CASE 180

History
A child presented with vomiting and ataxia.

CASE 181

History
A 2-month-old baby presented with cyanosis.

(see page 322 for case answer)
ANSWER 180

Observations (180a)
A series of axial MRI images of skull show a well defined hyperdense mass in the cerebellar vermis causing compression and anterior displacement of the 4th ventricle with obstructive hydrocephalus. A small amount of oedema surrounds the mass. The features are typical of a medulloblastoma.

Diagnosis
Medulloblastoma.

Differential diagnosis
Of posterior fossa tumour in children:
• Medulloblastoma:
  - Predominantly midline posterior to 4th ventricle.
  - Hyperdense on CT with oedema.
  - Avid enhancement.
  - 20% calcify, 50% necrose.

• Juvenile pilocytic astrocytoma:
  - Typically paracentral, posterior to 4th ventricle.
  - Majority are cystic with an enhancing mural nodule, the remainder are solid.
  - 20% calcify; oedema is rare.

• Ependymoma:
  - Arises within 4th ventricle.
  - Heterogeneous appearance and enhancement.
  - 50% calcify.

  • Hydrocephalus is often communicating type due to protein exudate obstructing CSF resorption.
  • Spreads through the exit foramen of fourth ventricle and wraps around brainstem (‘plastic growth’). Sagittal and axial T2 weighted MR images (180b) demonstrate a high signal lesion arising within the 4th ventricle, wrapping around the brainstem and spreading via the foramina of Luschka and Magendie. Hydrocephalus is present and a syrinx of the upper cervical cord has developed.

• Brainstem glioma:
  - Within pons, possibly causing pontine expansion or 4th ventricle displacement posteriorly.
  - Iso- or hypodense to brain so may be easily missed. Sagittal T1 weighted MRI with contrast (180c) demonstrates a large pontine glioma. Note how the lesion is nonenhancing and almost the same signal as surrounding brain. Smaller such lesions can easily be missed due to such imaging characteristics.
  - Enhancement often absent or minimal.
  - Hydrocephalus uncommon (because present with focal neurology before this occurs).

Discussion
Medulloblastoma is the second most common paediatric brain tumour and the most common in the posterior fossa. It is a type of primitive neuroectodermal tumour (PNET).

180b Sagittal and axial T2 MRI of the brain demonstrating an ependymoma in the 4th ventricle, which extends into the foramina of Luschka and Magendie and causes obstructive hydrocephalus. A syrinx of the upper cervical cord has developed.
arising from the roof of the 4th ventricle. The majority of patients affected are under the age of 15 years, with 80% of lesions arising from the cerebellar vermis, and the rest lying more laterally in the cerebellum. This lateral location is more common in older children. They are typically hyperdense on CT due to dense cellularity, and show avid, homogeneous enhancement. There is usually surrounding oedema, 20% show calcification and up to 50% show necrosis/cystic change. They are highly malignant and spread occurs via the CSF in up to a third. Medulloblastoma is rarely associated with Gorlin’s syndrome – an autosomal dominant disorder characterized by multiple cutaneous basal cell carcinomas during childhood with mandibular keratocysts and extensive intracranial calcification of the falk and tentorium.

At least 50% of primary brain tumours in children occur in the posterior fossa. Brainstem glioma tends to present with focal neurology due to involvement of the long tracts and cranial nerve nuclei, while the other three differential diagnoses listed present by way of mass effect and obstructive hydrocephalus with headache, vomiting and ataxia. The salient imaging features of each are listed. It is important when staging paediatric posterior fossa tumours to remember the potential for CSF spread with medulloblastoma in particular, but sometimes with ependymoma too. Post gadolinium scans should therefore include the whole spine as well as brain to pick up such deposits (‘drop metastases’). A sagittal T1 MRI post-contrast (180d) demonstrates an enhancing medulloblastoma in the posterior fossa causing obstructive hydrocephalus. CSF spread of tumour has occurred with a metastasis in the preoptic cistern.

**Practical tips**

- Make sure the post contrast scan looking for drop metastases is done preoperatively as postoperative haemorrhage and granulation tissue can cause confusion.
- Haemangioblastoma is primarily a tumour of adults but can be seen in adolescents in the posterior fossa when part of von Hippel–Lindau syndrome. It is typically a cystic mass with enhancing mural nodule, so has similarities with pilocytic astrocytoma.

**Further management**

MRI of the spine with intravenous contrast enhancement should be undertaken to look for ‘drop metastases’. Neurosurgical assessment is then clearly appropriate.

**Further reading**


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180c Sagittal T1 weighted MRI post IV contrast that shows a large pontine glioma.

