Defining an Evaluation Protocol for the Infant with Fetal Echogenic Bowel

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Abstract

Objective This study aimed to develop an algorithm for pediatricians to use for infants diagnosed with fetal echogenic bowel (FEB) to ensure that each patient is fully evaluated for possible complications while avoiding unnecessary morbidity and mortality and health care-associated costs.

Study Design This was a prospective cohort of neonates for which a diagnosis of FEB was made during a Level 2 anatomy ultrasound between February 2016 and January 2017. Women diagnosed with FEB were offered perinatal genetic counseling and testing. These women also received increased third trimester fetal surveillance, including daily fetal kick counts, fetal growth scans every 3 to 4 weeks beginning at 28 weeks, and weekly fetal nonstress test (NST) and/or BPP beginning at 32 weeks. After delivery, neonates received a postnatal evaluation including birth weight, gestational age at birth, presence of other abnormalities, and associated perinatal morbidity and mortality. Comparison between findings was performed using chi-square test. All statistical evaluation was performed using SPSS.

Results Among 919 pregnant patients who received Level 2 anatomy ultrasounds at a Regional Perinatal Center during the study period, 70 received a diagnosis of FEB. Of those diagnosed with FEB, 52 (74.3%) delivered at the same Regional Medical Center. Of these 52 delivered infants, 3 (5.8%) were intrauterine fetal demises (IUFDs) and 4 (7.6%) had unaffected twins. Only one multifetal gestation had the diagnosis of FEB in both the twins. Only 19 of the infants delivered had a kidney, ureter, and bladder X-ray (KUB) performed secondary to prematurity or abnormal exams.

Conclusion This study showed that the majority of infants diagnosed with FEB had a normal exam following delivery, and that most of the neonatal outcomes of neonatal intensive care unit admissions and other neonatal complications are a result of prematurity rather than FEB. Although the algorithm did not have significant results, it is easy to follow and implement in larger studies.

Keywords

- fetal echogenic bowel
- ultrasound
- neonate
- pregnancy

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Key Points

- Majority of infants with FEB have a normal physical exam after delivery.
- Majority of neonatal outcomes evaluated were a result of prematurity rather than FEB.
- FEB is a soft marker for potential abnormalities and fetal morbidity/mortality.

The definition of fetal echogenic bowel (FEB) is a bowel that has sonodensity greater than or equal to that of fetal bone. Typically, infants are screened in the second trimester between 16 and 24 weeks' gestation during their scheduled anatomy ultrasound. The prevalence of FEB is 0.2 to 1.8% of the population.[1–7] There are several prior studies evaluating detection and outcomes of FEB; however, there is currently no standardized protocol to evaluate these infants following delivery. Our study was aimed at proposing an algorithm to evaluate these infants after delivery.

FEB has been a continued topic of debate due to the subjectivity of the sonographer as well as the extensive associations with this marker. Prior studies have divided patients into groups based on level of sonodensity by grades and on gain used during ultrasound. It was noted that the perception of risk was largely dependent on the ultrasonic evaluator.[1] In another study by Buiter et al, cases were divided into groups based on FEB with other sonographic findings such as isolated FEB versus other soft marker or other major anomalies.[2] The largest of the studies is a French collaborative study of 682 cases that described all of the outcomes/diseases associated with FEB after delivery.[3]

We hypothesized that a standardized management protocol will help to identify and evaluate at-risk neonates. Primary outcomes included number of infants requiring invasive surgical intervention and number of infants requiring radiologic imaging. Secondary outcomes included neonatal intensive care unit (NICU) admission, congenital infection, aneuploidies or anomalies, and death.

