Effect of Body Position Changes on Postprandial Gastroesophageal Reflux and Gastric Emptying in the Healthy Premature Neonate

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Objective **To identify a body-positioning regimen that promotes gastric emptying (GE) and reduces gastroesophageal reflux (GER) by changing body position 1 hour after feeding.**

Study design **Ten healthy preterm infants (7 male; mean postmenstrual age, 36 weeks [range, 33 to 38 weeks]) were monitored with combined esophageal impedance-manometry. Infants were positioned in the left lateral position (LLP) or right lateral position (RLP) and then gavage-fed. After 1 hour, the position was changed to the opposite side. Subsequently, all infants were restudied with the order of positioning reversed.**

Results **There was more liquid GER in the RLP than in the LLP (median, 9.5 [range, 6.0 to 22.0] vs 2.0 [range, 0.0 to 5.0] episodes/hour; *P* = .002). In the RLP-first protocol, the number of liquid GER episodes per hour decreased significantly after position change (first postprandial hour [RLP], 5.5 [2.0 to 13.0] vs second postprandial hour [LLP], 0.0 [0.0 to 1.0]; *P* = .002). GE was faster in the RLP-first protocol than in the LLP-first protocol (37.0 ± 21.1 vs 61.2 ± 24.8 minutes; *P* = .006).**

Conclusions **A strategy of right lateral positioning for the first postprandial hour with a position change to the left thereafter promotes GE and reduces liquid GER in the late postprandial period and may prove to be a simple therapeutic approach for infants with GER disease.** ***(J Pediatr 2007;151:585-90)***

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Gastroesophageal reflux (GER) is very common in infancy and early childhood.[1] In premature infants, both apnea and GER occur frequently, although the causal relationship between these events is controversial.[2-5] Other typical GER symptoms, such as regurgitation, are normally mild and relatively harmless and thus are considered physiological. However, in a subgroup of infants, GER can cause more severe symptoms, such as feeding problems and failure to thrive, and such complications as esophagitis.

The acidity of GER episodes is thought to be a major pathophysiological factor in the development of these symptoms and complications. In infants, gastric contents are buffered by milk in the postprandial period.[6,7] Consequently, GER is likely to be weakly acidic ($4 < pH < 7$) in the first hour after a meal, and acid GER ($pH < 4$) occurs more often in the later postprandial period.[8]

In all age groups, transient lower esophageal sphincter relaxation (TLESR) is the major mechanism of GER in both healthy subjects and patients with GER disease (GERD).[9-12] Infants with GERD have a higher proportion of acidic GER episodes triggered by TLESR compared with asymptomatic controls.[11] Gastric distention-induced stimulation of tension receptors, especially those in the very proximal stomach, triggers TLESR.[13] This reflex is mediated through vagal afferent neurons, the nucleus tractus solitarius, and vagal efferent neurons (dorsal motor nucleus of the vagus nerve and nucleus

EGJ	Esophagogastric junction	LLP	Left lateral position
GE	Gastric emptying	PPH	Postprandial hour
GER	Gastroesophageal reflux	RLP	Right lateral position
GERD	Gastroesophageal reflux disease	TLESR	Transient lower esophageal sphincter relaxation
$GEt_{1/2}$	Gastric half-emptying time		
LES	Lower esophageal sphincter		

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ambiguous) and leads to regulated inhibition of the lower esophageal sphincter (LES), esophagus, pharynx, and crural diaphragm, thus allowing reflux to occur.[14]

The TLESR reflex has been well described. However, recent studies have found a selectivity for triggering gas over liquid reflux in healthy controls[15] and for acid over weakly acidic reflux in patients with GERD.[16] Notably, slow GE does not correlate with the number of TLESR episodes triggered.[17] This suggests that the mechanisms regulating the threshold for triggering of TLESR, as well as the GER "type" triggered by TLESR, appear to be more complex than can be explained by a single "stimulus–response" mechanoreceptor reflex.[16,18]

We recently studied the effect of left/right body positioning on GER and TLESR triggering in preterm infants using combined impedance and manometry and found that the right lateral position (RLP) was associated with an increased proportion of liquid reflux compared with the left lateral position (LLP).[19] This was probably due to the presence of gastric contents above the level of the esophagogastric junction (EGJ) in this position, as was demonstrated radiologically by Ewer et al.[20] The overall triggering of TLESRs after feeding was significantly greater and GE of the feed was significantly faster with the infants in the RLP.