180d Sagittal T1 MRI of the brain with gadolinium showing an enhancing posterior fossa mass, which causes obstructive hydrocephalus. A metastasis is seen in the preoptic cistern. This proved to be a medulloblastoma.
ANSWER 181

Observations (181a)
There is a right sided aortic arch. The heart is boot shaped indicating right ventricular hypertrophy. The lungs are not plethoric, in fact there is a reduction in the calibre of the pulmonary vessels. Overall, the features are suggestive of Fallot’s tetralogy.

Diagnosis
Tetralogy of Fallot.

Differential diagnosis
Of conditions associated with a right sided aortic arch:
• Truncus arteriosus.
• Tetralogy of Fallot.
• Transposition of great vessels.
• Pulmonary atresia.
• Ventricular septal defect (VSD).

Discussion
Tetralogy of Fallot is one of the most common causes of cyanotic congenital heart disease and is composed of the following: obstruction of right ventricular outflow, large VSD, right ventricular hypertrophy and an overriding aorta. Radiological features on CXR are:
• Concavity in the region of the pulmonary artery, which is small.
• Enlarged aorta.

• Normal sized heart.
• Boot shaped heart due to right ventricular hypertrophy.
• Right sided aortic arch in 25% of cases.
• Decreased calibre of pulmonary vessels.

Right sided aortic arch may also be seen in patients with another cause of neonatal cyanotic congenital heart disease – transposition of the great vessels. However unlike Fallot’s there is increased pulmonary vascularity and the heart has an ‘egg on its side’ appearance on the CXR due to the fact that the mediastinum is narrow because of the abnormal relationship of the great vessels. An example is shown (181b), though in this particular case the aortic arch is left sided.

Practical tips
• Fallot’s tetralogy, pulmonary stenosis and tricuspid atresia cause cyanosis with oligaeamic lungs.
• Transposition of the great vessels, truncus arteriosus and total anomalous pulmonary venous drainage cause cyanosis with plethoric lungs.

Further management
Cardiology referral for echocardiography and consideration for a palliative shunt or complete surgical repair.
CASE 182

History
An 11-month-old child with cleft palate and neurological abnormalities.
ANSWER 182

Observations (182)
The posterior fossa is enlarged with absence of the cerebellar vermis, hypoplasia of the cerebellar hemispheres and the presence of a large posterior fossa cyst, which is in continuity with the 4th ventricle. A ventriculoperitoneal shunt is seen in the right lateral ventricle. There is ventriculomegaly but the sulci are not effaced. The features are consistent with Dandy-Walker malformation.

Diagnosis
Dandy-Walker malformation.

Discussion
The Dandy-Walker malformation is a congenital malformation whereby the posterior fossa is enlarged and the tentorium cerebelli is elevated, however the cerebellar hemispheres are hypoplastic. Absence or hypoplasia of the cerebellar vermis is present with a posterior fossa cyst directly connected to the 4th ventricle. Ventriculomegaly and dysgenesis of the corpus callosum are associated findings. Most affected patients die in infancy. The less severe form, Dandy-Walker variant, is more common and is not associated with enlargement of the posterior fossa. The associated posterior fossa cyst is smaller and the cerebellar vermis is hypoplastic rather than absent.

There are numerous associated CNS anomalies, for example corpus callosum dysgenesis, holoprosencephaly, gyral dysplasia, grey matter migration anomalies and encephalocele. Associated anomalies outside the CNS include cleft palate, polydactyly and cardiac defects.

Practical tips
- A mega cisterna magna may mimic Dandy-Walker malformation, however there is no cerebellar vermis abnormality, continuity with or abnormality of the 4th ventricle.
- A posterior fossa arachnoid cyst may also mimic these appearances.
- If the posterior fossa is not enlarged and the cerebellar vermis is hypoplastic rather than absent, consider Dandy-Walker variant rather than malformation.

Further management
The associated CNS abnormalities can be better identified on MRI. Treatment often involves insertion of a ventricular shunt, as in this case, to relieve hydrocephalus. Genetic counselling may be appropriate for the family.

182 Absence of cerebellar vermis (left); sulci are not effaced (bottom left); ventriculomegaly (right); hypoplasia of cerebellar hemispheres (top right).
CASE 183

History
A newborn presented with bilious vomiting.
ANSWER 183

Observations (183)
Dextrocardia is present with situs solitus. A right femoral line is noted. An NG tube is present in the stomach, which is dilated with air. There is a ‘double bubble’ appearance of the dilated stomach and duodenal cap with no gas seen distally. The findings are consistent with duodenal atresia.

