Original Research Article

Gastric residual volume as a measure of feed intolerance/necrotising enterocolitis in very low birth weight infants: an observational cohort study

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ABSTRACT

Background: To evaluate the efficacy of Gastric Residual Volume (GRV) as a measure of feed intolerance /Necrotising enterocolitis in Very Low Birth Weight (VLBW) infants.

Methods: This prospective observational cohort study was done in a tertiary care hospital located in rural South India for a period of 2 years. All haemodynamically stable infants born between 30-34 weeks of gestation at birth and 1000-1500 grams of birth weight, admitted to Neonatal Intensive Care Unit (NICU) within first 24 hours of life during study period were enrolled in two groups; GRV group, where pre-feed gastric residual volume was checked and No-GRV group, where pre-feed gastric residual volume was not checked.

Results: Both groups had similar baseline characteristics. In No-GRV group, the days to reach birth weight (12.1) and days to attain full feeds (8.0) were less when compared to GRV group. In No-GRV group, average duration of NICU stay in days (16.60) and parenteral nutrition (5.25) was less when compared to GRV group. No-GRV group does not have increased incidence of sepsis or mortality compared to GRV group. In this study there was increased incidence of NEC noted in GRV group (30%) when compared to No-GRV group (p value-0.02).

Conclusions: In hemodynamically stable preterm VLBW infants, it is recommended not to check gastric residual volume routinely prior to the enteral feeding.

Keywords: Feed interruption days, Feed intolerance, Full feeds, Gastric residuals, Mortality, Necrotizing enterocolitis

INTRODUCTION

The birth of a preterm baby is a nutritional emergency. After stabilization of respiratory status, nutrition is the next most urgent challenge for clinicians caring for newborns admitted to the Neonatal Intensive Care Unit (NICU). In spite of extensive research in neonatal nutrition for very low birth weight and extremely low birth weight neonates, controversy exists about methods to provide optimal nutrition to improve both short term and long-term outcome. The landmark epidemiologic studies by Barker et al, have shown that in utero growth

retardation predisposes to cardiovascular diseases, hyperlipidemia, hypertension and type 2 diabetes mellitus.¹

The practice of checking pre-feed gastric residues has been beset with controversies. The proponents of checking Gastric Residual Volume (GRV) have cited risk of necrotizing enterocolitis in their defense, while those in favour of not to check GRV have cited better growth in their defense. Gastric residuals are nothing, but the stomach contents found at the start of the next feeding. This process of checking gastric residuals was meant to

confirm the correct placement of the feeding tube. Excessive gastric residual is an indication of feed intolerance for some caregivers. Often feeds are withheld, if there are excessive gastric residuals. This practice can lead to poor weight gain, delayed growth and can cause lasting effects on the neurodevelopment of the neonate. Therefore, it is imperative to research and provide evidence on feeding through gastric residuals.

METHODS

This observational cohort study was conducted in a level III neonatal unit of a teaching hospital in southern India between August 2016 and November 2018. The study was approved by Institutional Ethics Committee.

Inclusion criteria

- Hemodynamically stable infants born between 30-34 weeks of gestation with birth weight of 1000-1500 grams, admitted to NICU within first 24 hours of life. Gestational age was assessed by last menstrual period and supported by modified Ballard score.

Exclusion criteria

- Infants with cardiopulmonary or abdominal malformations, infants with hemodynamic instability and infants whose parents refused consent. Total infants included in study were 80 and were divided into two groups.

GRV group-Where pre-feed gastric residual volume (GRV) was checked and No-GRV group -where pre-feed Gastric Residual Volume (GRV) was not checked. An informed consent was obtained from the parents. All data was recorded in a predesigned structured proforma.

Data was collected for 40 babies in each group. Infants in both the groups were studied for predetermined outcomes. Expressed human milk was the nutrition of choice. When human milk was not available preterm formula was used.