Materials and Methods

This was an institutional review board-approved, prospective cohort analysis of patients diagnosed with FEB on Level 2 anatomy ultrasound performed at a Regional Perinatal Center between February 2016 and January 2017. The ultrasound examinations were performed with a Voluson E8 ultrasound device with a 5-MHz transducer. A total of 919 Level 2 anatomy ultrasounds were performed during that period, and 70 patients were given the diagnosis of FEB. The ages of the women ranged from 17 to 43, and diagnosis occurred in the second or third trimester, anywhere from 15 to 36 weeks' gestation. Four ultrasonographers were involved in the sonographic evaluations. Population characteristics are presented in ►Table 1. Though only 52 infants diagnosed with FEB were delivered at our facility, there were an additional 10 whose gender was determined by noninvasive prenatal testing (NIPT) or amniocentesis and were used for analysis in the study.

Women who were diagnosed with FEB received perinatal counseling and were offered prenatal testing to include infectious serologies (CMV and toxoplasmosis), cystic fibrosis screening, cell-free DNA screening, and amniocentesis. They also received increased third trimester fetal surveillance including daily fetal kick counts, fetal growth ultrasounds every 3 to 4 weeks beginning at 28 weeks, and weekly fetal nonstress test and/or biophysical profiles beginning at 32 weeks. This was standard at our institution secondary to the increased risk of fetal growth restriction and unexplained intrauterine fetal demise associated with the finding of FEB. For those patients diagnosed with other anomalies in addition to FEB, additional testing was ordered.

For the postnatal evaluations of FEB, an algorithm (►Fig. 1) was designed by a neonatologist at the Regional Medical Center. If physical exam was found to be normal, infants were to feed per protocol. If physical exam was abnormal or if infant was unable to tolerate feeds, an abdominal plain film was to be obtained. If abnormal, further

Table 1 Descriptive characteristics of patients ($n = 70$)

Characteristic	Mean (±SD) or *N* (%)
Age of mother (y)	27.6 (± 6.24)
Gestational age at diagnosis	22.7 (± 4.76)
BMI (kg/m^2)	27.6 (± 5.46)
BMI > 30	21 (30.00)
Race	
Caucasian	40 (57.14)
African American	26 (37.14)
Hispanic	2 (2.86)
Other	2 (2.86)
Gender of fetus	
Total male	31 (44.29)
Caucasian male	14 (45.16)
African American male	16 (51.61)
Hispanic male	1 (3.23)
Other male	0 (0)
Total female	31 (44.29)
Caucasian female	26 (83.87)
African American female	13 (41.94)
Hispanic female	1 (3.23)
Other female	2 (6.45)
Missing	10 (14.29)

Abbreviations: BMI, body mass index; SD, standard deviation.