Diagnosis
Duodenal atresia, possibly part of VACTERL syndrome.

Differential diagnosis
Of ‘double bubble’ on abdominal radiograph:
- Annular pancreas.
- Duodenal diaphragm.
- Peritoneal band.
- Choledochal cyst.

Discussion
Duodenal atresia is due to failure of recanalization of the duodenum at around 10 weeks and is the most common cause of congenital duodenal obstruction. The other major cause is annular pancreas, and both are associated with Down’s syndrome. The obstruction is just beyond the ampulla in the majority of cases and the ‘double bubble’ results from gas-fluid levels in the first part of duodenum and stomach. Gas may be seen more distally in the bowel if there is duodenal stenosis rather than complete atresia (though atresia is twice as common).

Duodenal atresia is associated with the VACTERL syndrome, a non-random association of congenital abnormalities affecting multiple systems, summarized by the mnemonic ‘VACTERL’. Three or more of the associated defects are required to make the diagnosis. The mnemonic is as follows:
- Vertebral anomalies.
- Anorectal anomalies – imperforate anus.
- Cardiovascular anomalies – most commonly endocardial cushion defects.
- Tracheo-Esophageal fistula.
- Renal anomalies – may be associated with a single umbilical artery.
- Limb anomalies – e.g. radial dysplasia, polydactyly, syndactyly.

The characteristic cardiac abnormality is a septal defect but dextrocardia, as in this case, has been described.

Practical tips
Always check the ‘double bubble’ radiograph for VACTERL associations, e.g. vertebral anomalies on the film.

Further management
Fluid and electrolyte imbalance must be corrected along with decompression of the stomach via NG tube insertion. Surgical correction is then required, usually with good outcome.
CASE 184

History
A child with dwarfism.
**ANSWER 184**

**Observations (184a)**
Lateral spinal radiograph shows vertebral bodies are flattened with central beaking anteriorly. There is also widening of the intervertebral disc spaces and posterior vertebral scalloping. The findings are suggestive of Morquio's syndrome.

**Diagnosis**
Morquio's syndrome.

**Differential diagnosis**
- Hurler's syndrome.
- Achondroplasia.

**Discussion**
Morquio's syndrome is a rare metabolic disorder classified as one of the mucopolysaccharidoses. It is autosomal recessive and presents in childhood with characteristic skeletal deformity and dwarfism. Patients also have deafness and cardiac dysfunction, however they may well live to adulthood. Atlantoaxial subluxation is a feature and there may be absence of the odontoid peg. Radiograph of the cervical spine in the same patient (184b) shows multiple flattened vertebral bodies and absence of the peg.

Hurler's syndrome (another of the mucopolysaccharidoses) and achondroplasia can have similar radiological features; in particular, both may cause posterior vertebral body scalloping and anterior vertebral body beaking.

The radiological features of Morquio's syndrome are described below:
- Spine:
  - Posterior vertebral scalloping.
  - Widening of intervertebral disc spaces.
  - Congenital flattening of the vertebral bodies (platyspondyly).
  - Anterior beaking of vertebral bodies.
  - Atlantoaxial subluxation.
  - Kyphoscoliosis.
- Pelvis:
  - Fragmentation and flattening of femoral heads (184c).
  - Flared iliac wings (184c).

![184b Lateral cervical spine demonstrating absence of the peg with flattening and posterior scalloping of the vertebral bodies.](image1)

![184c AP radiograph of pelvis showing fragmentation and flattening of the femoral heads with flaring of the iliac wings.](image2)
• Lower limbs:
  • Sloping of superior margin of tibial plateau laterally (184d).
  • Genu valgus deformity (184d).

• Hands and feet:
  • Proximal tapering of the metacarpal bones producing 'bullet-shaped' metacarpals (184e).
  • Short widened tubular bones with metaphyseal irregularity (184e).

Practical tips
It may be very difficult on imaging to differentiate Morquio's from achondroplasia or the other mucopolysaccharidoses. Some features may help radiological differentiation:
• Caudal narrowing of the spinal canal is not a feature of the mucopolysaccharidoses however it is present in achondroplasia; therefore assess the interpedicular distance on the AP of the spine.
• The anterior vertebral body beaks in Morquio's tend to be in the Middle of the vertebral body whereas in Achondroplasia and Hurler's syndrome they are Anterior inferior.

• If the spine radiograph includes the craniocervical junction always assess the peg as this may be absent in Morquio's and there may be atlantoaxial subluxation.
• On a pelvic radiograph flaring of the iliac wings will be seen in achondroplasia and the mucopolysaccharidoses, however in achondroplasia the sacrum may be horizontal in orientation therefore appearing absent (see Case 151).