GRV group

Feeding was initiated on first day for stable preterm infants with 10-20 ml/kg/day of Expressed Human Milk (EHM) or standard preterm formula (when EHM was not available) and was advanced by 20 ml/kg/day until maximum enteral feeds of 180 ml/kg/day were attained. Measured feed was given by a concerned nursing staff as a bolus Oro-Gastric (OG) feeds every 2nd hourly. He/she checked for pre-feed gastric residual volume prior to next feed and recorded it in feeding chart. Feeds were withheld and infant was evaluated for NEC if GRV was more than or equal to 50% of feed volume or pre-feed gastric residual was blood stained or bilious. Feeds were restarted if there were no features suggestive of NEC. Partial Parenteral Nutrition (PPN) was used for all

preterm babies less than 34 weeks of gestation till feed volume of 100 ml/kg/day was reached.

No-GRV group

Feeding was initiated on first day for stable preterm infants with 10-20 ml/kg/day of Expressed Human Milk (EHM) or standard formula (when EHM was not available) and was advanced by 20 ml/kg/day until maximum enteral feeds of 180 ml/kg/day were attained. Measured feed was given by a concerned nursing staff as a bolus OG feeds every 2nd hourly. He/she did not check for pre-feed gastric residual volume prior to next feed. Instead infant was evaluated for any abdominal distention, discoloration, emesis, and tenderness every 2-3 hourly. Feeds were withheld and infant was evaluated for NEC if any of the above symptoms or signs were there. Feeds were restarted if there were no features suggestive of NEC. Partial Parenteral Nutrition (PPN) was used for all preterm babies less than 34 weeks of gestation till feed volumes of 100 ml/kg/day was reached.

Authors primary outcome measures were incidence of NEC as per Bell staging, incidence of feed intolerance and mortality.^{2,3} Feed intolerance was defined as either GRV of more than 50% or presence of abdominal distension or emesis or both. Authors secondary outcome measures were duration of parenteral nutrition, duration of NICU stay, time taken to reach full enteral feeds of 180 ml/kg/day, time required to regain birth weight, feed interruption days and incidence of culture positive sepsis.

Statistical analysis

All continuous variables were reported as mean and standard deviation. Whereas all categorical variables were expressed as frequencies or percentages. The differences between groups for continuous variables were evaluated using independent student t test and categorical variables were analyzed using Fisher exact test/chi square test. A $p < 0.05$ was considered as significant difference. All statistical analysis was done using Statistical Package for Social Sciences (SPSS), version 17.0 for windows, IBM computers, New York, USA.

RESULTS

Total number of babies included in this study were 80; 40 babies were enrolled in each group.

There was no significant difference in baseline characteristics of both the groups. Of a total of 40 neonates in GRV group, 22(55%) were males and 18(45%) were females. Among 40 neonates No- in GRV group, 24(60%) were males and 16(40%) were females. The mean gestational age was 32.6 and 32.9 weeks in GRV and NO- GRV groups respectively. The mean birth weight was 1350 grams and 1380 grams in GRV and NO- GRV groups respectively. In both the groups, 8(20%)

newborns delivered through vaginal delivery, 32(80%) babies delivered through C-section (Table 1).

Table 1: Baseline characteristics of both groups.

		GRV group	No-GRV group
Sample size		40	40
Sex	Male	22(55%)	24(60%)
	Female	18(45%)	16(40%)
Gestational age (GA) (weeks)	30-32	14(35%)	10(25%)
	32-34	26(65%)	30(75%)
	Mean GA(SD)	32.6(1.31)	32.9(1.07)
Mean birth weight in grams (SD)		1350(120)	1380(100)
Mode of delivery	Vaginal delivery	08(20%)	08(20%)
	C-Section	32(80%)	32(80%)

It was inferred that mean age to reach full feeds in days were less in No-GRV group (8.00) when compared to

GRV group (11.53) and the mean age to reach birth weight in days were less in No-GRV group (12.10) when compared to GRV group (13.58). In No-GRV group, average duration of PPN in days (5.25) and average duration of NICU stay in days (16.60) group was less compared to GRV group in which duration of PPN and NICU stay were 9.05 and 22.05 days respectively. However, there was no significant statistical difference between the two groups for the above variables.

