PEDiatric RADIology

Marcin Białecki
Department of Radiology and Diagnostic Imaging CM UMK

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- Incomplete fracture
Intracranial bleeding in newborns

- common in premature infants with very low birth weight
- reason of bleeding: changes in perfusion of the delicate cellular structures augmented by the immaturity of the cerebral circulatory system
- not enough blood flow - cell death, breakdown of the blood vessel walls, and then bleeding
- most intraventricular hemorrhages - 72 hours after birth
- diagnosis - ultrasound
Grades of IVH

I - bleeding to the germinal matrix
II - bleeding also to the ventricles, but without enlargement of them
III - enlarged ventricles filled with blood
IV - bleeding to the brain tissue
Oesophageal atresia

- an absence in contiguity of the oesophagus due to an inappropriate division of the primitive foregut into the trachea and oesophagus
- the most common congenital anomaly of the oesophagus
- It is thought to occur in ~ 1:3000-4500 live births
Symptoms

- antenatal ultrasound
- in the neonate - inability to swallow saliva or milk
- aspiration during early feedings
- failure to successfully pass a catheter into the stomach
Classification of atresia

- associated with a tracheo-oesophageal fistula
- proximal atresia with distal fistula – most common
- isolated oesophageal atresia
- isolated fistula (H-type)
- double fistula with intervening atresia
- proximal fistula with distal atresia
Proximal fistula
Distal atresia  ~1%

Double fistula with oesophageal atresia  ~1%
a dilated pharyngeal pouch
the presence of air in the stomach and bowel in the setting of oesophageal atresia - there have to be a distal fistula
insertion attempt of an oesophago-gastric tube shows the tube blind looping and turning back at the upper thoracic part of the oesophagus or heading into the trachea and/or bronchial tree
contrast blindly ending and pooling in an oesophageal stump and/or evidence of the tracheo-oesophageal fistula
Fluoroscopy better to demonstrate H-type fistula
Hirschsprung disease

- aganglionosis (absence of ganglion cells) in the distal colon and rectum
- most common cause of neonatal colonic obstruction.
- 15 - 20% of all intestinal obstructions in the neonate
- 1:5000 - 8000 live births.
- short segment disease - a significant predilection for males
- (M : F of ~ 3 - 4:1), which reduces with increasing length of involvement
How long segment of colon is involved?

4 types according to the length of the aganglionic segment:

- **short segment disease**: ~75%
  - rectal and distal sigmoid colonic involvement only

- **long segment**: ~15%
  - typically extends to splenic flexure / transverse colon

- **total colonic aganglionosis**: 2 - 13%
  - also known as Zuezler - Wilson syndrome
  - occasional extension of aganglionosis into small bowel

- **ultrashort segment disease**
  - 3 - 4 cm of internal anal sphincter only

- hypoganglionosis (reduced number of ganglion cells) is responsible for intestinal pseudo-obstruction
Hirschsprung disease - X ray and fluoroscopy

- bowel obstruction.
- the affected bowel has smaller calibre - proximal colonic distension
- enterocolitis and perforation
- fluoroscopy - contrast enema
- neccersary to diagnose patient and to measure the length of involvement
Anal atresia

- anorectal abnormalities ranging from a membranous separation to complete absence of the anus.
- 1 in 5000 births
- 2 types:
  - high (supralevator)
  - low (infra levator) sub type depending on location of the atretic portion
Anal atresia - Xray/fluoroscopy

- can be variable depending on the site of atresia (e.g. high or low), level of impaction with meconium and physiological effects such as straining
- multiple dilated bowel loops with absence of rectal gas
- Xray of the abdomen with legs up show us the distance between gas in colon and the place where the anus should be
- **Fluoroscopy - contrast study**
- to detect recto-urinary, recto-vaginal or rectoperineal fistula
What kind of pathology do we have here?
Non-accidental injuries (NAI) represent both ethical and legal challenges to treating physicians.