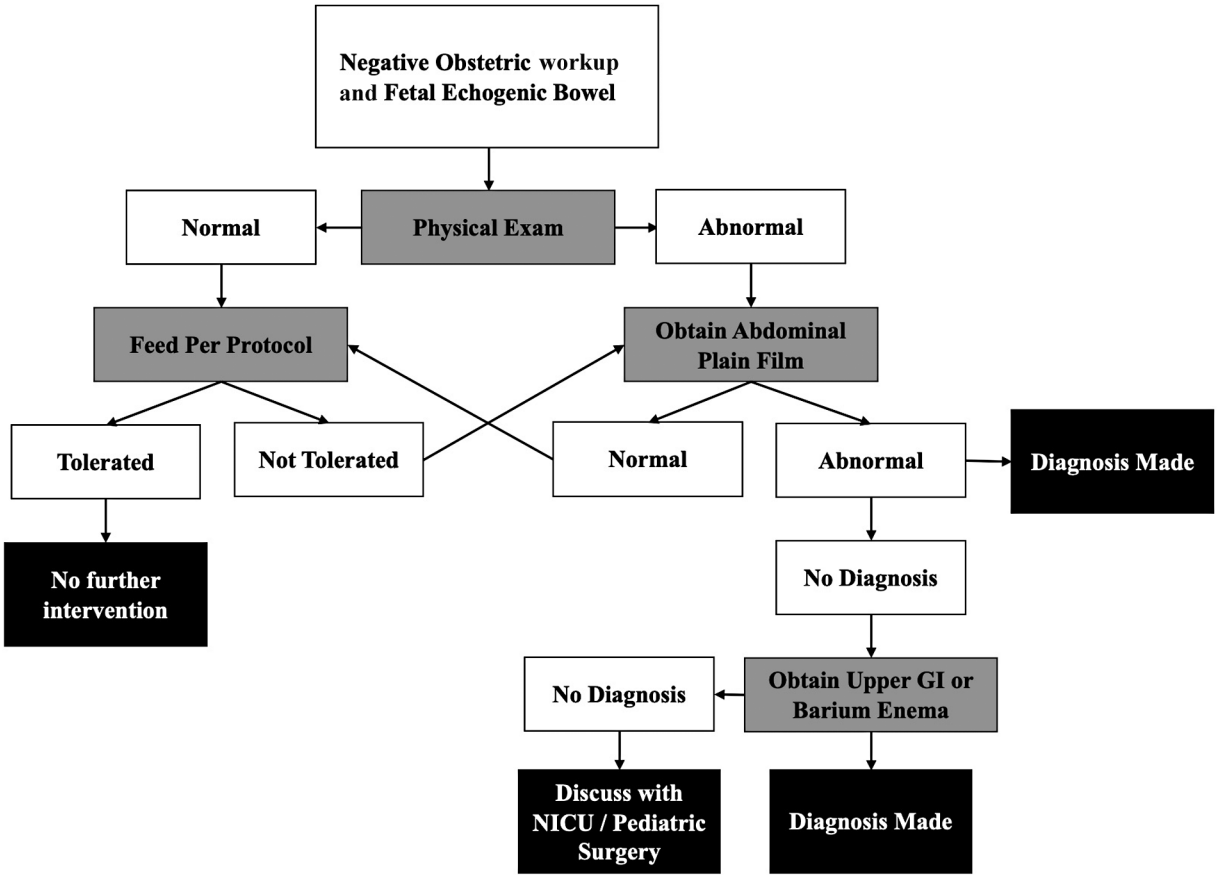

Fig. 1 Algorithm developed for postnatal evaluation of FEB. FEB, fetal echogenic bowel.

diagnosis could be made by obtaining upper gastrointestinal (GI) study or barium enema. Findings could also be discussed with Pediatric Surgery. The birth weight, gestational age at delivery, presence of other abnormalities, and perinatal morbidity or mortality was recorded for the infants diagnosed with FEB and delivered at the regional center.

Results

During the study period, we examined 70 pregnancies with FEB diagnosed during the second or third trimester. Of the 70 pregnancies, 56 total babies delivered at our facility, including five sets of twins. Fifty-two of those infants had received a diagnosis of FEB, with only one pregnancy in which both twins were affected. There were otherwise four unaffected twins who were not included in the remainder of the study. Out of the 70 pregnancies with FEB diagnoses, 24 were diagnosed with FEB alone. Three of the other 46 fetuses had only echogenic intracardiac focus as their additional ultrasound finding. Twenty-eight of the remaining fetuses received diagnoses of intrauterine growth restriction (IUGR) with or without other associated findings. About 16 fetuses in total had multiple anatomical or placental findings. Several of these associated findings were quite severe, including those identified in the three pregnancies that resulted in IUFD.

Of the 52 infants diagnosed with FEB that were delivered at our facility, 19 received a KUB after delivery, all for reasons unrelated to FEB (►Fig. 2). All but one of the infants who received a KUB was admitted to the NICU, with 16 of the 19 having been delivered premature between 24 and 34 weeks' gestation. In further evaluation, 7 of the 19 infants had other anomalies including patent ductus arteriosus, septo-optic dysplasia, total anomalous pulmonary venous return, and intrauterine growth restriction with reversed end-diastolic flow that resulted in demise at day 3 of life. Aside from an infant with known gastroschisis, none of the infants in the study required pediatric surgery consultation. There were three total IUFDs in our study population, each with severe associated findings that likely led to their outcome. The first occurred at 18 weeks' gestation and had cystic hygroma and trisomy 18. The second occurred at 24 weeks' gestation and also had several severe findings, including short long bones, concern for Smith–Lemli–Opitz syndrome, IUGR with reverse end-diastolic flow (REDF), and cell-free DNA testing suspicious for trisomy 16. The last occurred at 34 weeks' gestation, and had associated sirenomelia, thickened nuchal fold, severe hypoplastic kidneys, anhydramnios, and IUGR <5th percentile with absent Dopplers.

