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Original Article

Sonographic measurements of the abdominal esophageal length in premature neonates with and without gastro-esophageal reflux disease

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ABSTRACT

Introduction: Recently, association between the length of abdominal esophagus and increased risk for gastro-esophageal reflux disease (GERD) has been hypothesized. The aim of the present study was to determine this relation.

Methods: In a cross-sectional study, 75 consecutive premature neonates aged less than 30 days with birth weight less than 2000 gr hospitalized in Neonates' ward of the Mahdieh hospital in Tehran were included into the study. The certain diagnosis of GERD was based on clinical manifestations. The presence of GERD and also measurement of the abdominal esophageal length was assessed by portable sonography using SIUI sonography device.

Results: Clinically, Reflux was diagnosed in 15 neonates (20.0%). It was also diagnosed in 20 cases (26.7%) by sonography assessment yielding a sensitivity of 86.7%, a specificity of 88.3%, a positive predictive value of 65.0%, a negative predictive value of 96.4%, and an accuracy of 88% for this diagnostic device. The mean length of abdominal esophagus was estimated 15.2 ± 4.1 mm. There was a strong positive association of the length of abdominal esophagus with neonatal birth weight ($r = 0.553$, $P < 0.001$) and also with gestational age ($r = 0.491$, $P = 0.001$). In a multivariate linear regression model, shorter abdominal esophagus was shown to be related to the presence of reflux.

Conclusion: Shorter abdominal esophagus in premature neonates is associated with increased risk for GERD that is more highlighted in those neonates with lower birth weight and lower gestational age. Sonography has a high value for assessment of abdominal esophageal length and reflux diagnosis in premature neonates.

Introduction

Within the past decade, GERD has been more accurately diagnosed in order to an increased awareness of the disease condition as well as to more developing diagnostic techniques for both identifying and quantifying the disease (1). Normal gastroesophageal function is a complex mechanism that depends on effective esophageal motility, timely relaxation and contractility of the lower esophageal sphincter, the mean intraluminal pressure in the stomach, the effectiveness of contractility in emptying of the stomach, and the ease of gastric outflow (2, 3). Abnormality in one or more of these anatomical or functional factors can be often occurred in children with symptomatic GERD that even result in some serious and even life-threatening complications (4, 5). The most frequent complications of recurrent GERD in childhood include failure to thrive as a result of caloric deprivation and recurrent bronchitis or pneumonia caused by repeated pulmonary aspiration of gastric fluid. Reflux may also be a cause of obstructive apnea in infants and possibly a cause of recurrent stridor, acute hypoxia, and even the sudden infant death syndrome (6, 7). In this regard, timely diagnosis and evaluation of this phenomenon is certainly vital in these age subgroups. The most helpful test for diagnosing and quantifying GERD in childhood is the 24-hour esophageal pH monitoring study, besides, ultrasonography not only is a non-invasive, readily available, repeatable and cheap diagnostic tool, but also is a fast and highly sensitive technique (8-11) in the diagnosis of GERD in infants and children. Sonographic detection of GERD is mainly based on the detection of the returning gastric fluid to esophagus. In this regard, assessment of anatomical characteristics of esophagus in children has been recently identified as a main applications and advantages of sonography in GERD children. Recently, the association between length of abdominal esophagus assessed by the sonography and presence of GERD has been suggested. It has been

thus hypothesized that the children with shorter abdominal esophagus may be more susceptible to the increased risk for GERD and its-related complications. In healthy infants and children, abdominal esophagus length has been measured by different groups of researchers previously by sonography method (12, 13). However, in pediatrics with GERD, sonographic measurements of abdominal esophagus length have been undertaken in a few studies (14). Moreover, the utility of sonography for assessing length of abdominal esophagus and its association with GERD in premature neonates remained unclear. The aim of the present study was to provide sonographic measurements of the abdominal esophagus length in premature neonates with and without GERD.

Methods

Study design and participant

In a cross-sectional study, 75 consecutive premature neonates aged less than 30 days with birth weight less than 2000 gr who hospitalized in Neonates' ward of the Mahdieh hospital of Tehran from Sep 2013 to Sep 2014 were included into the study. Neonates hadn't evidenced abnormality and weren't under ventilated mechanically, and all of them were treated with mention dosages of caffeine and did not receive anti- reflux medication before entering the study.

