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The Role of Radiology in the Evaluation and Management of Necrotising Enterocolitis (NEC)

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ABSTRACT
Necrotizing enterocolitis (NEC) is a disease of premature infants. Following clinical diagnosis, there is need for early radiological evaluation for confirmation and identification of complications. This ensures early initiation of appropriate steps of management which will reduce the mortality associated with the disease. This paper describes a series of 3 cases of NEC and emphasizes early radiological evaluation of these patients with the various imaging modalities available, to cut down on the disease burden in our environment.

INTRODUCTION
Necrotizing enterocolitis (NEC) is one of the most common gastrointestinal emergencies in the new born. The syndrome shows highest incidence in premature infants with birth weight of less than 1 kg and occurs during the first 2 weeks of life[1,2,3].

The aetiology of the disease is considered multifactorial and related to ischaemia and bacterial colonization of the gut[4]. In all patients, the onset of NEC is associated with early clinical symptoms such as abdominal distension, retained gastric contents, lethargy and feeding intolerance. These may progress to gastrointestinal bleeding, bloody stools and septicaemia[1,2,3,4].

The management of NEC is inter disciplinary. The overall mortality ranges from 20 40%[4]. This is related to the ability to achieve early diagnosis which enables early initiation of appropriate therapeutic management. When complication of perforation are absent, conservative therapeutic regimen is favoured[1].

Radiological changes in NEC can be recognized early before complications set in. In the event of deterioration or improvement following establishment of a therapy, progress can be monitored radiologically[5,6,7]. This can help reduce the mortality associated with NEC as illustrated in the following series of 3 cases:

Case1:
FN is a 7-day old male baby admitted into Neonatal Intensive Care Unit (ICU) of EBSUTH with a day history of abdominal distension, bloody diarrhea and difficulty with breathing. The mother had ANC care in a local health facility and was delivered at the gestational age of 36 weeks. The baby had asphyxia at birth with apgar score of 4 in 1 minute; 6 in 5 minutes and 8 in 10 minutes following vigorous resuscitation. He had intravenous antibiotics and fluid replacement through the umbilical vein before transfer to EBSUTH.

Examination revealed a febrile baby with a temperature of 39?c, lethargic, moderately dehydrated and in respiratory distress. The abdomen was grossly distended and tense with visibly dilated veins. Percussion notes were tympanitic and bowel sounds were markedly reduced.

Based on clinical assessment, an impression of necrotizing enterocolitis with perforation was made.

Laboratory investigations revealed a total WBC of 16000, 90% Neutrophils and lymphocytes of 10%. Electrotyles were normal, blood culture was negative and urinalysis was unremarkable.
The urea level was raised (8mmol/L) and sodium was reduced (130mmol/L).

Plain abdominal radiograph done in supine position revealed a distended abdomen with free peritoneal air outlining the margins of the intraabdominal organs, (Pneumoperitoneum). The distension with

the overall lucency of the abdomen produced the typical "foot ball" sign (fig 1).

The granular and mottling appearance of the bowel loops in the (R) lower quadrant suggested pnemnatosis intestinalis.
Nasogastric tube was inserted to decompress the stomach. The patient was actively covered with antibiotics and exploratory laparotomy was done 7 hours after presentation. About three sites of perforation were identified in the distal ileum and closed. There were no identified areas of necrosis. He made steady progress in the post-operative days and was later discharged home. We lost him to follow up.

Case 2:
T D a female infant born to a social primp. The birth weight was 1.0 kg. She presented 2 weeks after birth with abdominal distensions, bloody diarrhea and progressive lethargy. There was no history of umbilical vein catheterization. A clinical impression of NEC was made. Plain abdominal radiograph done 7 hours after admission revealed pneumoperitoneum. Significant laboratory finding was marked acidosis. The rest of the laboratory findings were normal.

Patient was operated upon and at surgery the caecum was necrotic and perforated with peritoneal spillage. The distal ileum was cyanotic. No perforation was seen. The patient died same day post operative.

Case.3:
L A is female infant born at the gestational age of 34 weeks with a birth weight of 0.95 kg. A day later she presented with abdominal distension, bloody diarrhoea vomiting and fever with body temperature of 38?c.