In addition to neonatal outcomes such as NICU admissions, results were stratified between race and gender given a trend that was observed during data collection. The majority of the population diagnosed with FEB were Caucasian. Of those, most were female. ►Fig. 3 exhibits the distribution of maternal race in infants diagnosed with FEB, and ►Fig. 4 further compares race with fetal sex.

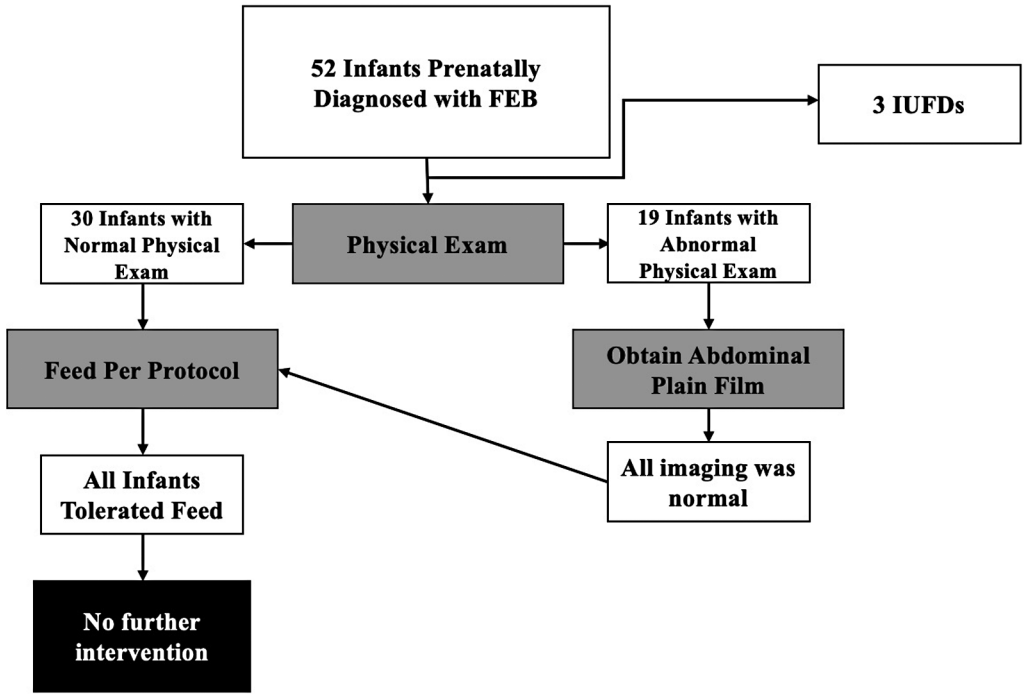

Fig. 2 Flowsheet demonstrating infant outcomes based upon the neonatal FEB algorithm depicted in ►**Fig. 1**. FEB, fetal echogenic bowel.