Radiologists are often the first to suspect NAI and a knowledge of these is essential if the opportunity to save a child from future neglect is not to be missed.
In 2001, 903,000 children were victims of maltreatment including:

- neglect - 57%
- physical abuse - 19%
  - cutaneous injury - most common
  - fractures in ~30% (range 11-55%)
- sexual abuse - 10%
- psychological maltreatment - 7%
- medical neglect - 2%
“Suspicious injuries”

- Injury in non-ambulatory/totally dependent child
- Injury and history given are incompatible
- Delay in seeking medical attention
- Multiple fractures with no family history of osteogenesis imperfecta
- Retinal haemorrhage
- Torn frenulum
- History of household fall resulting in fracture
  - Children are falling often, but fractures are uncommon
specific injuries - Xray/CT

- metaphyseal fracture
  - 39-50% of abused infants < 18 months
  - pathognomonic of NAI
- rib fractures
  - especially posterior ribs
  - may have no overlying bruising
  - although anterior rib fractures can occasionally be caused by vigorous CPR, posterior ribs do not occur
  - costochondral junction injuries and/or fractures
- skull fracture: suspicious features include:
  - non parietal skull fracture (a parietal fracture is more suggestive of accidental injury)
  - involves multiple bones
  - cross sutures
  - depressed fracture
- scapula
- sternum
Acute appendicitis

- inflammation of the appendix
- very common condition in general radiology practise
- major cause of abdominal surgery in young patients.
- typically a disease of children and young adults with peak incidence in the 2 to 3 decades of life
periumbilical pain (referred) which within a day or later localizes to McBurney's point

associated with fever, nausea and vomiting

children often present non-specific signs and symptoms

localized pain and tenderness
- RLQ pain over appendix = McBurney sign
- pelvic pain, diarrhoea and tenesmus (pelvic appendix)
- flank pain (retrocaecal appendix)
- groin pain (appendix within an inguinal hernia)

leucocytosis

atypical location: within pelvis (30%), extra-peritoneal (5%)
Acute appendicitis - imaging

- physical examination
- ultrasound
- CT in rare cases (gold standard but invasive)
the technique - graded compression- the linear probe over the site of maximal thickness, with gradual increasing pressure exerted to displace normal overlying bowel gas.

aperistaltic, noncompressible, dilated appendix

( > 6mm outer diameter)

appendicolith

periappendiceal fluid collection

echogenic prominent pericaecal fat
Acute appendicitis - CT

- highly sensitive (94 - 98%) and specific (up to 97%)
- dilated appendix with distended lumen
  ( > 6mm diameter)
- thickened and enhancing wall
- periappendiceal inflammation, including strand ing of the adjacent fat and thickening of the lateral conal fascia or mesoappendix.
- extraluminal fluid
- inflammatory phlegmon
- abscess formation
- appendicolith
newborn bowel obstruction of the distal ileum due to abnormally thick impacted meconium

meconium found in the intestine of a newborn, consisting of succus entericus (bile salts, bile acids, and debris from the intestinal mucosa)

normally evacuated 6 hours after delivery or earlier

meconium ileus occurs when meconium becomes inspissated and obstructs the distal ileum and is usually a manifestation of cystic fibrosis
dilated bowel loops proximal to the impaction

classically, there is a paucity or absence of air-fluid levels and a "bubbly" appearance of the distended intestinal loops on radiographs

Fluoroscopy - Contrast enema

microcolon involving the entire large bowel

impacted meconium pellets particularly in the right colon or in the distal ileum
Necrotising enterocolitis

- most common gastrointestinal condition in premature neonates
- significant mortality and morbidity
- develops 2-3 days following birth, with 90%, low birth weight infants (<1500g) is risk factor
Necrotising enterocolitis - pathology

- idiopathic and multi-factorial.
- a combination of ischaemic and infective aetiology with added contributive factors such as immature immunity.
- inflammation starts from the mucosal surface and progresses to haemorrhagic and coagulative necrosis with the ensuing loss of mucosal integrity, transmural necrosis and perforation.
- the most common location is the terminal ileum
Necrotising enterocolitis - Xray

- dilated bowel loops (often asymmetrical in distribution)
- bowel wall oedema with thumb printing
- pneumatosis intestinalis (intramural gas)
- portal venous gas
- pneumoperitoneum secondary to perforation
  - air on both sides of the bowel (Rigler sign)
  - air outlining the falciform ligament (football sign)
Necrotising enterocolitis - ultrasound