Further management
Mortality/morbidity are related to atlantoaxial instability due to odontoid peg hyperplasia. In addition, respiratory complications are common due to chest wall deformity.

Further reading
The breast can be evaluated with a number of different imaging modalities: the main ones utilized in diagnosis are mammography, ultrasound and MR imaging. Image-guided biopsies from specific areas in the breast can be obtained using any of these techniques to aid diagnosis and treatment of breast diseases/conditions.

With the development of more complex surgical procedures and oncological treatments, many breast cancer cases are often assessed by multiple imaging modalities including mammography, ultrasound, CT, MRI and nuclear medicine, incorporating PET/CT. This chapter focuses on a few salient breast imaging cases – complex multimodality staging is not discussed.

**MAMMOGRAPHY**

Until recently, most mammographic images were obtained as hard film copy. Today, many breast imaging departments have full-field digital mammography (FFDM) equipment enabling electronic storage and image manipulation to aid interpretation. In standard mammography two views of each breast are taken: the mediolateral oblique (MLO) projection and the craniocaudal (CC) or superioinferior (SI) projection. Particular care is taken with image acquisition in mammography – inadequate positioning may result in suboptimal images and missed diagnoses. During image acquisition the breast is compressed to even out the tissue thickness and hold the breast still in order to minimize blurring of the image caused by motion.

When viewing bilateral mammograms, both sides are assessed at the same time in a ‘back-to-back’ or ‘mirror image’ format, as shown opposite. By convention, the CC views are arranged with the lateral (outer) aspect at the top of the image and the medial (inner) at the bottom of the image. On the MLO view the inferior extent of the pectoral muscle should be at least at nipple level. Small densities and areas of asymmetry may be more apparent when viewing both sides simultaneously. In addition to a global overview, specific inspection of all areas is required. The examination may be evaluated by dividing each image into thirds and going back and forth between the right and left sides looking specifically for global and focal asymmetry, distortion, possible masses and calcification. Other signs to assess for are skin and nipple retraction, skin thickening, trabecular thickening and axillary lymphadenopathy. Small masses and areas of microcalcification should be looked at under magnification, using workstation tools with digital images or a magnifying glass with conventional analogue films. Previous mammograms may aid interpretation and assessing the significance of focal findings.

As in other aspects of imaging with ionizing radiation, there is always a slight chance of cancer from excessive exposure to radiation. However, the benefit of an accurate diagnosis far outweighs the risk. The effective radiation dose from a mammogram is about 0.7 mSv; about the same as the average person receives from background radiation in 3 months.

The proportion of glandular tissue to fatty tissue within the breast changes with age – there is more glandular tissue in younger women and as a result the background density on mammograms is generally dense. The glandular tissue tends to involute with age; the background density of mammograms in older women is generally lucent.

Mammography plays a central part in the early detection of breast cancers. Screening mammograms lead to early detection of cancers, when they are most curable and breast-conservation therapies suitable management options. In the UK, the NHS Breast Screening Programme saves over 1,400 lives per year. Currently, women in the UK are invited every 3 years for bilateral two-view mammography between the ages of 50 and 70 years. The screening
Breast Imaging

Programme in the UK is due to be extended to include women between ages 47 and 73.

Diagnostic mammography is used to evaluate a patient with abnormal clinical findings and may also be done after an abnormal screening mammography in order to evaluate the area of concern on the screening examination. Initial mammographic images themselves are not usually enough to determine the existence of a benign or malignant disease with certainty. And while mammography is the best screening tool for breast cancer available today, mammograms do not detect all breast cancers. Also, a small proportion of mammograms indicate that a cancer could possibly be present when it is not (a false-positive result). Between 5 and 15% of screening mammograms are equivocal and further evaluation with additional mammograms or ultrasound may be required. In addition to standard views, spot compression views may merge out background tissue from a lesion and magnification views to further assess calcification may be undertaken. Most of these tests turn out to be normal. If there is an abnormal finding, a follow-up or biopsy may have to be performed. Most of these biopsies result in a benign diagnosis.

**Breast Ultrasound**

Breast ultrasound is used to characterize abnormalities detected by physical examination or potential abnormalities seen on mammography. Ultrasound imaging can help to determine if an abnormality is solid (which may be a malignancy, a benign tumour such as a fibroadenoma or other nonmalignant tissue) or fluid-filled (such as a benign cyst). As ultrasound provides real-time images, it is often used to guide biopsy procedures.

