within-subjects design, taking for each subject measurement of GER in different postural conditions. In a within-subjects design, the same subjects are tested in each condition; therefore, differences among subjects can be separated from error, increasing the power of significance tests. A possible drawback of this method is the "carry-over" effect—a persistent effect in a subsequent treatment period from treatment in the previous period. In our study, this could be represented by the effect on GER of each position on the subsequent position. To limit this effect, we randomly assigned to each enrolled infant a different sequence of the possible postural combinations.

Postural Intervention

In the 24-hour examination, 4 positions—supine (S), prone (P), right side (RS), and left side (LS)—were studied. Each position was maintained for 6 hours, except for 2 periods of 30 minutes each for feeding. The order of different positions was assigned randomly and was not known by the data analysts. Each infant received 8 meals (1 every 3 hours) through a feeding bottle or an orogastric tube, inserted and removed at each meal. This approach allowed us to include 2 meals and 2 150-minute postprandial periods in each body position.

GER Monitoring

Each patient underwent a 24-hour, continuous, simultaneous measurement of intraesophageal pH and multichannel electrical impedance. The system was calibrated before each measurement using pH buffer solutions of pH 4.0 and pH 7.0. A single-use combined MII–pH probe (Comfortec MII-pH, 2.1 mm in diameter; Sandhill Scientific, Highlands Ranch, CO) was used. The flexible catheter contained seven impedance electrodes representing 6 bipolar impedance channels and 1 antimony electrode for pH detection. The distance between each impedance electrode was 1.5 cm, except for the distal couple spaced at 2 cm. The pH sensor was located 1 cm above the distal impedance ring, in the middle of the most distal impedance-measurement segment. The catheter was inserted through a nostril without sedation and placed under fluoroscopic guidance. The tip was fixed 1 to 1.5 cm above the gastroesophageal junction. Before removal, the position of the catheter was compared with the initial position by checking the depth mark on the catheter, to exclude possible displacement. Data were acquired on a portable Sleuth system (Sandhill Scientific), stored at the end of each test in a personal computer, and analyzed by BioVIEW Analysis software, version 5.0.9 (Sandhill Scientific) and by direct visual evaluation of each event.

During each GER episode, we recorded the minimum pH value; the height (in cm), calculated by the distance from the lower esophageal sphincter (LES) of the most proximal electrode that detected the reflux; and the duration (in seconds), defined as the time between the onset of GER and the recovery of 50% of the initial impedance value, measured at the level of the distal impedance bipolar channel (ie, 1.5 cm). To be detected as MII-GER, the bolus, moving in a retrograde direction, had to contact at least 3 impedance electrodes, reaching a height of at least 4 to 4.5 cm above the gastroesophageal junction. An MII-GER episode was defined as acid (aMII-GER) if the pH was <4 and as nonacid (NaMII-GER) if the pH was ≥ 4.[7] The total percentage of time with a MII-GER in the esophagus was indicated as bolus exposure index (BEI) and further separated into acid (aMII-GER-BEI) and nonacid (NaMII-GER-BEI) reflux indexes.

The number of all acid GERs, including those detected only by pH electrode and those detected by MII as well, was classified as pH-acid-GER. The total percent time of esophageal exposure to a $pH < 4$ was designated as the reflux index (RIpH). This latter measurement substantially represents a traditional pH monitoring and includes periods of acid esophageal exposure associated with retrograde movement detected by MII and periods with acid esophageal exposure not associated with retrograde movement detected by MII. The mean time (in seconds) required for pH to return to 4 after a GER episode was designated the mean acidic clearing time (MACT).

Because the features of GER change during postprandial hours,[8] we further analyzed and compared GER indexes measured during the first 75 postprandial minutes (first period) with those measured during the second 75 postprandial minutes (second period).

The study design was approved by the hospital's Institutional Ethics Committee. Written informed consent was obtained from a parent of each infant enrolled in the study.