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Effects of Body Position and Time after Feeding on Gastric Residuals in LBW Infants

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Purpose. To examine the effects of body position and time after feeding on gastric residuals in low birth weight infants(LBW).

Methods. A repeated measures design was conducted. Twenty LBW infants being fed via indwelling nasogastric tubes were randomly assigned to one of 5 different position orderings. In each position, gastric residuals were measured at 30, 60, 90, 120, 150, and 180 minutes after feeding.

Results. In comparisons of gastric residuals with position and time, the main effects of position and time were statistically significant (F = 5.038, $p = 0.001$; F = 429.763, $p < 0.001$, respectively), but the interaction between position and time was found not to be significant. In pairwise comparisons, the gastric residuals were more reduced in the right anterior oblique and prone positions compared with the left lateral position ($p < 0.05$) and the differences across time periods were significant ($p < 0.001$).

Conclusions. The body position after feeding has a significant affect on gastric residuals over time in LBW infants. The right anterior oblique or prone position is recommended rather than left lateral position after feeding. Knowledge of the proper position and the pattern of gastric emptying over time after feeding may lead to the development of evidence-based nursing care.

Key Words: low birth weight infant, gastric emptying, enteral feeding, body position

INTRODUCTION

Advances in newborn medical care have greatly reduced the number of infant deaths in the last several decades. Moreover there is strong evidence for decreasing birth weight-specific mortality rates. However, the decline in the birth rate of low-birth weight (LBW) infants (< 2,500 grams) was less than the decline of their overall mortality rate (Alexander et al., 2003). Most of the LBW infants are also preterm babies, delivered before 37 wks of gestational age; hence, they may face serious health problems and are at increased risk of long-term disabilities (Behrman, Kliegman, Nelson, & Vaughan, 1992).

A primary care goal for LBW infants is to promote weight gain and to prevent the occurrence of complications that may have a negative influence on further growth and development of healthy infants. Thus, early enteral feeding is recommended in neonatal care and has demonstrated benefits such as lower mortality rates, fewer septic complications, more rapid weight gain, and

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shorter lengths of stay in the hospital (van der Voort & Zandstra, 2001; Williams, 2000). LBW and preterm infants do not suck effectively, lack coordination for sucking, swallowing and breathing, and have delayed gastric emptying (Cavell, 1979). Thus, gavage (tube feeding) is the approved method for obtaining adequate nourishment in the earlier postnatal period.

The gastric residual volume is regarded as an objective parameter for gastric emptying and tolerance of feeding and is measured before each feeding as a common practice in clinical settings. When residual volumes from previous feedings limit the milk amount offered to an infant, it can cause problems in nutritional support (Behrman et al., 1992). The emptying time of the stomach and its residual capacity has a direct effect on the volume and schedule of feeding (Malhotra, Deorari, Paul, Bagga, & Singh, 1992). Gastric emptying is affected by gestational age, postnatal age, types of formula, nutrient compositions, drugs, and position (Yu, 1999).

Supportive nursing care related to feeding plays a significant role in improving the nutritional state for LBW infants. This care requires some basic considerations regarding the volume of the feed, type of formula, duration between successive feeds, gastric residual volume, and prevention of associated complications (Yu, 1999). Infant body position after feeding has also been considered as an important factor affecting gastric emptying (Kim, Lee, Seok, & Oh, 2000; Yu, 1975). The effect of position on gastric residuals or gastric emptying has been mostly conducted in preterm infants (Malhotra et al., 1992). However, the effects of various body positions used in clinical settings on the changes of gastric residuals over time have not been fully addressed in LBW infants. Even in studies conducted on preterm or LBW infants, the findings have not led to clinical application due to lack of control or randomization in some of these studies. Therefore, controversies remain regarding the best position after feeding.

Positioning the infant is a primary nursing task. It is an important topic not only for its effects on feeding, but also on sleep and respiration for infants (Chang, Anderson, & Lin, 2002; Dimitriou et al., 2001; Goto, Maeda, Miriran, & Ariagno, 1999). Therefore, a well-designed study is needed for the development of more rational feeding strategies and better understanding for neonatal nursing interventions.