- bowel wall thickening
- alteration of vascular state:
  - hypervascular (viable but engorged in early stage)
  - hypovascular (infarcted in later stage)
- intramural gas manifesting as high echo foci within the bowel wall
- free fluid especially with echogenic debris is suspicious for perforation
one segment of bowel is pulled into itself (or a neighbouring loop of bowel) by peristalsis.

important cause of an acute abdomen in children usually after the first three months of life - passive immunity

in children, no lead point can usually be identified (90%)

enlarged lymphoid tissue following an infection
Intussusception - pathology

- A proximal part of bowel is pulled into the distal lumen.
- The prolapsing part of the bowel is described as the *intussusceptum*.
- The distal segment of bowel receiving the intussusceptum is described as the *intussuscipiens*.
- The mesentery is incorporated into the intussusception, venous return is compromised resulting in oedema and further restriction to blood flow.
- Eventually arterial supply to the bowel is interrupted and ischaemia and necrosis ensues.
Intussusception - symptoms

- abdominal pain, vomiting and right upper quadrant mass, plus occult or gross blood on rectal examination
- approximately 15% (range 13-22%) of patients with intussusception do not present abdominal pain
essentially anywhere, although in children there is a strong predilection for the ileocolic region:

- ileocolic - most common (75-95%), presumably due to the abundance of lymphoid tissue related to the terminal ileum and the anatomy of the ileocaecal region
- ileoileocolic - second most common
- ileoileal and colocolic - uncommon
Intussusception - Xray

- demonstrate an elongated soft tissue mass (typically in the right upper quadrant in children) with a bowel obstruction proximal to it
Intussusception - ultrasound

- pseudokidney sign - the fat containing mesentery which is dragged into the intussusception, containing vessels, is reminiscent of the renal hilum, with the renal parenchyma formed by the oedematous bowel.

- Target sign (also known as the doughnut sign)
- Surgery is not needed in most cases.
- A water soluble medium or air, retrograde pressure can be exerted to reduce the intussusception.
- If symptoms have been protracted, rectal blood is present, there are signs of peritonitis or enema reduction is unsuccessful then surgical intervention is usually required.
- Recurrence rates of up to 30% without surgery.
Pyloric stenosis

- idiopathic thickening of gastric pyloric musculature which then results in progressive gastric outlet obstruction
- relatively common with male predilection (M:F ~ 4:1), more commonly seen in Caucasians
- typically between the 4-8 weeks of life
- may be a positive family history
- HPS is less common in India and among black and Asian populations
Pyloric stenosis

Normal values *

Length: <15mm
Single muscle thickness: <3mm
Pyloric width: <7mm

* values vary somewhat from publication to publication
Pyloric stenosis - symptoms

- non-bilious projectile vomiting in the second month of life
- the hypertrophied pylorus can be palpated as an olive sized mass in the right upper quadrant
Pyloric stenosis - ultrasound

- Hypertrophied muscle is hypoechoic,
- Central mucosa is hyperechoic.
- The pyloric muscle thickness (diameter of a single muscular wall on a transverse image) should normally be less than 3 mm and the length should not exceed 15 mm.
- With the patient right side down, the pylorus should be watched and should not be seen to open.
Testicular torsion

- Testicular torsion - cut off of blood supply
- Common symptom: acute testicular pain
- First obstruction of venous, later arterial flow
- Testicular ischemia depends on the degree of twisting (180°-720°)
- The duration of the torsion
Testicular torsion – differential diagnosis

- epididymorchitis—symptoms are very similar: scrotal pain, swelling, redness or tenderness
- in most situations epididymorchitis is soft
- testicular abscess
- testicular tumours
- torsion of epididymal appendix
- acute idiopathic scrotal oedema
Vesicoureteric reflux

- abnormal flow of urine from the bladder into the upper urinary tract
- typically a problem in young children
Vesicoureteric reflux - symptoms

- Pyelonephritis - entry of bacteria to the sterile upper tract.
- Urinary tract infection in a young child.
- Vesicoureteric reflux may be an isolated abnormality or associated with other congenital anomalies including:
  - Posterior urethral valves
  - Duplex collecting system
**Vesicoureteric reflux - grading**

