

# RELEVANT RADIOLOGICAL FINDINGS FOR THE DIAGNOSIS OF NECROTIZING ENTEROCOLITIS AND ITS COMPLICATIONS\*

Beatriz Regina Alvares<sup>1</sup>, Daniel Lahan Martins<sup>2</sup>, Renato Lopes Roma<sup>3</sup>, Inês Minniti Rodrigues Pereira<sup>1</sup>

**Abstract** Necrotizing enterocolitis is one of the most frequent and severe gastrointestinal emergencies occurring in the neonatal period. Once necrotizing enterocolitis is suspected a simple abdominal x-ray is a routine examination and this film will play an essential role in the diagnosis of the disease and the follow-up care of the patient, as well as in the detection of complications. In the present study we reviewed the pertinent literature and described the radiological findings, illustrated with cases from our institution. We concluded that the radiological diagnosis of necrotizing enterocolitis done at all stages contributes for an immediate therapeutic management, reducing the complications and improving the patient's survival.

*Keywords:* Necrotizing enterocolitis; Newborn; Radiological diagnosis.

**Resumo** Aspectos radiológicos relevantes no diagnóstico da enterocolite necrosante e suas complicações.

A enterocolite necrosante representa uma das emergências gastrintestinais mais freqüentes e graves no período neonatal. Na suspeita clínica dessa doença, o exame radiológico simples de abdome é um procedimento de rotina, desempenhando um papel fundamental no diagnóstico, acompanhamento e detecção de complicações. No presente trabalho, realizamos uma revisão da literatura pertinente e descrevemos os achados radiológicos da enterocolite necrosante, ilustrados com casos do nosso serviço. Concluímos que o diagnóstico radiológico da enterocolite necrosante realizado em todas as suas etapas, contribui para uma conduta terapêutica imediata, reduzindo as complicações e aumentando a sobrevida dos pacientes.

*Unitermos:* Enterocolite necrosante; Recém-nascido; Diagnóstico radiológico.

## INTRODUCTION

Necrotizing enterocolitis (NEC) represents a condition whose etiology still remains unclear, predominantly affecting neonates (NN) weighing less than 1,500 g, and is one of the most frequent and severe gastrointestinal emergencies occurring in the neonatal period<sup>(1-3)</sup>.

Most frequently accepted etiological factors for explaining this condition are intestinal ischemia, resulting in alterations of the intestinal mucosa, excessive bacterial growth with formation of gas in the intestinal wall and persistent intestinal ir-

ritation because of oral feeding. The most suggestive clinical findings of this disease are abdominal distension, food or bilious emesis and presence of blood in stools<sup>(2,3)</sup>.

The abdominal plain x-ray is a routine procedure in NN with NEC, since it plays an essential role in the diagnosis, follow-up and detection of complications indicating the need for surgery. During the treatment, NN should undergo serial plain x-rays every hour to allow the early diagnosis of complications<sup>(4,5)</sup>.

## RADIOLOGICAL ALTERATIONS

### 1 – Generalized intestinal distension

The earliest radiological alteration in NEC is a diffused and persistent intestinal gas distension<sup>(5)</sup>. Radiologically, an intestinal loop may be considered as dilated when its measure surpasses the width of the first lumbar vertebral body<sup>(6,7)</sup>. This may be a non-specific radiological finding in NN with other abnormalities, especially those under continuous ventilation by positive pressure<sup>(8)</sup>. Nevertheless, the suspect of NEC should be always be raised in radiological of NN presenting with persistent,

generalized intestinal distension and characteristic clinical picture<sup>(2,6)</sup> (Figure 1).

### 2 – Localized distension of an intestinal loop

Localized distension of an intestinal loop presenting a tubular configuration and thickened walls was initially described as a radiological sign of imminent perforation. Currently, this radiological sign has not been considered as an imminent risk of perforation anymore, although it is useful to raise the suspicion of NEC at its early phase, since this may mean loop distress<sup>(9,10)</sup> (Figure 2).