**Breast MR Imaging**

MR imaging of the breast is not usually a replacement for mammography or ultrasound imaging but rather a supplemental tool for detecting and staging breast cancer and other breast abnormalities. MR imaging of the breast may be performed to:

- Identify early breast cancer not detected through other means, especially in women with dense breast tissue and those at high risk for the disease.
- Evaluate abnormalities detected by mammography or ultrasound in equivocal cases.
- Assess multiple tumour locations, especially prior to breast conservation surgery.
- Assess the effect of chemotherapy.
- Determine the integrity of breast implants.

Dynamic contrast enhanced MRI to evaluate the breast parenchyma for cancer has a high sensitivity (~90%), with a lower variable specificity (40–80%) – a relatively high number of false-positive results can be generated. Close attention to scanning technique, full standard breast imaging workup and integration of all breast imaging findings during scan interpretation increases diagnostic yield.

**Computer-Aided Detection**

Computer-aided detection (CAD) uses pattern recognition software to help read medical images. Such techniques bring features on medical images to the attention of the film reader and may decrease false-negative readings when films are single read. The use of CAD has been evaluated in both mammography and breast MRI, but has not been used widely in the UK, where screening mammograms are interpreted by two human readers.

**Image Guided Intervention**

Lumps or abnormalities in the breast are often detected by physical examination, or by mammography or other imaging studies. However, it is not always possible to tell from these imaging tests whether a growth is benign or cancerous. Usually the preferred modality for intervention is ultrasound, from both the operator's perspective and that of the patient's (breast compression is not required as is the case with a mammographic stereotatic biopsy or MRI biopsy).

Image guidance may be used in four biopsy procedures:

- **Fine needle aspiration (FNA):** rarely used in isolation when evaluating breast lesions; it may be the method of choice when sampling axillary nodes.
- **Core biopsy:** uses a hollow needle, usually 14G, to remove one sample of breast tissue per insertion. This process is usually repeated three to six times.
- **Vacuum assisted device (VAD):** where vacuum pressure is used to pull tissue from the breast through the needle, often 11G, into the sampling chamber. The device rotates positions and collects a greater volume of tissue than standard core biopsy. Small benign lesions such as fibroadenoma may be excised by this method. The diagnostic yield from sampling calcification is usually greater using this technique than standard core biopsy. A small marker coil may be placed at the site so that it can be located in the future if necessary.
- **Wire localization:** in which a guide wire is placed into a nonpalpable lesion/suspicious area or at the site of a marker coil to enable surgical excision biopsy. This may be undertaken when the diagnosis remains uncertain after a breast biopsy procedure.

**Evaluation of Ipsilateral Axilla**

Once a breast cancer is suspected or confirmed, the ipsilateral axilla may be staged clinically or with ultrasound: the area between the axillary vein, latissimus dorsi muscle and medial border of the pectoralis minor muscle is carefully inspected. Any nodes of suspicious configuration (signs include loss of uniform reniform shape, loss of echogenic fatty hilum and eccentric cortical thickening) should undergo FNA or core biopsy to assess for metastatic spread. If the axillary FNA or core biopsy histology is negative in proven cases of breast malignancy then combined anline blue dye and scintigraphic sentinel node surgical biopsy is usually performed.

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CASE 185

History
Screening mammograms in a 61-year-old woman.
ANSWER 185

Observations (185)
There is a semi-spiculate microlobulated dense mass in the upper inner quadrant of the right breast. The remainder of the right breast is normal. The left breast is normal. The suspicious mass in the upper inner right breast likely represents a unifocal carcinoma.

Diagnosis
Breast carcinoma (invasive ductal carcinoma; IDC).

Differential diagnosis
For stellate lesion:
- Malignancy.
- Post-surgical scar (ask about a history of previous surgery).
- Fat necrosis (often post-trauma or surgery).
- Radial scar (a lesion with central scar formation and radiating hyperplastic ducts).

Discussion
The most common mammographic sign of an invasive breast cancer is a mass: a space-occupying lesion that is seen in at least two mammographic projections. The typical features on mammography of a mass due to an invasive cancer are irregular shape, ill-defined or spiculate margins and high radiographic density. In about 40% of cases the mass is associated with calcification of malignant configuration – pleomorphic and irregular.

Mammographic ill-defined masses require further evaluation. Ultrasound will often demonstrate a hypoechoic irregular mass with ill-defined borders. Image guided core biopsy should be performed – if not possible with ultrasound then under mammography guided stereotaxis.

In such cases, ultrasound of the ipsilateral axilla should be performed and any nodes of suspicious configuration should undergo fine needle aspiration (FNA) or core biopsy to assess for metastatic spread (see introduction to this chapter).