- **grade 1** - reflux limited to ureter
- **grade 2** - reflux into renal pelvis
- **grade 3** - mild dilatation of ureter and pelvicalyceal system.
- **grade 4** -
  - tortuous ureter with moderate dilatation.
  - blunting of fornicies but preserved papillary impressions.
- **grade 5** -
  - tortuous ureter with severe dilatation of ureter and pelvicalyceal system.
  - loss of fornicies and papillary impressions
Vesicoureteric reflux

normal

reflux limited to ureter

grade 1

reflux into renal pelvis
without pelvicalyceal dilatation

grade 2

mild dilatation of ureter
and pelvicalyceal system

grade 3

blunting of fornices but
preserved papillary impressions
and moderate dilatation of the pelvicalyceal system

tortuous ureter
with moderate dilatation

grade 4

loss of fornices
and papillary impressions
and severe dilatation of the pelvicalyceal system

tortuous ureter
with severe dilatation

grade 5
Wilms tumour (nephroblastoma)

- most common paediatric renal mass
- early childhood (1 - 11 years) with peak between 3 and 4 years of age
- asymptomatic painless upper quadrant abdominal mass.
- haematuria
- pain - uncommon.
Wilms Tumour

- large heterogeneous solid masses, sometimes cystic.
- metastases - lung, liver and local lymph nodes
- tumour thrombus into the renal vein, IVC and right atrium
Wilms Tumour - ultrasound

- Very useful examination - distinguish between a cystic mass and a solid mass.
- Doppler examination the renal vein and IVC - tumour thrombus
Wilms Tumour - treatment

- unilateral Wilms tumour - combination of nephrectomy and chemotherapy
- preoperative chemotherapy - down-stage the tumour
- radiotherapy - limited role - peritoneal spread or incomplete resection
- prognosis - cure 90% of cases
neuroblastoma

- tumour of neuroblastic origin
- most common extracranial solid childhood malignancies
- infants and very young children (≈ 22 months)
Neuroblastoma - symptoms

- pain / palpable mass
- abdominal distension
- Bony metastases - skeletal pain
- paraneoplastic syndrome
- blueberry muffin syndrome: multiple cutaneous lesions
Neuroblastoma ultrasound/CT

- heterogeneous mass with internal vascularity
- areas of necrosis
- calcification
- CT - heterogeneous with
- areas of necrosis
- aggressive tumours direct invasion of the psoas muscle or tumour
- enlarged lymph nodes
Ewing sarcoma

- primary bone tumour of children and adolescents between 10 and 20
- rare in black people
- non-specific symptoms with local pain
- soft tissue mass palpable
- pathological fractures
Ewing sarcoma - location

- lower limb: 45%
  - femur most common
- pelvis: 20%
- upper limb: 13%
- spine and ribs: 13%
  - sacroccocygeal region most common
- skull / face: 2%
Ewing sarcoma – Xray/CT

- large poorly marginated tumours,
- extension into adjacent soft tissues
- laminated (onion skin) periosteal reaction
- sclerosis
- Codman triangles
- spiculated (sunburst) or thick periosteal reaction
- bone expansion or cystic components.
- soft tissue calcification uncommon
Incomplete fracture

- heterogeneous group of fractures that predominantly occur in the long bones of paediatric patients
- the majority of forearm and lower leg fractures occur after indirect injury (e.g. the fall on an outstretched arm or jump from a height) rather than a direct injury (e.g. strike with a bat)
Bowing fractures

- incomplete fractures of tubular long bones in paediatric patients (especially the radius and ulna), often require no intervention and heal with remodelling
Torus fracture

- incomplete fractures of the shaft of a long bone that is characterised by bulging of the cortex
- result from trabecular compression from an axial loading force (along long axis of bone)
- Usually seen in children, frequently involving the distal radial metaphysis
Greenstick fracture

- incomplete fractures of long bones
- usually seen in young children
- commonly mid-diaphyseal, affecting the forearm and lower leg
- distinct from torus fractures
Pathology

- Force applied to a bone results in bending of the bone such that the structural integrity of the convex surface is overcome.
- The integrity of the cortex overcomes that results in fracture of the convex surface.
- Bending force doesn't break the bone completely and the concave surface of the bent bone remains intact.