Ethical disclosure

The study was approved by Ethics Committee of Shahid Beheshti University of Medical Science and registered by code 1392.310.

Inclusion and Exclusion criteria

All premature neonates aged less than 30 days with birth weight less than 2000 gr were entered in the study and neonates with birth weight higher than 2000 gr, or with any anatomical or genetic abnormalities as well as those with parents' dissatisfaction to the inclusion, were excluded from the study.

Gathering data

Some necessary data such as cause of admission, type of delivery, age, sex were collected for all samples and also the clinical diagnosis of GERD was based on clinical manifestations including vomiting, apnea, and dropping arterial oxygen saturation more than 5% and for more than 60 seconds, cyanosis, and respiratory distress at least for 30 minutes after nutrition. All symptoms were assessed and recorded by the pediatrician. Also, 30 minutes after the nutrition, the presence of GERD was assessed by portable sonography using Shantou Institute of Ultrasonic Instruments Co., Ltd. (SIUI) sonography device and the length of abdominal esophagus was measured from its entrance into the diaphragm to the base of gastric folds in fed neonates. The study endpoints were to determine overall prevalence of clinical and sonographic GERD in the neonates, to determine association between the length of abdominal esophagus and presence of GERD, to determine main correlates of the length of abdominal esophagus in premature neonates with and without GERD, as well as to assess diagnostic performance of sonography for diagnosis of GERD.

Statistical analysis

Results were reported as Mean ± SD for the quantitative variables and percentages for the categorical variables. The groups were compared using the Student's T-Test or Mann-Whitney U test for the continuous variables and the chi-square test (or Fisher's exact test if required) for the categorical variables. The Pearson's correlation test was used to determine correlation between the two-measuring test. Multivariable linear regression model was used to determine association between the length of abdominal esophagus and GERD with the presence of other baseline variables as the confounders. Sensitivity and specificity were calculated using the Chi-Square test. P values of 0.05 or less were considered statistically significant. All the statistical analyses were performed using SPSS version 19.0 (SPSS Inc., Chicago, IL, USA) and SAS version 9.1 for Windows (SAS Institute Inc., Cary, NC, USA).

Results

Seventy-five neonates (47 boys and 28 girls) with the mean age of 15.47 ± 10.09 days (ranged 2 to 30 days) and mean weight 1447.87 ± 374.93 gr (ranged 590 to 2000) were assessed. The mean of gestational age was also 31.43 ± 2.74 weeks (ranged 26 to 37). Regardless of prematurity as the main cause of admission, other concomitant reasons for admission included Respiratory Distress Syndrome (RDS) in 57 neonates (76%), sepsis in three neonates (4%), icterus in two neonates (2.7%), cyanosis in one neonate (1.3%), and asphyxia in one neonate (1.3%). Mode of delivery in 81.3% of neonates was cesarean section and in others (18.7%) was normal vaginal delivery. Clinically, Reflux was diagnosed in 15 neonates (20.0%). It was also diagnosed in 20 cases (26.7%) by sonography assessment yielding a sensitivity of 86.7%, a specificity of 88.3%, a positive predictive value of 65.0%, a negative predictive value of 96.4%, and an accuracy of 88% for this diagnostic device. The mean length of abdominal esophagus was 15.19 ± 4.10 mm (ranged 8 to 27 mm). The mean length of abdominal esophagus in neonates < 10 days, 10 to 20 days, and > 20 days were 16.30 ± 3.54 mm, 14.94 ± 4.47 mm, and 14.11 ± 4.27 mm, respectively with no significant difference (P > 0.05). There was no difference in the length of abdominal esophagus between males and females (14.85 ± 3.86 mm vs. 15.75 ± 4.49 mm, P = 0.382). Also, no correlation was found between this measurement and age variable (r = -0.176, P = 0.131) (Figure 1).