Invasive ductal carcinoma is the most common indistinctly margined carcinoma. IDC may be divided into various specific subtypes: the majority of ductal malignancies fall into the generalized category of lesions that are undifferentiated and have no particular distinguishing histological features; these are termed not otherwise specified (NOS) and account for 65% of invasive breast cancers.

Practical tips
- Look closely for associated microcalcification in the lesion.
- Avoid saturation of survey: once one lesion/abnormality is identified, continue searching for multifocal (other lesions in the same quadrant, same duct system or within 4 cm of the affected breast), multicentric (other lesions in a different quadrant, different duct system or separated by >4 cm in the affected breast) or contralateral disease.
- Look in the axilla for nodes – malignant involvement cannot be diagnosed, but the presence of large nodes should be commented upon and the suggestion of ultrasound guided sampling made.

Further management
Recall for clinical examination, ultrasound +/- further mammographic views with the intention to proceed to image guided core biopsy.
CASE 186

History
A 56-year-old woman with a firm mass in the central left breast.
Bilateral mammograms show that in the upper central and lateral aspects of the left breast there is extensive pleomorphic microcalcification. Within the left axilla there is a 21 mm diameter rounded node. The right breast appears normal. Ultrasound of the superior central left breast demonstrates an irregular solid mass.

The extensive microcalcification is of a configuration suspicious for malignancy in the central left breast. There is possible metastatic spread to the large axillary node. The ultrasound demonstrates a probable malignancy. Further investigation with urgent biopsy of the lesion is required.

**Diagnosis**
Ductal carcinoma in situ (DCIS) with involved axillary nodes.

**Differential diagnosis**
For pleomorphic calcification on mammograms:
- DCIS.
- Atypical ductal hyperplasia.
- Fat necrosis.
- Fibrocystic change.

For enlarged axillary nodes:
- Ipsilateral breast malignancy.
- Infection/inflammation of ipsilateral breast or arm.
- Collagen vascular disease/rheumatoid arthritis.
- Lymphoproliferative diseases: lymphoma and leukaemia.
- Metastases (melanoma, lung, contralateral breast).
- HIV adenopathy.

**Discussion**
Pleomorphic microcalcification may be defined as irregular calcifications of varying sizes and shapes, usually <0.5 mm in size. Orthogonal mammographic views may clarify the characteristics — for instance, linear and segmental distributions suggest that the calcification is ductal in origin, whereas regional or diffuse multiple bilateral groups are less likely to represent a ductal process.

A small percentage of malignant lesions arise from the stromal elements of the breast. Ninety per cent of breast cancers have cellular features that are similar to ductal epithelium and are consequently classified as ductal cancers. When confined to the duct they are termed ductal carcinoma in situ (DCIS). When the cells have breached the basement membrane around the duct and invaded the surrounding tissues, they are termed invasive ductal carcinoma (IDC).

The diagnosis of DCIS is associated with the possibility of associated invasive disease. If no invasive focus is identified on mammography further assessment with ultrasound and possibly MR imaging with a view to potentially finding an invasive component may be performed.

**Practical tips**
- Not infrequently, microcalcification is of equivocal configuration — if there is doubt there is a low threshold to proceed to biopsy.

**Further management**
Further imaging assessment is suggested: mammographic magnification orthogonal views (typically craniocaudal and mediolateral) may evaluate morphology and distribution of the microcalcification. Ultrasound guided biopsy of the solid lesion and mammographic stereotactic biopsies to obtain a sample containing calcification should be performed. The suspicious node should be sampled under ultrasound guidance. In this case, the biopsies showed: ultrasound solid lesion — invasive carcinoma; stereotactic cores — DCIS; axillary node — malignant cells.

Once a diagnosis of malignancy has been established, surgical referral is required. In this case the patient underwent a mastectomy and axillary lymph node clearance. Histological findings were of a 12 mm IDC in the superior central breast with extensive (7 cm) intermediate grade DCIS; 4 out of 15 axillary nodes were involved with tumour.
CASE 187

History
A 33-year-old woman with a soft mobile smooth left breast lump.

CASE 188

History
A 64-year-old woman with a swollen erythematous right breast.
ANSWER 187

Observations (187a, 187b)
The breasts are heterogeneously dense. There are semi-ovoid low-density opacities in both breasts. There is a large dominant lesion in the upper outer left breast.

Ultrasound of the left breast lump demonstrates a well defined smooth margined anechoic mass with through transmission. The appearance of the lesion assessed ultrasound is in keeping with a benign simple cyst.

Diagnosis
Benign simple cysts.