It was inferred that No-GRV group has increased episodes of feed intolerance (10%) compared to GRV group (0%), however No-GRV group does not have increased incidence of feed interruption days. In this study, 12(30%) newborns in the GRV group have NEC whereas no NEC noted in No-GRV group which was statistically significant (p value-0.02). Among the 12 newborns in GRV group who developed NEC, 6(15%) had stage I NEC, 4(10%) newborns had stage II NEC and 2(05%) newborns had stage III NEC. There were 2 deaths (5%) in GRV group. Present study also demonstrated increased incidence of culture positive sepsis in GRV group compared to No-GRV group, though statistically not significant (Table 2).

Table 2: Outcome measures in both groups.

Outcome measure	GRV group	NO-GRV group	p value
Mean age to reach full feeds in days (SD)	11.53(8.32)	8.00(3.38)	0.089
Mean age to reach birth weight in days (SD)	13.58(8.59)	12.10(5.00)	0.513
Average duration of PPN in days (SD)	9.05(8.31)	5.25(2.84)	0.061
Average duration of NICU stay in days (SD)	22.05(13.05)	16.60(10.57)	0.155
Episodes of feed intolerance (%)	0(0.0%)	4(10%)	0.487
Average duration of feed interruption in days (SD)	2.60(6.82)	0.00(0.00)	0.097
Number of infants who developed NEC (%)	12(30%)	0(0.0%)	0.02
NEC stage I (%)	6(15%)	0(0.0%)	0.230
NEC stage II (%)	4(10%)	0(0.0%)	0.487
NEC stage III (%)	2(05%)	0(0.0%)	1.00
Number of culture positive sepsis cases (%)	12(30%)	08(20%)	0.716
Number of deaths	2(05%)	0(0.00%)	1.00

DISCUSSION

Necrotizing enterocolitis is the commonest gastrointestinal emergency in the NICU population and usually results in very devastating consequences.⁴ It has been one of the most difficult disorders to eradicate and its pathogenesis remains as elusive as optimal strategies for prevention and treatment, despite decades of research.⁵ While data from Randomized Control Trials (RCT) and meta-analyses indicate that some factors have positive impact on the incidence of NEC (e.g. use of antenatal steroids, breast milk, probiotics), there is an ongoing controversy regarding enteral feeding practices

and regimens and feeding strategies may vary substantially between countries and institutions.^{4,6-10}

Prefeed gastric residuals usually reflect poor gastric emptying, duodeno-gastric reflux or gastro-duodenal hypo motility, all of which are characteristics of the preterm immature gut. GRV is also largely influenced by the feeding method in use and by infant position.^{11,12} Gastric residuals are leading marker for assessment of feeding tolerance in the preterm infant, both in clinical practice and in research as well. "Excessive" Gastric Residual Volume (GRV) has different definitions in the literature, either an absolute (ml/kg) or a relative quantity (% of the previous feeding volume). Another issue is that

various authors have arbitrarily defined a cut-off GRV to assess the outcomes. An absolute value of 2-5 ml/kg is usually considered as a pathological GRV.¹³⁻¹⁵