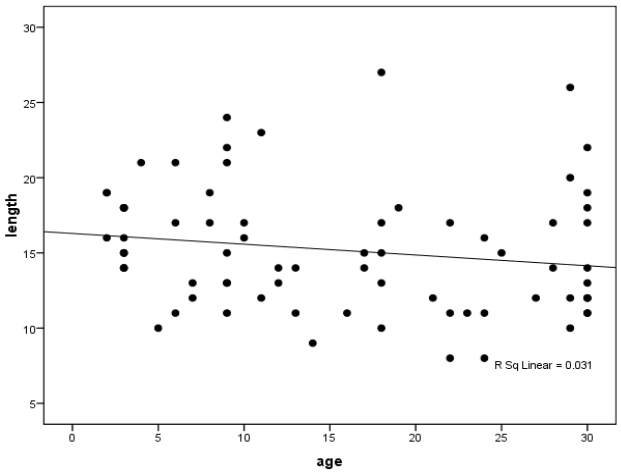

Figure 1. Correlation between length of abdominal esophagus and neonatal age

However, there was a strong positive association of the length of abdominal esophagus with neonatal birth weight (r = 0.553, P < 0.001) (Figure 2), and also with gestational age (r=0.491, P = 0.001) (Figure 3). Also, those neonates with RDS had significantly shorter esophagus than those with underlying icterus and those with sepsis (P = 0.004). In assessment of relationship between reflux and the length of abdominal esophagus in premature neonates, those with clinical diagnosis of reflux had significantly shorter abdominal esophagus than neonates without reflux (11.47 ± 1.36 mm vs. 16.12 ± 4.03 mm, P = 0.001). In a multivariate linear regression model (Table 1), shorter abdominal esophagus was shown to be related to the presence of reflux and birth weight. In this model, birth weight was also significantly correlated with the length of abdominal esophagus. Considering cut-off point of 15 mm for the value of abdominal esophagus, neonates with shorter

abdominal esophagus were at increased risk for reflux compared with other neonates (37.8% vs. 0%, P = 0.001).

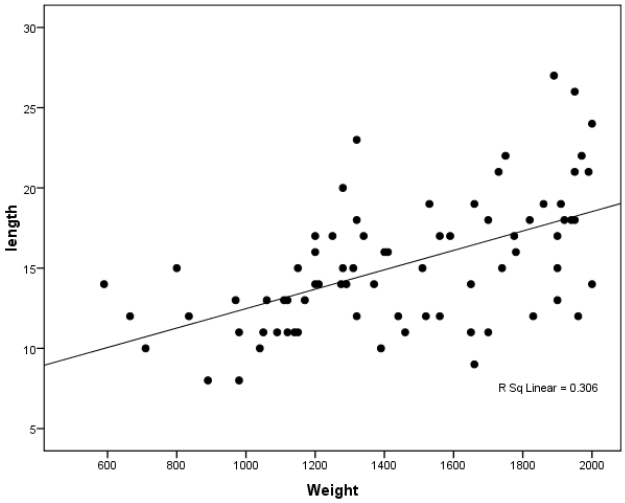

Figure 2. Correlation between length of abdominal esophagus and neonatal birth weight

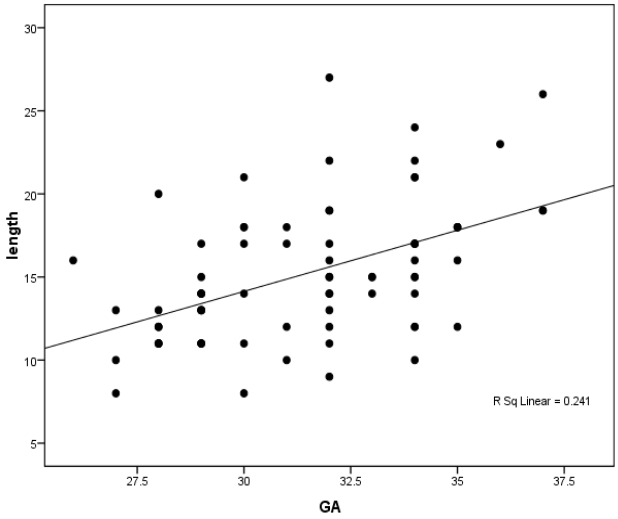

Figure 3. Correlation between length of abdominal esophagus and gestational age

Table 1. Multivariate linear regression analysis results

Variable	Beta	SE	P-value
Clinical reflux	2.764	1.068	0.012
Sex of neonate	0.630	0.780	0.470
Age of neonate	0.014	0.043	0.747
Birth weight	0.004	0.001	0.005
Gestational age	0.203	0.207	0.332
Apgar score	-0.183	0.235	0.439
Etiology of NICU admission	0.212	0.185	0.257