Differential diagnosis
Of a smooth low-density lesion on mammography:
- Simple cyst.
- Oil cyst.
- Fibroadenoma.
- ~1.5% of circumscribed round lesions may be malignancies.

Of an echoic lesion on ultrasound:
- Simple cyst.
- Complicated (proteinaceous) cyst.
- Duct ectasia.
- Intraductal/intracystic papilloma – look carefully on ultrasound for a mural lesion.

Discussion
Cysts are asymptomatic in many women. Presentation is variable. A palpable mass or masses may develop rapidly and is/are associated with tenderness. They develop perimenopausally in many women, but can be found in women of all ages. Cysts may develop after commencing oestrogen (hormone) replacement therapy.

On mammography, cysts appear as semi-ovoid masses with variable margins and density. There may be a peripheral halo and/or rim egg shell calcification. On ultrasound, cysts usually appear as well defined, anechoic masses with posterior acoustic enhancement. In some, high specular echoes shift in position as gain is increased ('gurgling' cysts). Posterior enhancement is not always demonstrable, particularly if the cyst is small or close to the chest wall. If there is any question as to the cystic nature of a lesion, aspiration is recommended. On occasion lesions appear cystic on ultrasound, but aspiration is unsuccessful – thick proteinaceous fluid may be too gelatinous to be aspirated.

Practical tips
- Avoid satisfaction of survey: look for other, more suspicious lesions.
- Cysts often recur after aspiration.
- If the lesion is clearly a simple cyst, aspiration is not required unless the symptoms of the mass are distressing.
- If there is any doubt as to the nature of the cystic lesion, core biopsy is suggested.

Further management
If there is any doubt about the mammographic appearances, further evaluation with ultrasound should be undertaken.

ANSWER 188

Observations (188)
There is diffuse trabecular prominence throughout the right breast which is of generalized increased density. The skin is thickened. There are enlarged nodes in the right axilla. The left breast is normal.

Diagnosis
Probable inflammatory right breast cancer with axillary nodal involvement.

Differential diagnosis
For diffuse trabecular/skin thickening:
- Post radiotherapy change.
- Progressive systemic sclerosis.
- Obstruction of the superior vena cava.
- Lymphoma.
- Infection/inflammatory mastitis – most common in lactating women.
- Trauma.
- Generalized oedema due to causes such as congestive heart failure or nephritic syndrome.

Discussion
Ultrasound or MR imaging may be used to find a discrete invasive focus which could be biopsied. The diagnosis could also be obtained from skin punch biopsy or from image guided core biopsy of an axillary node.

Inflammatory breast cancer may be defined by clinical diagnosis dependent on findings of oedema, erythema and 'peau d’orange' or on histological findings of metastatic breast cancer in dermal lymphatics. The definition is debatable: not all women with clinical findings suggestive of inflammatory breast cancer have involved dermal lymphatics and not all patients with tumour cells in the dermal lymphatics present with signs of inflammation. Inflammatory malignancies account for 1% of all breast cancers and up to 40% of locally advanced breast cancers.

The differentiation between mastitis and inflammatory carcinoma may be difficult.

Practical tips
- Patients often undergo neoadjuvant chemotherapy prior to mastectomy.
- Consider inflammatory breast cancer when an inflamed breast fails to respond to a brief course of antibiotics.
CASE 189

History
A 42-year-old man with a soft mobile tender left breast lump.

CASE 190

History
Screening mammograms in a 57-year-old woman.
ANSWER 189

Observations (189)
In the left breast there is a fan shaped density emanating from the nipple which gradually blends into surrounding fatty tissue. The right breast appears normal.

Diagnosis
Gynaecomastia.

Differential diagnosis
Of a breast lump in a male:
- Gynaecomastia.
- Male breast cancer (circumscribed or spiculate mass usually evident; often eccentric to the nipple).
- Pseudogynaecomastia (fatty enlargement with no ductal or stromal proliferation; secondary to obesity).
- Diabetic mastopathy (firm mass in patient with longstanding type 1 diabetes mellitus).
- Abscess (erythema; acute history).

Discussion
Gynaecomastia usually appears as a fan shaped density emanating from the nipple, gradually blending into surrounding fat. Three mammographic patterns of gynaecomastia have been described: nodular, dendritic and diffuse. There may be prominent extensions into the surrounding fat and, in some cases, an appearance similar to that of a heterogeneously dense female breast. Although there are characteristic mammographic features that allow breast cancer in men to be recognized (round/spiculate subareolar mass typically eccentric to the nipple), there is substantial overlap between these features and the mammographic appearance of benign lesions. Male breast cancer is rare, accounting for <1% of all male cancers.