A clinical impression of NEC was made. An initial plain abdominal radiograph done in the new born revealed pneumoperitoneum. Peritoneal tap done a day later revealed pus.Culture revealed mixed gram negative and gram positive organisms. Patient died on the second day before establishment of antibiotic therapy. No autopsy was done.

IMAGING IN NEC:
NEC as a disease entity has attracted a lot of work from different authors who all agree that early diagnosis and therapy are important. Generally the imaging modalities of plain radiography of the abdomen, sonography, doppler sonography, contrast studies and MRI are all valuable evaluation techniques for early diagnosis of NEC[8].

PLAIN RADIOGRAPHY:
The earliest radiographic findings on frontal abdominal radiographs of NEC patients are initially distension of the small bowels, and then the colon[9]. The patients further develop pneumatosis intestinalis in about 80% of cases[4,10]. This may persist and the air passes into the portal vein system causing pneumoportogram.

The persistent focal bowel dilatation which is the earliest radiological sign of the disease and the subsequent presence of intramural gas which presents a bubby appearance are usually localized in the (R) lower quadrant of the abdomen -(pneumatosis intestinalis)[11].

When pneumatosis intestinalis is present, the appearances vary, depending on the location of the gas in the intestinal wall. When the gas is located within the serosal layer of the intestinal wall, the appearance is that of a target sign but when located in the submucosal layer it presents a cystic appearance[6]. More often than not, the appearances are mixed, presenting a mottling. This mottling appearance presents a diagnostic puzzle, for an admixture of faeces and gas in collapsed colonic segment can present similarly. A plain abdominal radiograph taken prone is able to differentiate the two conditions. The mottling persists in pneumatosis intestinalis whereas in the case of admixture of faeces and gas in a collapsed colonic segment the mottling disappears[6].

Prediction of the outcome of the disease can be based on radiographic findings only as plain radiographs can detect severe pneumatosis intestinalis and portal venous gas. These are often seen in infants who develop pan-necrosis and so produce the worst outcome in the disease [7,12].

Monitoring of the progress of the disease or the management can be critically assessed using follow-up plain films of the abdomen[6,]. Improvement or deterioration usually manifests within 48 hours of onset of the

disease hence repeat follow-up radiographs done within 12-24 hours of onset of the disease gives a good assessment of the progress.

When late complications of the disease like perforation has set in and gives rise to pneumoperitoneum, plain abdominal radiographs can provide a good assessment[4]. Perforation occurs in about 12-30% of cases[13]. On plain films an overall lucency and distension of the abdomen are seen producing the 'typical foot ball sign'(fig 1). Free peritoneal gas outlining the margins of the intra-abdominal viscera are seen (fig 2).

Free peritoneal fluid (ascites) may also complicate NEC when peritonitis occurs. This sign of deterioration can be seen on plain abdominal radiographs as distension of the flanks with a generalized ground glass appearance.

In 10% of cases, infants who develop pan-necrosis of the intestines, have free air gaining access into the portal venous system and this produces a pneumoportogram[8,14] . Plain abdominal radiographs are able to show this as fine branching lucencies extending from the porta-hepatis to within 2 cm of the liver capsule in the right hypochondrial region[14].

ULTRASONOGRAPHY:
There is increased recognition of the value of sonography in diagnosing and monitoring complications of NEC. With sonography, distension of the bowel loops, thickening and pneumatosis in the bowel walls can be visualized. The free intra peritoneal fluid and pneumoportogram can be easily depicted [8]. This appears as patchy areas of echogenicity within the liver parenchyma and this is usually localized in the (R) upper quadrant of the abdomen [15] (fig 3).

The sonographic identification of portal venous gas (PVG) supports a tentative diagnosis of NEC even prior to radiography. However, the prognostic importance of PVG in NEC is still controversial [16, 17]. PVG may be present within 24 hours of onset of abdominal distension or bloody stools. This is considered a relative indication for surgical intervention since some patients managed conservatively without laparatomy survive hence the controversy[17].

Pneumatosis of the urinary bladder wall is a complicating feature of NEC and can be sonographically detected[18].