Randomized controlled trials conducted so far have not demonstrated any increased risk of Necrotizing Enterocolitis (NEC) in the No-GRV group. However, in view of the heterogeneity in study design, methodology and definitions used in these trials, their results may not be universally applicable. Cobb et al, found that gastric residuals are increased in VLBW infants developing NEC which was a retrospective study.¹⁶ In the study conducted by Bertino et al, GRV was analyzed since birth in VLBW infants developing NEC in comparison with control infants of the same GA and BW.¹⁷ The mean maximum residual (7.46 ml vs 4 ml; $p=0.04$) and the mean value of maximum residual as a percentage of the previous feed (113.24% vs 42.87%; $p=0.018$) were significantly higher in the NEC group. Given the data published in the current literature by Lucas et al, Berseth et al regarding the incidence of NEC and its potential association with gastric residual volume, in contrary, the aim of this study was to assess the efficacy of gastric residual volume as a measure of feed intolerance/necrotising enterocolitis in VLBW infants in our NICU.¹⁸⁻²⁰

Authors found that though No-GRV group have increased episodes of feed intolerance compared to GRV group, it is not statistically significant. These results were comparable to study by Shulman et al, wherein he concluded that GRV was an unreliable indicator to predict attainment of full gavage feeding.²¹ Mihatsch et al, who reported that Gastric Residuals (GR), including green-colored GRs, were a poor indicator of feeding intolerance, and suggested their presence should not delay advancement of feeding volumes in the absence of other clinical signs and symptoms.²² Malhotra et al, evaluated mean basal 4-hour gastric residual volumes in 50 healthy preterm infants and a linear correlation was not found between increase in abdominal girth and gastric residuals.²³

In this study, incidence of NEC was more in GRV group when compared to No-GRV group (p value-0.02). These results were comparable with Torrazza et al, who found no evidence that the routine evaluation of GRV helps prevent complications such as NEC.²⁴ In the study by Bertino et al, GRV was significantly higher in infants with NEC, but as there were associated co-morbidities, it is difficult to consider these as specific warning signs of an impending NEC.¹⁷

Authors also found that infants in No-GRV group reached birth weight earlier than GRV group and were found to have better postnatal growth. There was reduction in duration of hospital stay as well as less duration of parenteral nutrition in No-GRV group. These results were comparable to study by Torrazza et al, where the mean time to reach a full feeding volume was nearly 6 days earlier in the No- GRV group.

Authors also found that No-GRV group does not have increased incidence of mortality or sepsis compared to GRV group. In current study, there were 2 deaths in GRV group which can be attributed to co morbidities while there was no mortality in No-GRV group. It was inferred that infants who receive regular GRV evaluations require central access for longer duration which increases the risk of blood stream infection and ultimately morbidity and mortality. These results were comparable to study by Torrazza et al, strength of our study was adequate power to detect a difference. Limitation of this study was short-term assessment of postnatal growth.

CONCLUSION

In hemodynamically stable preterm VLBW infants, it is not recommended to check for gastric residual volume routinely prior to enteral feeding. However, there is a need of randomised controlled trials with adequate sample size before implementing it into clinical practice.

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Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Klingenberg C, Embleton ND, Jacobs SE, O'Connell LA, Kuschel CA. Enteral feeding practices in very preterm infants: an international survey. *Archiv Dis Childhood-Fetal Neonat Edit.* 2012 Jan 1;97(1):F56-61.
2. Walsh MC, Kliegman RM. Necrotizing enterocolitis: treatment based on staging criteria. *Pediatr Clin North Am.* 1986 Feb 1;33(1):179-201.
3. Lee JS, Polin RA. Treatment and prevention of necrotizing enterocolitis. *Seminars Neonatol.* 2003 Dec 1;8(6):449-59.
4. Berseth CL, Bisquera JA, Paje VU. Prolonging small feeding volumes early in life decreases the incidence of necrotizing enterocolitis in very low birth weight infants. *Pediatrics.* 2003 Mar 1;111(3):529-34.
5. Neu J, Walker WA. Necrotizing enterocolitis. *New Eng J Med.* 2011 Jan 20;364(3):255-64.
6. Chauhan M, Henderson G, McGuire W. Enteral feeding for very low birth weight infants: reducing the risk of necrotising enterocolitis. *Archiv Dis Childhood-Fetal Neonat Edit.* 2008 Mar 1;93(2):F162-6.
7. Morgan J, Young L, McGuire W. Delayed introduction of progressive enteral feeds to prevent necrotising enterocolitis in very low birth weight infants. *Cochrane Database Syst Rev.* 2014(12):CD001970.
8. Oddie SJ, Young L, McGuire W. Slow advancement of enteral feed volumes to prevent necrotising enterocolitis in very low birth weight infants. *Cochrane Database Syst Rev.* 2017;(8):CD001241.