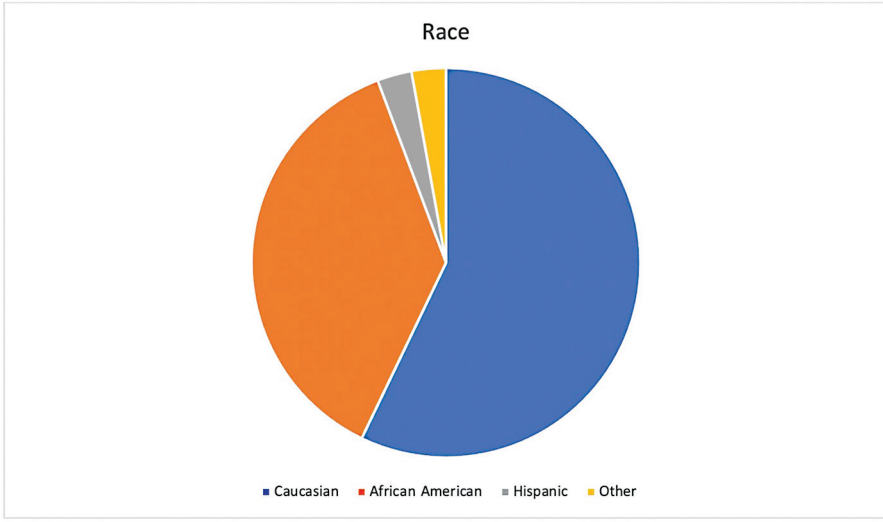

Fig. 3 A pie chart showing the distribution of the maternal demographics of infants with FEB included in this study. Fifty-seven percent of women were Caucasian (blue), 37% of women were African American (orange), 2% were Hispanic (gray), and 2% of women were other (2%). FEB, fetal echogenic bowel.

Discussion

Our goal was to determine a protocol for evaluating FEB postnatally for infants diagnosed at a Maternal–Fetal Medicine practice and delivered at a Regional Perinatal Center. Because of the institution's role as a referral center, diagnosis of FEB is made in approximately 4 to 5 fetuses per week at our practice, resulting in approximately 250 cases per year. Therefore, the goal was to collect data on 170 patients to ascertain the successfulness of the protocol (95% confidence). This study showed that the majority of infants diagnosed with FEB have a normal exam following delivery, and that most of the neonatal outcomes of NICU admissions and other neonatal complications are likely a result of prematurity rather than FEB.

A literature review was performed that had similar findings regarding neonatal outcomes in infants diagnosed with FEB. In the study by Buiter et al, of 116 cases of FEB, those with findings of isolated FEB had no pathological abnormalities postpartum and therefore had a good prognosis. In total, of the 116 cases with FEB, 71 (61.2%) had no pathology postpartum. This study also noted that a transducer frequency of more than 5MHz could lead to overdiagnosis of FEB.