The purpose of this study was to examine the effect of body position over time after feeding on gastric residuals in LBW infants. Findings from this study suggest proper positions after feeding for LBW infants and provide scientific evidence for guidelines to be utilized in neonatal care units.

The specific aims are:

1) To compare the gastric residuals among five different positions (supine, right lateral, right anterior oblique, prone, and left lateral position) measured at 30 minute intervals for three hours after feeding

2) To examine the effects of position and time after feeding on gastric residuals

DEFINITION OF TERMS

Low birth weight infants: Infants who weigh less than 2500 gram and more than 1500 gram at birth

Gastric residuals: The amount of gastric content that can be aspirated through nasogastric tube after a feeding compared to the total amount of the given feeding and expressed as a percentage

$$\text{Gastric residuals (\%)} = \frac{\text{Aspirated volume (ml)}}{\text{Given milk volume (ml)}} \times 100$$

METHODS

Research Design

A within-subjects repeated measures design was conducted.

Sample

This study was carried out in the Neonatal Care Unit at P University Hospital in Busan Metropolitan City between June and October 2002. Twenty consecutive infants were enrolled into this study if they fulfilled the following criteria: low birth weight and 1,500 - 2,500 gram at the beginning of the study; more than 14days old; receiving enteral feeding via indwelling nasogastric tube; not taking parenteral or oral medications; stable vital signs; no vomiting and regurgitation during the study, and no specific medical problems.

Power analysis was conducted to estimate sample size using G*Power (Erdfelder, Faul, & Buchner, 1996). In a within-subjects repeated measures ANOVA test and the medium effect size of 0.15(Cohen, 1988), 16 - 21 subjects per group were necessary to reach about 80 - 90% power with an alpha level of 0.05. Therefore, 20 samples were considered with some attrition rate.

Procedures

All infants studied were being fed per every 3 hours routinely for more than 2 days via indwelling nasogastric polyethylene tubes (No. 6 French). The feeding tube was passed through the nose and left in situ after verifying the distance from the nostril to the tragus to the xiphoid cartilage. The infants were given their usual meals of approximately 22 ml/kg of formula at the standard concentration and temperature of 37°C. The attending nurse verified tube placement and no gastric residuals before the feeding. Infants were weighed naked in the morning of the first data collection.

In order to maintain homogeneity and minimize the effect of position ordering, five different positions were grouped into 5 different permutations; each infant was randomly assigned to one of five permutations by using calculator program (UCLA Department of Statistics, 2002). According to the randomly allotted position ordering, a planned position was applied for an infant in the incubator for 3 hours twice a day, in the morning and in the afternoon. During each day, data were collected from one position of an infant. For example, if an infant was randomly assigned to a position ordering of prone, left lateral, supine, right lateral, and right anterior oblique, data from the prone would be collected at 10:00AM and 4:00PM in the first day; data from the left lateral in the following day; and so on. Therefore, it took at least 5 days to collect the data from 5 different positions in each infant.

The gastric residuals were aspirated with a sterile 10cc syringe through the feeding tube, measured their volume, then injected them again via the feeding tube into the stomach at each of these times; 30, 60, 90, 120, 150, and 180 minutes after feeding. Each residual volume was expressed as a percentage (%) of the aspirated volume to the given milk volume and the mean of two readings was recorded. To obviate inter-personal error, one trained RN measured all gastric residual volumes. Any disturbance was avoided during the study protocol, except for minimal care procedure when necessary.

Prior verbal parental informed consent was obtained.

Data analysis

Data were analyzed using SPSS WIN 10.0 version. To describe the characteristics of subjects and the gastric residual volumes at each position and time, descriptive statistics were used.

After examining with a histogram and the test for normality using Kolmogorov-Smirnov, the data were found to be distributed normally. Therefore, repeated measure analysis of variance was used to identify the differences in gastric residuals among 5 different positions over time after feeding. Post hoc analysis was done using pairwise comparison with the Bonferroni correction. The level of significance was set of priori at $p < 0.05$.

RESULTS

Characteristics of sample

Characteristics of the samples are shown in Table 1. The twenty infants, 10 males and 10 females, had a mean birth weight of 1634.75 gram (range 1500 - 2090) and a mean gestational age of 31.90 weeks (range 27.43 - 35.71). At the time of the study their mean body weight was 1934.25 gram (range 1640 - 2200) and, their postnatal age was 31.75 days (range 14.0 - 94.0).

