Contents lists available at ScienceDirect

The Egyptian Journal of Radiology and Nuclear Medicine

Role of Abdominal Ultrasonography in the assessment of Neonatal Necrotising Enterocolitis

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A B S T R A C T

Aim of work: To evaluate the role of ultrasound and color Doppler in diagnoses and predicting the outcome of necrotising enterocolitis patients at neonatal ICU.

Subjects and methods: Thirty neonates clinically diagnosed with NEC were examined, 51 ultrasound examinations were done including color Doppler sonography and findings were compared with laboratory data, clinical picture, staging, abdominal radiography and patient's outcome.

Results: Bloody stools and abdominal discoloration correlated with highest risk, low PH and neutropenia and increased DAAS score matched poor outcome. echoegnic free fluid, thin bowel wall, absent wall perfusion, aprestalsis, dilated anechoic bowel, increased bowel perfusion and pneumatoses intestinalis matched adverse outcome. sonographic signs of pneumatoses intestinalis interrelated with radiographic signs.

Conclusion: US was found to be highly sensitive and specific in diagnosing, staging and predicting the outcome of NEC patients, based on group of findings that were categorized per their risk ratio and correlated with outcome.

1. Introduction

Necrotizing enterocolitis (NEC) is the most common severe neonatal gastrointestinal emergency that predominantly affects premature infants. The mortality of NEC ranges between 20 and 30%, with the greatest mortality among those requiring surgery. Abdominal radiography is currently the reference standard in imaging neonates with NEC; however, the diagnostic role of bowel ultrasound can be equal to or even superior to radiography in certain regards [1].

The main observations to be made on the plain abdominal radiograph relate primarily to the presence, and distribution of intraluminal gas, intramural gas, portal venous gas, and free intraperitoneal gas. however, according previous studies, if meticulous attention is paid to technique, abdominal US is in fact more sensitive in detecting intramural gas and portal venous gas and even free abdominal gas than plain abdominal radiography [2,3,4,1].

Guided by the role of previously established abdominal US findings in staging and diagnoses of NEC, the protocol of this study was designed, while also comparing the results of this study with previous ones [5,6,4,1].

Our study's main goal was to assess the sensitivity and specificity of US in predicting outcome and to correlate US and radiographic findings with patients' outcome.

2. Patients and methods

This is a prospective study that incorporated thirty neonates, including all cases clinically diagnosed with suspected or established NEC and were admitted to the Neonatal Intensive Care Units (NICU). Patients with large abdominal wall defects were excluded. These 30 cases were prospectively analyzed during the period from January to October 2016. The study was approved by local Ethical Committee, and informed consent from the parents of neonates were taken.

Perinatal history, Clinical data of the patients were retrospectively obtained, the data included, gestational age in weeks, date of birth, birth weight in grams and age at presentation, Table 1. Clinical symptoms included, abdominal distension, abdominal discoloration, gastric residue and bloody stool were used for clinical staging of the patients according to modified Bell's criteria [7], Table 2. Laboratory tests in-

Table 1
Demographic distribution of the studied cases.

	Mean	Standard deviation	Median	Minimum	Maximum
Gestational age (weeks)	*30.97*	*3.07*	*30.00*	*26.00*	*40.00*
Age at presentation (days)	*16.20*	*12.70*	*12.50*	*2.00*	*60.00*
Birth weight	*1312.67*	*322.42*	*1300.00*	*450.00*	*2100.00*

Table 3
Duke Abdominal Assessment Scale (DAAS) of Abnormal Radiographic Findings in Neonates and Infants with Clinically Suspected Necrotizing Enterocolitis.

0	Normal gas pattern
1	Mild diffuse distention
2	Moderate distention or normal with bubbly lucencies that are likely stool
3	Focal moderate distention of bowel loops
4	Separation or focal thickening of bowel loops
5	Featureless or multiple separated bowel loops
6	Possible pneumatosis with other abnormal findings
7	Fixed or persistent dilation of bowel loops
8	Pneumatosis highly probable or definite
9	Portal venous gas
10	Pneumoperitoneum

cluded the presence of thrombocytopenia, neutropenia, pH level and blood culture in case of suspected sepsis. The perinatal history included the presence of preeclampsia, premature rupture of membranes and APGAR score at 1, 3, 5 min.