Further management
On the diagnosis of gynaecomastia it is important to correlate the imaging findings with the clinical history.

Many cases of gynaecomastia are idiopathic but underlying causes should be investigated - serum hormone levels should be taken. Ask for a drug history and the presence of signs of chronic renal insufficiency, cirrhosis and a testicular mass; other imaging investigations pertaining to the patient may raise one of these possibilities.

ANSWER 190

Observations (190)
In the anterior aspects of both breasts there are smooth well defined spherical calcifications with lucent centres. No abnormal masses or distortion are seen.

Diagnosis
Bilateral calcification of benign configuration.

Differential diagnosis
For benign calcification:
- Vascular - usually secondary to medial atherosclerosis. May be associated with diabetes and hyperparathyroidism. Often demonstrates a characteristic 'train track' configuration.
- Fat necrosis - peripheral calcification in a lucent mass; history of trauma or surgery.
- Fibroadenoma involution - 'popcorn-like' calcifications usually beginning at the periphery and then involving the central portion.
- 'Milk of calcium' - a benign process that can be diagnosed with magnification views of orthogonal projections: on the CC view, calcifications appear poorly defined and smudgy; when imaged on the MLO view, the calcifications are seen as sharply defined and crescent shaped or linear.
- Plasma cell mastitis and duct ectasia - large rod-like calcifications oriented along the axes of the ductal system. These calcifications tend to be coarser and larger (usually >1 mm in diameter) than malignant calcifications.
- Skin or dermal - usually spherical and lucent-centre calcifications at the periphery of the breast.
- Suture - usually seen at a known surgical site. The calcifications may be linear or tubular.

Discussion
Calcification is a frequent finding on mammograms. The arrangement of calcification aids categorization as to whether it is benign or malignant. Clustered (occupying a volume <1 µl of tissue), linear and segmental calcification may be secondary to benign or malignant processes. Regionally and diffusely distributed calcifications are most likely due to benign processes. These calcifications are scattered in a large volume of the breast and do not necessarily conform to a ductal distribution.

Practical tips
If calcification is of equivocal configuration, there is a low threshold to proceed to biopsy.

Further management
No intervention required. Routine recall for screening.
CASE 191

History
A 44-year-old woman with fullness in the medial left breast on clinical examination. There is no discrete mass.
ANSWER 191

Observations [191a, 191b, 191c]
Bilateral mammograms show fibroglandular densities scattered in both breasts. There is general increased density in the medial left breast. The right breast appears normal.

Ultrasound of the upper inner left breast (191b) shows ill-defined architectural distortion with indistinct margins and posterior shadowing. Appearances are suspicious of an invasive malignancy and further imaging with breast MR imaging is suggested to assess extent of disease.

The single axial view of a T1 fat saturation gadolinium enhanced scan (191c) demonstrates extensive ill-defined microlobulated inhomogeneous enhancement within the upper inner/central left breast, which would be consistent with an invasive carcinoma.

Diagnosis
Invasive lobular carcinoma (ILC).

Differential diagnosis
For mammographic asymmetry:
- Normal variant – dominant glandular tissue (stable compared to previous mammograms, usually nonpalpable).
- Summation artefact – due to superimposed normal structures (thins on spot compression mammograms; ultrasound normal).
- Hormone influences – between 20% and 40% of women commenced on hormone replacement therapy (HRT) develop increased density which may be focal or generalized.
- Malignancy (invasive ductal carcinoma [IDC], invasive lobular carcinoma [ILC], ductal carcinoma in situ [DCIS]) – this must be considered when there is asymmetrical density that is newly developed when compared to previous mammograms, and that persists on spot compression mammograms; and/or when encountering a hypoechoic mass on ultrasound.

Discussion
Invasive lobular carcinoma accounts for 8–12% of invasive breast malignancies.

ILC most commonly presents as a spiculate mass on mammography, but not infrequently may manifest as isolated architectural distortion or focal asymmetry. Asymmetrical density refers to a relative increase in the volume of density as compared with the corresponding area in the other breast. Such asymmetry usually represents a normal variation in distribution of fibroglandular tissue. Occasionally, asymmetrical density is a sign of breast cancer. ILC may be difficult to detect mammographically due to the insidious growth pattern. Ultrasound may help depict mammographically subtle or occult ILC, but often underestimates the size of the lesion and multifocality/multicentricity – many centres now stage the breast with MRI prior to making a decision on the type of surgical management (breast conserving technique or mastectomy).

Practical tips
Check thoroughly for multcentric and contralateral malignancies, which are of a high proportion in ILC.

Further management
Please refer to the introductory section in this chapter for indications for breast MRI.
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