Comparison of gastric residuals with positions at each time period

The mean±SD of the gastric residuals (%) in supine, right lateral, right anterior oblique, prone, and left lateral positions at 30, 60, 90, 120, 150, and 180 minutes after feeding is shown in Table 2. Gastric residuals after feeding ranged from 52.29 - 62.18% at 30 minutes, 36.95 - 43.73% at 60 minutes, 19.27 - 26.94% at 90 minutes, 6.18 - 12.32% at 120 minutes, 1.75 - 5.67% at 150 minutes, and 0.36 - 3.01% at 180 minutes. When comparing between time intervals, the differences of gastric residuals were statistically significant at 30, 120, 150, and 180 minutes after feeding ($p<0.05$). In pairwise comparisons, there were significant differences in gastric residuals (%) with a level of significance of 0.05 between prone and left lateral positions at 30 minutes (52.59±11.43, 62.18±11.28, respectively), between right anterior oblique and supine positions (1.75±2.66, 5.94±5.10, respectively) and between right anterior oblique and left lateral positions (3.01±4.02, 0.36±0.73, respectively) at 150 minutes, and between right anterior oblique and left lateral positions at 180 minutes

Table 1. Characteristics of the sample (N=20)

Characteristics	Mean±SD	Range
Birth weight (gm)	1634.75±178.59	1500.0 - 2090.0
Gestational age (wk)	31.90±2.47	27.43 - 35.71
Weight at study (gm)	1934.25±203.84	1640.0 - 2200.0
Postnatal age (day)	31.75±22.56	14.0 - 94.0

(0.36±0.73, 3.01±4.02, respectively). All five positions had highly significant differences in gastric residuals across each time period for three hours ($p < 0.001$).

3. Effect of position and time on gastric residuals

A repeated measure ANOVA was performed to examine the effects of different positions and time after feeding on gastric residual volume. Because Mauchley's spericity test was not significant in any position (p = 0.154), the assumption of compound symmetry had been met, and univariated results were reported. However, time and the interaction between position and time had significance in Mauchley's spericity test, indicating that the assumption of compound symmetry was violated. Therefore, Geisser and Greenhouse's epsilon was used to adjust the degrees of freedom for F tests (Munro, 2001).

When comparing of gastric residuals with position and time, the main effects of position and time were significant statistically (F=5.038, p=0.001; F=429.763, p<0.001, respectively), but there was no significance in the interaction between position and time (Table 3). Because position and time were found to be significant, pairwise comparisons with the Bonferroni correction were done. There were significant differences in the percentage of gastric residuals between left lateral and prone positions (p=0.044) and between left lateral and right anterior oblique positions (p=0.023). Figure 1 shows the change of gastric residuals over time in each position. It represents the initial rapid reduction of gastric residuals and the following slow phase.

DISCUSSION

Findings in this study indicate that various kinds of body positions for LBW infants have an influence on the gastric residuals over time after feeding. The gastric residual volumes by position over time, in order from smallest to largest, were right anterior oblique, prone, right lateral, supine, and left lateral. It is similar to the findings of Yu (1975) that a stomach empties more rapidly in the prone and right lateral position than in the supine and left lateral position. When comparing among the right lateral decubitus , prone, and supine positions in Choi (1998) and Kim et al. (2000)'s studies, the gastric residuals in the right lateral decubitus and prone positions were less than in supine position. Roentgenographic evidence has suggested that stomach emptying is facilitated by placing the infant in the right lateral position and prone position (Blumenthal, Ebel & Pildes, 1979). The standard position

Table 2. Comparison of mean gastric residuals (%) with positions over time (N = 20)

