Acute abdominal imaging in the neonate- A pictorial review from The Royal Liverpool Children Hospital, Alder Hey, Liverpool

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Learning objectives

The aim of this pictorial review is to expose radiologists, particularly radiologists in training, to a range of acute abdominal conditions in neonates. For each condition, a brief description of the mode of presentation and the typical characteristics on imaging with various modalities, especially fluoroscopy and ultrasound, are explained.
Background

Current medical practice allows severely preterm infants to survive. As a result the neonatal period, which starts at birth and usually extends to 4 weeks post term, may extend to a number of weeks. During this time acute abdominal symptoms are common.

The clinical radiologist plays a vital role in timely diagnosis and management of all acute neonatal abdominal pathologies and the importance of recognising these cases cannot be emphasised enough.
Hypertrophic pyloric stenosis is an idiopathic thickening of the muscle of the pylorus that results in gastric outlet obstruction. The child is usually male (5:1 ratio) and presents around 6 weeks of age (range between 1 week to 3 months) with non-bilious vomiting. An olive size mass is typically felt on abdominal examination in the right upper quadrant. Ultrasound is the modality of choice to confirm the diagnosis. Typical sonographic features (Fig 1, 2, 3 & 4) are an increased transverse single muscle wall thickness at the pylorus >3mm and a longitudinal measurement (length of pyloric canal) of >15mm. A proximally distended stomach may also be seen. Anecdotally a normal pylorus is more difficult to image than an abnormal pylorus.

This electronic presentation also deals with the common acute causes of intestinal obstruction in neonates. This can be subdivided into high and low obstruction. The high intestinal obstruction involves malrotation or midgut volvulus and other small bowel atresia. The low intestinal obstructions are Hirschsprung disease, meconium plug syndrome, ileal atresia, meconium ileus and anal atresia/anorectal malformations.

Neonates with low intestinal obstruction are usually well on physical exam and typically present with abdominal distension, multiple loops of dilated bowel (Fig 9, 13, 15 & 17) on the abdominal radiograph and failure to pass adequate amount of meconium. Fluoroscopic investigation with a water soluble contrast study is the next step.

Anal atresia or Anorectal malformation:

This is commonly associated with other congenital malformations or may be part of a spectrum of malformations like VACTERAL deformities. Absence of the anus is identifiable on physical examination at birth and urgent defunctioning colostomy is performed before any radiological imaging.

A subsequent contrast study via the colostomy with a anal marker (Fig 5, 6, 7 and 8) will demonstrate the level and degree of anorectal malformation as a tapering blind loop of rectum above the level of anal marker. Also note the late filling of the bladder and antegrade urethral opacification due to an abnormal colovesical communication. The contrast study is used for diagnosis as well as surgical planning of the malformation.

Hirschsprung disease:
This is due to congenital absence of ganglion cells that innervate the colon leading to spasm of the affected segment of colon causing functional obstruction. On a contrast enema (Fig 9, 10, 11 and 12) the control film demonstrates multiple loops of dilated bowel, most prominent in the region of the proximal colon.

The contrast enema films show the affected portion of the recto-sigmoid as irregular with a narrow calibre, with dilatation of the colon proximal to the pathological segment.

Hirschsprung's disease usually involves the rectum and variable length of proximal colon in a continuous fashion with no intervening normal segment of innervations.

Definitive diagnosis is by rectal biopsy.

Ileal atresia:

This is usually congenital.

The abdominal radiograph (or control film of a contrast enema) (Fig 13 & 14) demonstrates multiple loops of dilated bowel with absence of gas in the distal colon and rectum. Abdominal radiograph and clinical assessment may be sufficient for making the diagnosis, but a contrast enema may also be valuable.

The contrast enema will reveal a microcolon due to disuse and distal ileal atresia.

Meconium ileus:

This is due to presence of tenacious meconium within the bowel causing obstruction of the distal ileum and is classically associated with cystic fibrosis. The typical imaging features on contrast enema (Fig 15 and 16) are that The abdominal radiograph or the control film of a contrast study typically shows multiple loops of dilated bowel, with a microcolon and filling defects of meconium in the colon on contrast examination.

In conjunction with the medical and surgical teams serial water soluble enemas, using high osmolar contrast medium, may be used as a non-surgical option for treatment in these patients, but should always be used with caution.

Neonates with high intestinal obstruction (Malrotation/Midgut volvulus) are physically very ill and may have multiple loops of dilated bowel on the abdominal radiograph, secondary to ischemia or infarction.
This is one of only a small number of true emergencies in paediatric surgery, where a delay in diagnosis may be catastrophic and could result in a large length of bowel necrosis.

Malrotation occurs due to incomplete rotation of the midgut about the axis of the superior mesenteric artery. This results in the duodenojejunal flexure being positioned to the right of the midline, resulting in a short small bowel mesentery predisposing to volvulus.

The typical imaging features (Fig 17, 18, 19 and 20) on the control film are seen as dilatation of multiple bowel loops due to ischemia with the subsequent contrast images demonstrating the abnormal position of the DJ flexure to the right of the midline on AP views consistent with malrotation and the 'corkscrew' appearance of the duodenum on the lateral projection consistent with a volvulus. Also note the transverse section on the ultrasound (Fig 21 and 22) which demonstrates the abnormal orientation of the SMV (left of SMA) to the SMA (Normally SMV is on the right side to the SMA).
Fig. 1: Pyloric Stenosis: Longitudinal Section on Ultrasound

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Fig. 2: Pyloric Stenosis: Longitudinal Section on Ultrasound

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Fig. 3: Pyloric Stenosis: Longitudinal Section on Ultrasound

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Fig. 4: Pyloric Stenosis: Transverse Section on Ultrasound

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Fig. 5: Ano-Rectal Malformation Control Image with Anal Marker

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Fig. 6: Ano-Rectal Malformation showing distended blind-ending rectum

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Fig. 7: Ano-Rectal Malformation showing fistulous tract to urinary bladder neck

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**Fig. 8:** Ano-Rectal Malformation showing fistulous tract to urinary bladder and contrast in the urethra

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Fig. 9: Hirschsprung’s Disease - Control Film

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**Fig. 10:** Hirschsprung's Disease: Lateral Projection of Contrast Enema

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Fig. 11: Hirschsprung's Disease: AP Projection Contrast Enema

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Fig. 12: Hirschsprung's Disease: AP Projection

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Fig. 13: Abdomen x-ray showing dilated bowel loops

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Fig. 14: Microcolon with suspected distal ileal atresia on Water Soluble Atresia

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Fig. 15: Abdomen X-Ray showing dilated bowel loops

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Fig. 16: Microcolon and meconium ileus on water soluble enema

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**Fig. 17:** Malrotation: Abdominal X-Ray

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**Fig. 18:** Malrotation: AP Projection Barium Meal

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Fig. 19: Malrotation: AP Projection Barium Meal

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Fig. 20: Malrotation: Lateral Projection Barium Meal

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Fig. 21: Malrotation: SMA and SMV location on Ultrasound

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Fig. 22: Malrotation: SMA and SMV location on Ultrasound

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Conclusion

In many areas the training programmes only allow for a limited amount of paediatric radiology exposure and yet almost all consultant radiologists will be faced with paediatric imaging during their day to day practice.

It is therefore essential that the radiologist is aware of the importance of prompt diagnosis, appropriate imaging and prompt referral in all paediatric pathologies, particularly when dealing with the acute neonatal abdomen where delays in prompt diagnosis may be catastrophic.
References


Gastrointestinal: page no 88 to 97.