9. Henderson G, Anthony MY, McGuire W. Formula milk versus maternal breast milk for feeding preterm or low birth weight infants. *Cochrane Database Syst Rev.* 2007;(4):CD002972.
10. Vasu V, Modi N. Assessing the impact of preterm nutrition. *Early Hum Dev.* 2007;83(12):813-8.
11. Geraldo V, Pyati S, Joseph T, Pildes RS. Gastric Residual (GR): Reliability of the Measurement. *Pediatr Res.* 1997 Apr 1;41(S4):150.
12. Rice TW. Gastric residual volume: end of an era. *JAMA.* 2013 Jan 16;309(3):283-4.
13. Mihatsch WA, Pohlandt F, Franz AR, Flock F. Early feeding advancement in very low-birth-weight infants with intrauterine growth retardation and increased umbilical artery resistance. *J Pediatr Gastroenterol Nutr.* 2002 Aug 1;35(2):144-8.
14. Karagol BS, Zenciroglu A, Okumus N, Polin RA. Randomized controlled trial of slow vs rapid enteral feeding advancements on the clinical outcomes of preterm infants with birth weight 750-1250 g. *J Parent Enteral Nutr.* 2013 Mar;37(2):223-8.
15. Raimondi F, Spera AM, Sellitto M, Landolfo F, Capasso L. Amino Acid-based Formula as a Rescue Strategy in Feeding Very-Low-Birth-Weight Infants with Intrauterine Growth Restriction. *J Pediatr Gastroenterol Nutr.* 2012 May 1;54(5):608-12.
16. Cobb BA, Carlo WA, Ambalavanan N. Gastric residuals and their relationship to necrotizing enterocolitis in very low birth weight infants. *Pediatrics.* 2004 Jan 1;113(1):50-3.
17. Bertino E, Giuliani F, Prandi G, Coscia A, Martano C, Fabris C. Necrotizing enterocolitis: risk factor analysis and role of gastric residuals in very low birth weight infants. *J Pediatr Gastroenterol Nutr.* 2009 Apr 1;48(4):437-42.
18. Lucas A, Cole TJ. Breast milk and neonatal necrotizing enterocolitis. *Lancet.* 1990 Dec 22;336(8730-8731):1519-23.
19. Berseth CL. Gut motility and the pathogenesis of necrotizing enterocolitis. *Clin Perinatol.* 1994 Jun 1;21(2):263-70.
20. Berseth CL. Neonatal small intestinal motility: motor responses to feeding in term and preterm infants. *J Pediatr.* 1990 Nov 1;117(5):777-82.
21. Shulman RJ, Ou CN, Smith EB. Evaluation of potential factors predicting attainment of full gavage feedings in preterm infants. *Neonatal.* 2011;99(1):38-44.
22. Mihatsch WA, von Schoenaich P, Fahrenstich H, Dehne N, Ebbecke H, Plath C, et al. The significance of gastric residuals in the early enteral feeding advancement of extremely low birth weight infants. *Pediatrics.* 2002 Mar 1;109(3):457-9.
23. Malhotra AK, Deorari AK, Paul VK, Bagga A, Meharban S. Gastric residuals in preterm babies. *J Trop Pediatr.* 1992 Oct 1;38(5):262-4.
24. Torrazza RM, Parker LA, Li Y, Talaga E, Shuster J, Neu J. The value of routine evaluation of gastric residuals in very low birth weight infants. *J Perinatol.* 2015 Jan;35(1):57.

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