Modified Bell's staging was used for NEC staging, Radiographic studies were done and interpreted using the Duke Abdominal Assessment Scale (DAAS) scoring system. which is a study of radiographic findings using a numeric score was designed to indicate that a patient has advancing NEC (Table 3).

Ultrasound examination: fifty one sonographic examinations were performed bedside, by two radiologists, blind of clinical findings except for NEC, using TOSHIBA *NEMIO* XG ultrasound device, equipped with a high-resolution linear transducer of 5–10 MHz and a convex 2–4 MHZ sector probe.

In cases of labile patients, abdominal US was performed after their stabilization (in about 48hs period). Gray scale abdominal ultrasound was done for the Presence of peritoneal fluid, its site and character, peritoneal air, portal venous gas, bowel wall thickening, (2.7 mm or greater), bowel wall thinning (1.0 mm or less), bowel wall hyperechogenicity, aperistalsis (defined as absence of peristalsis on real time imaging) and pneumatosis intestinalis. Color Doppler US examination was done for the presence of increased bowel wall perfusion, absent bowel perfusion i.e. (no flow on a scale of 0.029 m/sec velocity), power Doppler study was used to detect the slowest possible velocities.

3. Statistical analysis:

The statistical package IBM SPSS (Statistical Package for the Social Sciences) version 23 was used for statistical analyses. Data was summarized using mean, standard deviation, median, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Comparisons between quantitative variables were done using the non-parametric Mann-Whitney test [8]. For comparing categorical data, Chi square (χ2) test was performed. Exact test was used instead when the expected frequency is less than 5 [9]. Relative risk and its 95% confidence interval were calculated. ROC curve was constructed with area under curve analysis performed to detect the ability of US parameters to detect poor outcome. when the P-values are less than or equal to 0.05 or if the range of 95% CI (confidence interval) excluded 1.0, findings were considered as statistically significant.

4. Results

The neonates presenting with NEC were divided into two groups according to their outcome:

- **Group A**: included 16 patients: (6 males, 10 females) who showed complete recovery following only medical treatment. The mean gestational age in this group is 30.7 weeks (range, 26–36). The mean birth weight is 1,367 gm (range, 850–1,790). the age they started showing symptoms was 15.9 days (range 2–40).
- **Group B**: included 14 patients, (9 males, 5 females) who required surgery or died with sepsis, with mean gestational age of 31.2 weeks (range 27–40), and mean birth weight of 1250 (450–2100). Their

Table 2
Modified bells staging system.

Stage	Classification	Systemic signs	Intestinal signs	Radiologic signs
IA	Suspected necrotizing enterocolitis (NEC)	Temperature instability Apnea Bradycardia Lethargy	Increased pregavage residuals, mild abdominal distention, emesis, guaiac-positive stool	Normal or intestinal dilation, mild ileus
IB	Suspected (NEC)	Same as above	Bright red blood from rectum	Same as above
IIA	Proven NEC-mildly ill	Same as above	Same as above, plus absent, bowel sounds, with or without abdominal tenderness	Intestinal dilation, ileus, pneumatosis intestinalis
IIB	Proven NEC-moderately ill	Same as above, plus mild metabolic acidosis, mild thrombocytopenia	Same as above, plus absent bowel sounds, definite abdominal tenderness, with or without abdominal cellulitis or right lower quadrant mass	Same as IIA, plus portal venous gas with or without ascites
IIIA	Advanced NEC-severely ill, bowel Intact	Same as IIB, plus hypotension, bradycardia, severe apnea, combined respiratory and metabolic acidosis, disseminated intravascular coagulation, and neutropenia	Same as above, plus signs of generalized peritonitis, marked tenderness, and abdominal distension	Same as IIB with definite ascites
IIIB	Advanced severely ill, bowel perforated	Same as IIIA	Same as IIIA	Same as IIB, plus Pneumoperitoneum