### 3 – Intestinal pneumatosis

Pneumatosis means presence of gas in the intestinal wall, representing a complication from necrotizing enterocolitis. Although there is also a destruction of the intestinal mucosa, the presence of intramural gas is considered as a consequence of an excessive bacterial increase with gas passage from the intestinal lumen into the loop wall. The gas may be in the stomach and intestine walls, but predominates in the large intestine wall<sup>(11)</sup>.

\* Study developed in the Department of Radiology of Faculdade de Ciências Médicas da Universidade Estadual de Campinas (Unicamp), Campinas, SP, Brazil.

1. PhDs, Professors for Department of Radiology of Faculdade de Ciências Médicas da Universidade Estadual de Campinas (Unicamp), Campinas, SP, Brazil.

2. MD, Resident at Department of Radiology of Faculdade de Ciências Médicas da Universidade Estadual de Campinas (Unicamp), Campinas, SP, Brazil.

3. Physician Assistant at Department of Radiology of Faculdade de Ciências Médicas da Universidade Estadual de Campinas (Unicamp), Campinas, SP, Brazil.

Mailing address: Profa. Dra. Beatriz Regina Alvares, Rua Alberto de Salvo, 238, Distrito de Barão Geraldo, Campinas, SP, Brazil, 13084-759. E-mail: alvaresb@terra.com.br

Received March 29, 2005. Accepted after revision July 5, 2005.



**Figure 1.** Abdominal plain x-ray film obtained in dorsal decubitus demonstrating generalized intestinal distension.

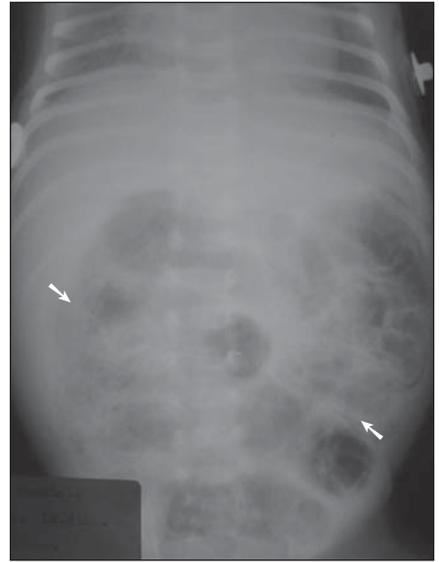


**Figure 2.** Abdominal plain x-ray study in dorsal decubitus demonstrating a single, dilated intestinal loop in the right iliac fossa.

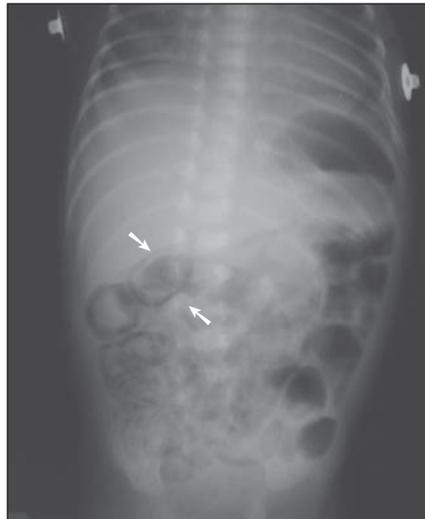
Intestinal pneumatosis represents the most pathognomonic radiological finding of NEC, presenting as visible radiolucent, linear, curved-linear or bullous images on the intestinal loop wall. In some circumstances, the radiological appearance resembles the intestinal fecal contents, and the diagnosis is made by means of serial x-rays demonstrating the permanence of in-