These paradoxical findings of increased reflux triggering in a setting of accelerated GE are difficult to explain based on gastric tension receptor–mediated triggering of TLESR alone. Furthermore, these data suggest that postural interventions may be a useful nonpharmacologic means of controlling both GE and GER.

The aim of the current study was to investigate the effects of changing body position on the triggering of TLESR, GER, and GE in an attempt to identify a positioning regimen that would both promote GE and decrease the number of GER episodes occurring during the late postprandial period, when GER becomes more acidic.

METHODS

We studied 10 preterm infants (7 males and 3 females) who did not experience any symptoms related to GERD or other gastrointestinal diseases and were healthy apart from their prematurity. All subjects were studied at the Women's and Children's Hospital in Adelaide, Australia. The subjects had a median gestational age of 31.5 weeks (range, 27 to 36 weeks) and a median postnatal age of 23 days (range, 11 to 62 days), for a median corrected age of 36 weeks (range, 33 to 38 weeks). The median weight at the time of entry into the study was 2415 g (range, 2130 to 2800 g) (Table I; available at www.jpeds.com). For ethical reasons, all infants had to receive at least 1 daily feed by gavage. The parents or guardians gave written informed consent before the start of each study. The study protocol was approved by the Research Ethics Committee of the Women's and Children's Hospital, Children, Youth, and Women's Health Services.

Measurement techniques

Esophageal Impedance and Manometry A combined multichannel intraluminal impedance and manometry catheter (outer diameter, 2 mm) that also allowed for gavage feeding was developed for this study (Figure 1; available at www.jpeds.com). The assembly consisted of a water-perfused manometric sleeve catheter with side holes at 3, 4.5, 6, and 11.5 cm proximal to the midpoint of the sleeve for recordings in the esophagus (the first 3 side holes) and the pharynx (the last side hole). The incorporated sleeve was 3 cm long to allow for continuous measurement of LES pressure during breathing- and swallowing-associated movements of the LES relative to the assembly. Electrode rings positioned at 2.25, 3.75, 5.25, 6.75, 8.25, and 9.75 cm proximal to the midpoint of the sleeve allowed for the recording of 5 segments of intraluminal impedance throughout the esophagus. A feeding lumen was incorporated with its opening at the distal end of the assembly.

The esophageal side holes and the sleeve were perfused with degassed distilled water by a low-compliance pneumohydraulic perfusion pump (Dentsleeve, Wayville, South Australia, Australia) at a rate of 0.027 mL/min per channel. The pharyngeal side hole was perfused with air at a rate of 2.6 mL/min using the same pump.

Pressure and impedance signals were acquired at a frequency of 50 Hz using a computerized acquisition system (Sandhill Scientific, Highlands Ranch, CO).[21]

GE Rate The GE rate was determined using the ^{13}C-Na-octanoate breath test, as described in detail elsewhere.[22] In short, ^{13}C-labeled Na-octanoate was added to the infant's feed, and breath samples were taken before the feed, at 5-minute intervals for the first 30 minutes after the start of the feed, and at 15-minute intervals thereafter. The samples were analyzed for $^{13}CO_2$ content using an isotope ratio mass spectrometer. The $^{13}CO_2$ concentration in the breath samples was used to calculate the following GE variables: $GEt_{1/2}$, GEt_{lag}, GEt_{max}, and the GE coefficient, a general index for GE that takes into account the overall shape of the $^{13}CO_2$ excretion curve rather than the amount of $^{13}CO_2$ excreted at a given time point.[23]

Experimental Protocol

Each infant was studied twice on 2 consecutive days and subjected to 2 positioning protocols in a randomized crossover fashion (Figure 2). The assembly was passed transnasally into the stomach and positioned with the sleeve straddling the LES. The infant was then positioned in either the RLP or LLP and gavage-fed the normal feed (expressed breast milk or formula). Feed volume was identical for both studies, and the feed was infused by the same research nurse, who strove to keep the infusion velocity constant. One hour after the end of the feed, the infant's position was changed to the opposite lateral side, and motility and reflux recording continued for another 2 hours.