Position / Time (min)	S	RL	RAO	P	LL	F (p)
	M±SD	M±SD	M±SD	M±SD	M±SD	
30	57.92±12.40	56.19±10.03	54.18±13.74	52.59±11.43	62.18±11.28	3.820 (0.007)
60	41.17±11.57	39.40±12.02	36.95±12.02	38.04±12.28	43.73±12.82	1.639 (0.173)
90	23.95±11.96	21.21±13.78	19.27±12.34	21.51±11.81	26.94±13.26	2.102 (0.088)
120	11.77±9.36	8.94±9.88	6.18±7.19	7.46±9.38	12.32±9.53	2.996 (0.024)
150	5.94±5.10	3.44±5.05	1.75±2.66	2.72±5.14	5.67±6.63	5.046 (0.001)
180	2.10±3.25	1.48±3.40	0.36±0.73	0.94±2.21	3.01±4.02	3.799 (0.007)

M±SD: Mean±Standard Deviation
Note: All values in each position are mean(standard deviation in percentage (%) of gastric residuals.
S: supine RL: right lateral RAO: right anterior oblique P: prone LL: left lateral

Table 3. Repeated measures ANOVA of the effects of position and time on gastric residuals (N = 20)

Source of Variation	Sum of Squares	df	Mean Square	F	p	Pairwise comparison
Position	2777.85	4	694.46	5.038	0.001	LL > P* LL > RAO*
Time	242162.24	2.25[a]	107865.03	429.763	< 0.001	30 > 60 > 90 > 120 > 150 > 180**
Position X Time	517.87	7.87[a]	65.84		0.758	0.638

[a] Epsilon correction with Greenhouse-Geisser
Pairwise comparison with Bonferroni correction
*p < 0.05, **p < 0.001
LL: left lateral P: prone RAO: right anterior oblique

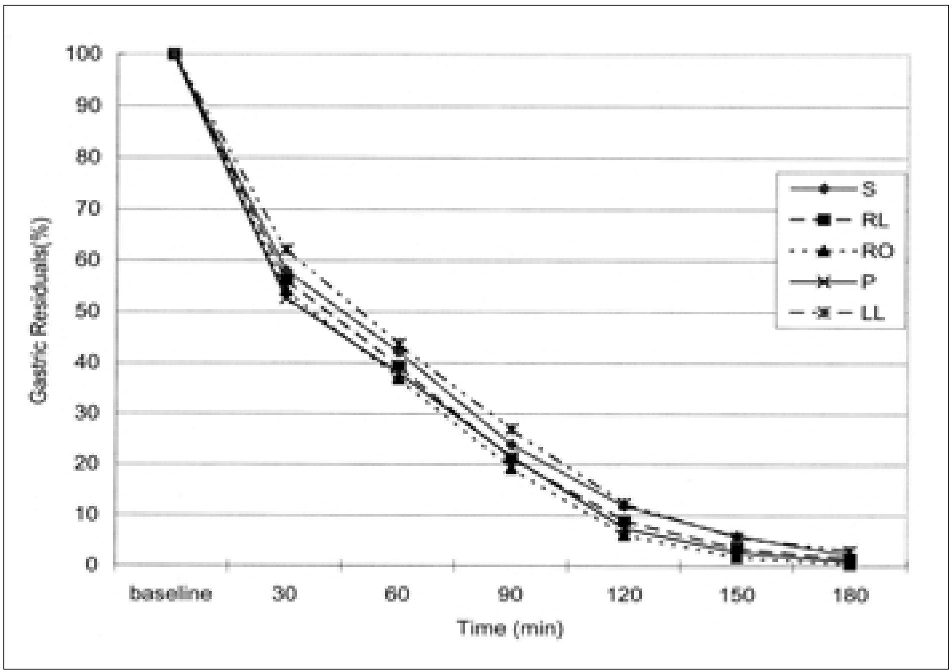

Figure 1. Change in gastric residuals over time after feeding at different positions
S: supine RL: right lateral RO: right anterior oblique P: prone LL: left lateral

in upper gastrointestinal studies is right anterior oblique, with the right side of the infant down, and that enhances gastric emptying (Javier, Leonard, Fernando, Seham & Elma, 1996).