Discussion

In first assessment, we could demonstrate a strong association between the length of abdominal esophagus in premature neonates and presence of GERD adjusted for neonatal gender and age, birth weight, gestational age, apgar score, and also reasons for admission to NICU. In fact, shorter abdominal esophagus is associated with increased risk for reflux in this age group. Considering the value of 15 mm as the cutoff for the length abdominal esophagus, the existence of shorter abdominal esophagus increases the risk for GERD about 1.5 times. Only two similar studies have been published in line with our survey. Dehdashti and colleagues (15) showed that neonates and infants with reflux had a significantly shorter abdominal esophagus than subjects without reflux: the mean difference in neonates, 4.65 mm; 1-6 months, 4.57 mm; 6-12 months, 3.61 mm. Also, Koumanidou et al. (14) found that neonates and infants with reflux had a significantly shorter abdominal esophagus than subjects without reflux: the mean difference in neonates, 4.8 mm; 1-6 months, 4.5 mm; 6-12 months, 3.4 mm. In their study, the children with severe reflux had a shorter esophagus compared with those with mild and moderate reflux only in the neonate group. The main difference between our study and above studies was to consider neonates with lower age range in our study so that we only entered neonates < 1 month of birth, while the two pointed studies considered a wide age range from 1 day to 12 months. On the other hand, our study was only focused on premature neonates, but not older infants. In total, it seems that the relation between the length of abdominal esophagus in premature neonates and presence of GERD is independent to children age. The unique finding in our study was to obtain significant association between other neonatal baseline variables including birth weight and gestational age and the length of abdominal esophagus that can be very valuable for assessment of reflux in those premature neonates with a short abdominal esophagus. In fact, we could show that the premature neonates with lower birth weight and also lower gestational age face more with the risk for GERD.

We also showed higher diagnostic value of sonography for assessment of both GERD and anatomical indices of esophagus. In this regard, sonography was shown to have a high sensitivity, specificity, and accuracy for assessment of GERD in neonates. Similarly, Koumanidou et al. (14) found a sensitivity of 94% for sonography diagnosis of GERD. According to the study by Savino et al., (16) ultrasonography allows exclusion of several non-GERD causes of symptoms and that it provides morphological and functional data with high sensitivity and positive predictive value for the diagnosis of GERD. Sonographic assessment of findings such as abdominal esophageal length, esophageal diameter, esophageal wall thickness and gastroesophageal angle provide important diagnostic indicators of reflux and related to the degree of GERD. In total, sonography not only can be applied to assess reflux in neonates, but is valuable for assessing analytical status of abdominal esophagus.

The main strengthen of our study was to determine a strong association between abdominal esophageal length and GERD and also significant association of the two indices of birth weight and gestational age with abdominal esophageal length independent to other neonatal characteristics that was not assessed previously. Also, according to the values related to the length of abdominal esophagus in our study, these values can be used as the standard values or both premature neonates with and without GERD. However, our study had some potential limitations including a small sample size, and focusing only on neonates in age range lower than 30 days.

Conclusion

Results showed that shorter abdominal esophagus in premature neonates is associated with increased risk for GERD that is more highlighted in those neonates with lower birth weight and lower gestational age. Also, sonography has a high value for assessment of both presence of GERD and also anatomical state of abdominal esophagus in premature neonates.

Ethical disclosure

The study was approved by Ethics Committee of Shahid Beheshti University of Medical Science and registered by code 1392.310.

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Author contributions

All the authors have accepted responsibility for the entire content of this submitted manuscript and approved submission.

Conflict of interest

There is no conflict of interest.

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