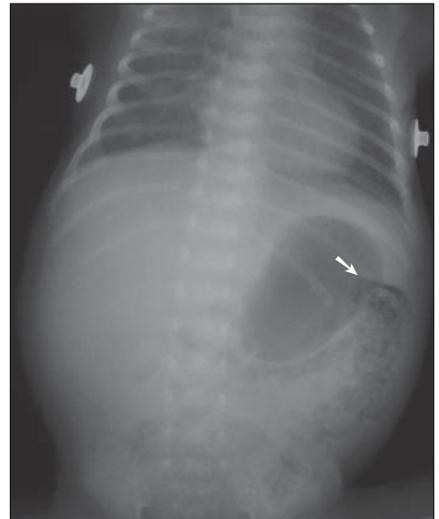
**A**



**B**



**C**



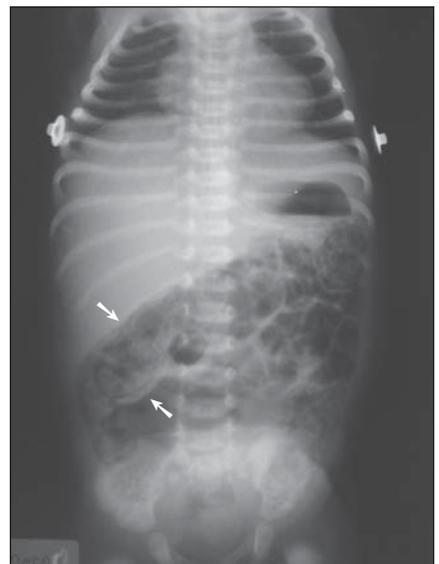
**D**

**Figure 3(A-E).** Abdominal x-ray films of different patients in dorsal decubitus demonstrating intestinal pneumatosis characterized by visible radiolucent lines in the walls of the intestinal loops (arrows).

tramural gas, contrarily to the feces with present motility<sup>(2,11-13)</sup> (Figure 3A-E).

#### 4 – Air within the portal system

The intestinal pneumatosis may extend into the venous portal system, and is visible on abdominal plain x-ray films as radiolucent, linear images in hepatic projection, and extending to peripheral areas<sup>(6, 11,14,15)</sup> (Figures 4A and 4B). This type of distribution allows the differential diagnosis with air in the biliary tract, with a radiological aspect similar to that of air within



**E**

the portal system, but with a more central hepatic localization<sup>(6)</sup>.

### 5 – Pneumoperitoneum

The term pneumoperitoneum refers to the presence of free air within the peritoneal cavity caused by a perforated hollow, and is a complication from necrotizing enterocolitis<sup>(1,2,6,11)</sup>. The radiological signs can be seen on abdominal plain x-rays performed in dorsal decubitus, with vertical and horizontal x-ray beams, orthostatic position and left lateral decubitus with horizontal beams<sup>(11,16)</sup>.

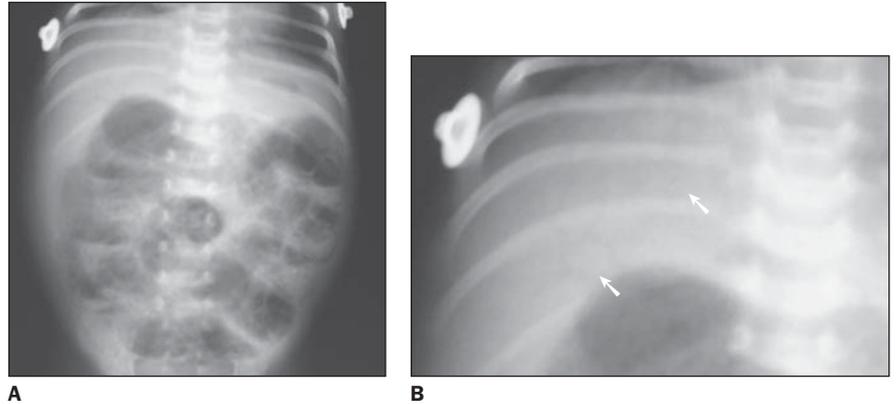
On x-ray films obtained in dorsal decubitus with vertical x-ray beams a darkened abdominal cavity is observed, and the intestinal wall is visualized because of the presence of air both inside and outside the loop (Figure 5). On this view, a falciform ligament may appear, the association of these images being described as “football sign” for resembling the shape of the ball used in the American football<sup>(11)</sup>. On x-ray films obtained with the patients in orthostatic position (Figure 6), dorsal decubitus (Figures 7A and 7B) and left lateral decubitus with horizontal x-ray beam (Figures 8A and 8B), the free air movement is observed within the abdominal cavity, under the diaphragmatic cupula, anteriorly, or between the liver and the right abdominal wall.