The best position for a neonate has been the subject of controversy for decades. Most of the debate has concentrated on the prone and supine positions, probably because of the difficulty of maintaining neonates in the lateral position. To prevent sudden infant death syndrome (SIDS), the non-prone position was recommended (American Academy of Pediatrics Task Force on Infant Positioning and SIDS, 1996). However, in the prone position the oxygenation was higher than in the supine position (Dimitriou et al., 2001; Mizuno & Aizawa, 1999). In addition, infants sleep more and quietly (Goto et al., 1999; Martin, Herrell, Rubin, & Fanaroff, 1979; Masterson, Zucker, & Schulze, 1987; Myers et al., 1998), cry less, and have more regular respirations, all of which may result in less air actually introduced into the stomach while in the prone position (Chang, Anderson, & Lin, 2002; Yu, 1975). It can also reduce gastroesophageal reflex that may cause apnea, aspiration pneumonia, and chronic lung disease (Ewer, James, & Tobin, 1999).

The supine position may predispose infants to regurgitation and inhalation, because fluid-filled fundus and swallowed air inhibit gastric emptying (Yu, 1975). However, when taking care of high-risk infants in clinical settings, the supine position might be easier for caregivers in observing and handling the infant than the prone position. It was reported that the supine position was better for the development of sensory perception, particularly the eyes (Blumenthal, Ebel & Pildes, 1979).

In regards to the relationship of time and gastric residuals, gastric residual volume was decreased significantly over time. The pattern of reducing gastric residuals determined by this study was generally similar for each position characterized by an initial rapid phase followed by a slow phase. More specifically, the greatest reduction in gastric residuals, of about 50%, was in the first 30 minutes, followed by a relatively smaller decrease until 120 minutes and the lowest reduction during the rest of the time. This pattern is similar to those found by Blumenthal, Ebel, & Pildes (1979), Kim et al. (2000), and Lee (1999). The approximation of gastric residuals after feeding indicates 50% to 60% at 30 minutes, 30% to 40% at 60 minutes, 20% at 90 minutes, and less than 10% at 120 minutes and later.

From this study, we will mention and suggest some considerations. In this study, infants were placed in a planned position for a feeding interval, 3 hours, for examining the change in gastric residuals. Placing neonates in one position for a long time is not desirable. Health care providers in neonatal care units have a responsibility and opportunity to affect body alignment and influence posture and movement through neonatal positioning (Sweeney & Gutierrez, 2002). In addition, the 3 - 5% of gastric residual differences among positions from this study were yielded from one feeding. Because infants are fed seven to eight times in a day by their routine feeding schedules, the accumulated effects on gastric residuals are more serious in clinical practice. It can lead to insufficient gastric emptying and nutritional uptake in low birth weight infants. Paying more attentions to feeding and positioning are also needed for vulnerable infants, who are pretem (Ewer, Jamesa, & Tobinb, 1999; Myers et al., 1998), have very low birth weight (Lee, 1999), and have respiratory problems(Chang, Anderson, & Lin, 2002; Dimitriou et al., 2001). Based on the findings of this study and previous other studies, the desirable positions and sustaining time in relation to feeding should be explored further in specific clinical situations.

This study was designed in a within-subjects repeated measures design for decreasing individual difference and enhancing the power of the analysis, resulting in the need for fewer subjects (Munro, 2001). In addition, for the purpose of avoiding overestimation of the results, the Bonferroni correction was used for identifying more significant differences among positions rather than the LSD (least significance difference) method in pairwise comparisons.

In order to provide information for further studies in estimating sample size, we shall report the effect size of position was 0.21 of eta2 and the estimated power was 0.954 in this study. This effect size (eta2) was over the moderate effect of 0.15, justified by Cohen (1987).

CONCLUSION

This study examined the effect of five different positions on gastric residuals over intervals of 30 minutes for three hours after feeding via NG tube in LBW infants. Positions after feeding significantly influenced gastric residuals over time. For clinical implications, the specific information about the changes in gastric residuals can provide better understanding for care-providers to develop effective feeding strategies in neonatal care. Therefore, the placement of the infant in either the right anterior oblique position or the prone position after feeding could reduce gastric residuals and thus improve gastric emptying. On the other hand, the left lateral position was a less appropriate position placed after feeding. From these findings, it is recommended that the prone position be preferred up to 30 minutes after feeding and the right anterior oblique position during the following time period. Although the prone position has lots of benefits in association with an infant's feeding, sleeping, and respiration, the infant should be placed with careful attention. Exploring the best position after feeding for LBW infants is a very important but in no way a simple matter, because all of their other conditions need to be considered together in clinical practice.

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