In monitoring the course of the disease, sonography has become invaluable and should be performed so that fewer plain radiographs will be required in the follow ups[19].

DOPPLER SONOGRAPHY:
The use of colour Doppler ultrasonography can improve the diagnostic work-up of new born suspicious of the disease[20,21].
The coeliac trunk and the superior mesenteric artery show elevated systolic flow velocity and diminished resistance index in NEC when compared with normal subjects.

CONTRAST STUDIES:
The most common late complications of NEC are intestinal strictures and stenosis which occur in 15-35% of recovered infants[4]. These complications can be demonstrated radiologically by contrast studies using water soluble media. Barium enema studies are not recommended because of the danger of perforation of the already necrotic and immature bowel[11,22].

MAGNETIC RESONANCE IMAGING (MRI):
This non-invasive modality of imaging has the potential of diagnosing intestinal necrosis. This will aid timing of surgical intervention in these preterm infants with clinical diagnosis of NEC[23].

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CONCLUSION:
Early radiological evaluation of patients with NEC is important for confirmation of clinical diagnosis and initiation of appropriate steps of management. The imaging modalities discussed above if employed early as diagnostic tools where available may well make the difference between life and death for the premature infant. Clinicians are encouraged to avail themselves of the great advantage of the radiological facilities available. This may greatly reduce the mortality associated with NEC and cut down the disease burden in our environment.

Fig. 1: Plain Radiograph of patient with distension of the abdomen showing overall lucency and producing the typical 'foot ball' sign

Fig. 2: Shows free peritoneal gas outlining the margins of intra-abdominal viscera, the liver, the walls of the stomach and th ligaments of the liver

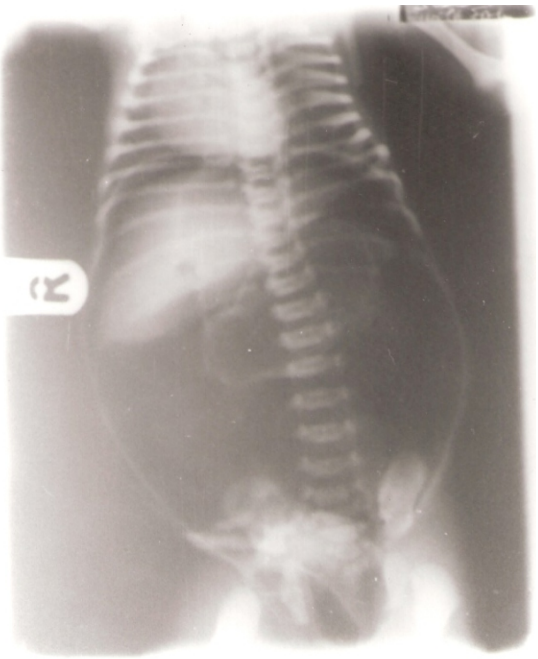
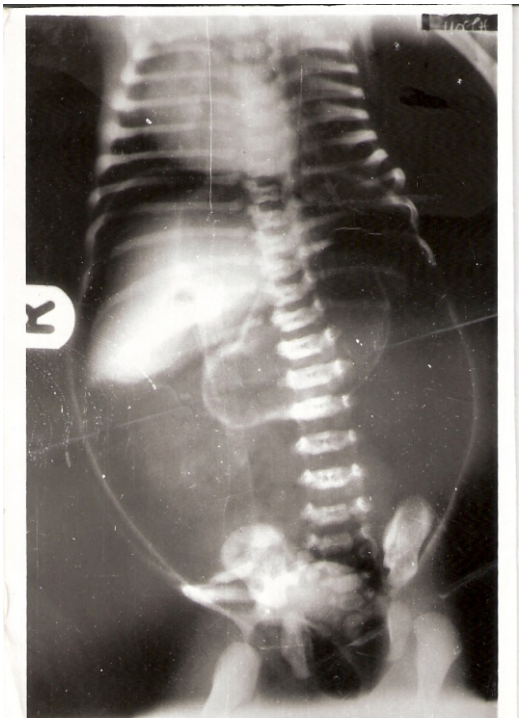


Fig. 3: Shows patchy area of increased echogenicity within the liver parenchyma due to portal ramous gas



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