### 6 – Late complications

Areas of stenosis of the large intestine represent a late complication from necrotizing enterocolitis, manifesting clinically through obstruction. On plain abdominal x-ray films, a significant intestinal distension is observed with absence of air in the rectum<sup>(17,18)</sup>. The diagnosis is confirmed by opaque enema demonstrating areas of stenosis in the large intestine. In the presence of risk of intestinal rupture, this examination should be performed with diluted iodinated contrast agent<sup>(18,19)</sup> (Figures 9, 10A and 10B).

### CONCLUSION

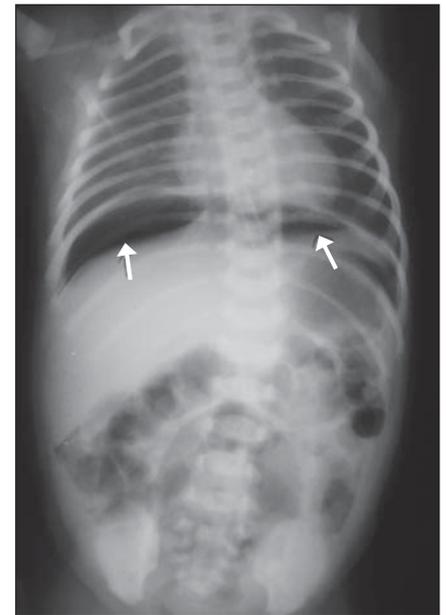
The radiological diagnosis of NEC accomplished in all phases contributes for an immediate therapeutical management, reducing the rate of complications and improving the patients’ survival.



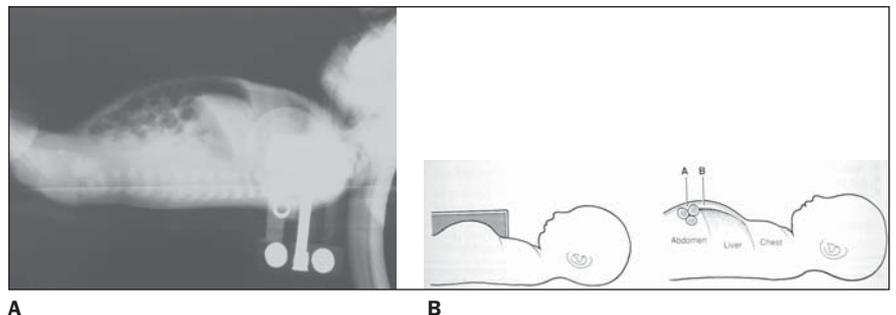
**Figure 4(A,B).** Abdominal plain x-ray film obtained in dorsal decubitus demonstrating the presence of air within the portal system — radiolucent linear images in hepatic projection, extending to peripheral areas. Also, intestinal pneumatosis is observed (A).



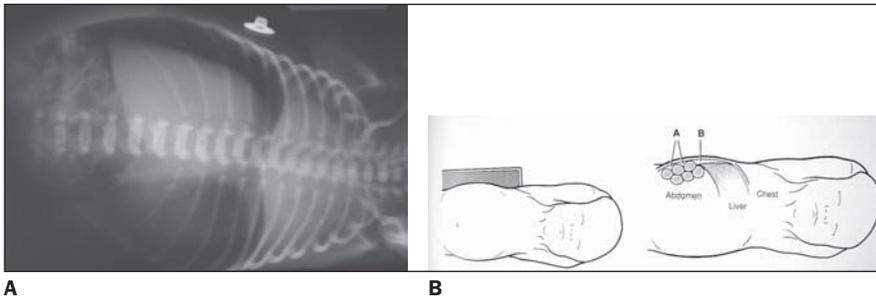
**Figure 5.** Abdominal plain x-ray in dorsal decubitus showing abdominal hypertransparency because of pneumoperitoneum. Also, the intestinal loop wall is observed, due to the presence of air both inside and outside the loop.



**Figure 6.** Abdominal plain x-ray film obtained in orthostatic position with horizontal x-ray beam (lifted NN) demonstrating pneumoperitoneum under the diaphragmatic cupula (arrows).