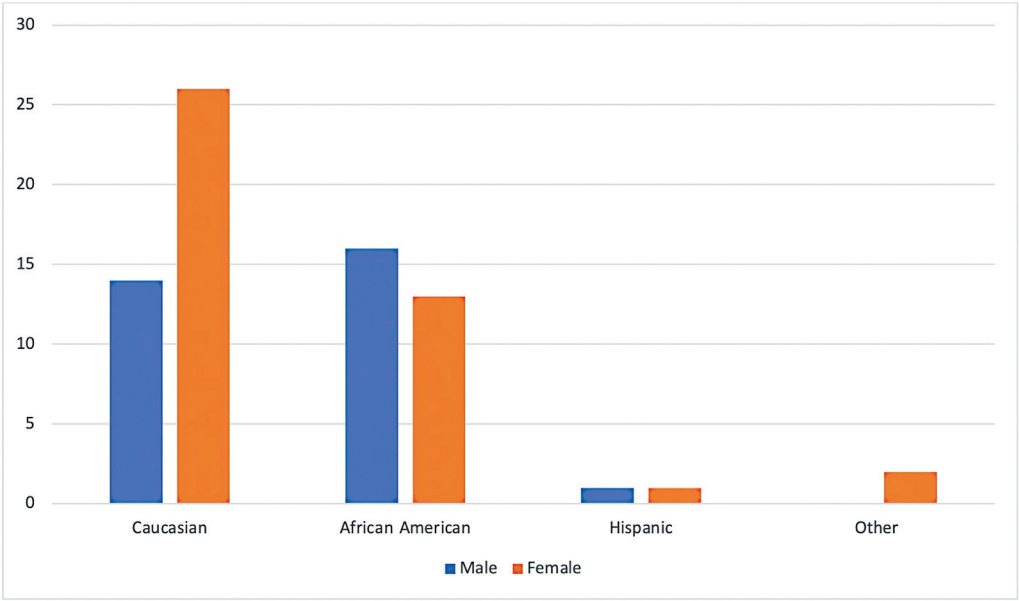

Fig. 4 A graphic representation of the comparison between race with infant sex. The majority of the population diagnosed with FEB were Caucasian, and of those, most were noted to be female. FEB, fetal echogenic bowel.

Those who were noted to have FEB associated with early IUGR had a poor prognosis, and therefore these pregnancies may warrant close observation.[2] Perhaps one of the largest studies was a French collaborative study of 682 cases with an aim to describe diseases associated with FEB, which include, but are not limited to, cystic fibrosis, infectious serologies, structural GI abnormalities, and chromosomal abnormalities. Overall, 35% of the cases with FEB were found to have other serious fetal abnormalities. This study also recommended that a thorough pediatric exam can be performed with possible surgical treatment if necessary (e.g., in the case of bowel atresia).[4] Ultimately, the consensus of the literature is that FEB continues to be a soft marker for other potential abnormalities and fetal morbidity/morality. Therefore, prenatal sonographic screening should continue, and a thorough pediatric exam performed to rule out postnatal complications of FEB.

The women in our study fell between the ages of 17 and 43 years, which is representative of the majority of women of reproductive age. Race demographics for our studied population do differ, somewhat, from the general population of the surrounding metro area as depicted from U.S. Census Bureau data compiled in 2015. The percentage of African Americans studied in our population (37.14%) is lower than that of the surrounding region (43.7%). This may be due to several socioeconomic factors as it pertains to access of care and referrals from outside regions.[8] The average body mass index (BMI) of our patient population was 27.6 kg/m^2, however 21 patients (30%) were obese (BMI $>$ 30 kg/m^2). This is similar to the general population of Georgia, where around 30 to 35% of the adult population is obese.[9,10]

Limitations include selection bias due to the fact that low-risk pregnancies are less likely to receive referral to the perinatal ultrasound unit, which may result in an overestimate of the frequency of FEB diagnosis. Additional weaknesses include definition bias, as there is subjective definition of echogenic bowel in the literature, which may affect diagnosis frequency and outcome data. A new perinatologist was hired during the time of the study, and we did not formally study interobserver variation. There is also confounding bias due to the other findings that tend to accompany FEB, including IUGR, fetal anomalies, and prematurity. Finally, the infants were only followed to discharge after their delivery admission. Therefore, it is not possible to know whether they were diagnosed with other conditions later in life.

Additional research with multiple perinatal facilities across the state would be useful for future efforts to adopt a neonatal protocol for FEB. It would also be beneficial for future studies to further evaluate gender/race of those diagnosed with FEB. Such a study would be difficult at our facility, as there are a significant number of referrals from outlying regions. Therefore, neonatal outcome data would be difficult to obtain, as many infants are delivered at other facilities. An additional obstacle with studying FEB is the subjectivity of the diagnosis, which may make it difficult to determine which infants will be at-risk following delivery. Our study chose specifically to develop an algorithm for the immediate postnatal period, but future research could also follow infants longitudinally to identify health concerns that arise later in life. In assessment of the diversity of possible diagnoses, a systematic approach for evaluation of the neonate is essential in preventing poor fetal outcomes. Implementation of our proposed algorithm demonstrates that in cases of isolated FEB on prenatal ultrasound with no other concerns on physical exam, it is safe to feed the infant after delivery. Complications of prematurity and other comorbid conditions may necessitate imaging and surgical interventions unrelated to a prenatal FEB diagnosis.

Conflict of Interest

None declared.

Acknowledgments

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