**Figure 7(A,B).** A: Abdominal plain x-ray obtained in dorsal decubitus with horizontal x-ray beam. Free air movement is observed anteriorly within the abdominal cavity. B: Scheme demonstrating the NN positioning to be adopted for study in dorsal decubitus with horizontal beam to demonstrate pneumoperitoneum (reference 16).



**Figure 8(A,B).** **A:** Abdominal x-ray film obtained in left lateral decubitus with horizontal x-ray beams, where pneumoperitoneum is demonstrated between the liver and the right abdominal wall. **B:** Scheme demonstrating the NN positioning to be adopted for study in left lateral decubitus with horizontal beam to demonstrate pneumoperitoneum (reference 16).



**Figure 9.** Opaque enema demonstrating areas of stenosis in the ascending colon.



**Figure 10(A,B).** Anteroposterior (**A**) and lateral (**B**) views of opaque enema demonstrating areas of stenosis in the transverse and sigmoid colon.



**REFERENCES**

1. Kosloske AM, Musemeche A. Necrotizing enterocolitis of the neonate. *Clin Perinatol* 1989;16:97-111.
2. Buonomo C. The radiology of necrotizing enterocolitis. *Radiol Clin North Am* 1999;37:1187-1198.
3. Ostlie DJ, Spilde TL, St Peter SD, et al. Necrotizing enterocolitis in full-term infants. *J Pediatr Surg* 2003;38:1039-1042.
4. Kanto WP Jr, Hunter JE, Stoll BJ. Recognition and medical management of necrotizing enterocolitis. *Clin Perinatol* 1994;21:335-346.
5. Daneman A, Woodward S, da Silva M. The radiology of neonatal necrotizing enterocolitis (NEC). A review of 47 cases and the literature. *Pediatr Radiol* 1978;7:70-77.
6. Morrison SC, Jacobson JM. The radiology of necrotizing enterocolitis. *Clin Perinatol* 1994;21:347-363.
7. Edwards DK. Size of gas-filled bowel loops in infants. *AJR Am J Roentgenol* 1980;135:331-334.
8. Jaile JC, Levin T, Wung JT, Abramson SJ, Ruzal-Shapiro C, Berdon WE. Benign gaseous distention of the bowel in premature infants treated with nasal continuous airway pressure: a study of contributing factors. *AJR Am J Roentgenol* 1992;158:125-127.
9. Wexler H. The persistent loop sign in neonatal necrotizing enterocolitis: a new indication for surgical intervention? *Pediatr Radiol* 1978;126:201-204.
10. Leonard T Jr, Johnson JF, Pettett PG. Critical evaluation of the persistent loop sign in necrotizing enterocolitis. *Radiology* 1982;142:385-386.
11. Swischuk LE. Alimentary tract. In: Swischuk LE, editor. *Imaging of the newborn, infant, and young child*. 5th ed. Philadelphia: Lippincott Williams & Wilkins, 2004;341-589.
12. Heng Y, Schuffler MD, Haggitt RC, Rohmann CA. Pneumatosis intestinalis: a review. *Am J Gastroenterol* 1995;90:1747-1758.
13. Pear BL. Pneumatosis intestinalis: a review. *Radiology* 1998;207:13-19.
14. Molik KA, West KW, Rescorla FJ, Scherer LR, Engum SA, Grosfeld JL. Portal venous air: the poor prognosis persists. *J Pediatr Surg* 2001;36:1143-1145.
15. Briski LE, Von Berg V, Humes JJ. Necrotizing enterocolitis of the newborn. *Ann Clin Lab Sci* 1982;12:186-193.
16. Gyll C. The abdomen. In: Meerstadt PWD, Gyll C, editors. *Manual of neonatal emergency x-ray interpretation*. London: Saunders, 1994;152-237.
17. Virgee JP, Gill JG, Desa D, Somers S, Stevenson GW. Strictures and other late complications of neonatal necrotizing enterocolitis. *Clin Radiol* 1979;30:25-31.
18. Kao SCS, Smith WL, Franken Jr EA, Sato Y, Sullivan JH, McGee JA. Contrast enema diagnosis of necrotizing enterocolitis. *Pediatr Radiol* 1992;22:115-117.