Biopsy, endoscopy and body imaging

In the fifth article in our series on clinical testing, **Pam Mason** describes some of the diagnostic procedures patients could talk to pharmacists about

This article looks at some of the diagnostic procedures performed in hospitals and clinics. Pharmacists need a basic knowledge of these in order to discuss issues with patients and other health care professionals. Moreover, some of these procedures involve the administration of radiopharmaceuticals, contrast media and other drugs.

Biopsy

Biopsies, the removal and examination of tissue or fluid from the body, can be performed to diagnose disease or to check tissue matching for transplants. One of the most commonly encountered biopsies in primary care is the cervical smear or pap test. The purpose of a smear test is to detect cells that are precancerous or cancerous. In the UK it is currently recommended that women between the ages of 25 and 64 years have a smear test every three or five years, depending on age.

Percutaneous biopsies, in which a syringe is used to extract tissue ("core needle biopsy") or cells and fluid ("fine needle aspiration"), are usually done in hospital. Examples include taking bone marrow (eg, to diagnose Hodgkin's disease), liver tissue (eg, to diagnose hepatitis) or cells from a cyst or tumour. In suspected cases of encephalitis, meningitis or malignancies of the central nervous system, lumbar puncture can be performed. A spinal needle is passed into an intervertebral space (generally between the fourth and fifth lumbar vertebrae) and cerebrospinal fluid collected for cell counts, analysis of proteins and microbiological culture.

These procedures are usually done under a local anaesthetic, such as 2 per cent lidocaine, and body imaging techniques can be used to guide the needle to the sample site. If the tissue of interest cannot be easily or safely reached with a needle, a surgical or "open" biopsy will be performed under general anaesthetic (eg, dilatation and curettage to obtain endometrial tissue). However, increasingly, surgical biopsies are being replaced with endoscopic biopsies. These allow the sample to be removed through a much smaller surgical incision or a natural body orifice. For example, a laparoscope can be used to direct a biopsy of abdominal organs.

Once a sample is obtained, it can be examined microscopically. Tissue is soaked in molten paraffin wax and allowed to harden. Thin slices are then cut and mounted onto slides. Alternatively, smears are prepared by spreading fluid and cells onto slides, then fixing (preserving) and staining them.

Tissue samples can also be cultured. For example, if a tuberculous pleural effusion is suspected, pleural fluid is withdrawn (a needle is passed between the ribs, into the pleural space) and sent for bacterial culture.

Apart from bleeding, biopsies can cause bruising and present a small risk of infection. After some biopsies (eg, kidney biopsy), patients may be advised to avoid strenuous exercise or heavy lifting.

Endoscopy

An endoscope basically consists of a camera mounted onto a fibre-optic tube (which can be flexible or rigid) and a light source. Endoscopy is used to inspect the surface of organs visually for tumours or lesions (particularly hollow organs such as the stomach or lungs) or to direct a biopsy. The endoscope can be inserted through a natural body opening or through a surgical incision. Many types of endoscopic procedure exist and some examples are given in Panel 1 (p574).

Body imaging

Body imaging can be performed using x-rays, radio waves or sound waves.

X-rays X-rays are a form of electromagnetic radiation that pass through tissue to produce images on photographic plates. Exposing a patient to x-ray radiation is the key to many body imaging techniques, known collectively as radiography. Most of these techniques are non-invasive, although contrast media can be administered intravenously. Depending on the body part of interest, the patient could be asked to fast for four to six hours before a body imaging procedure.

Simple x-rays In a simple radiograph ("x-ray"), the radiation passing through a patient is collected on photographic film or a digital imaging plate. Where the x-ray particles are blocked (eg, by dense structures, such as bone), white regions appear on the image. Muscles, fat and fluid appear grey and structures containing air appear black. X-ray films can be used to detect, for example, a shadow in the lung or fractures. However, these images can be difficult to interpret because three dimensional structures are presented as flat images.

Fluoroscopy In fluoroscopy, x-rays are directed onto a fluorescent plate, which is usually linked to a television camera. This allows the radiographer to watch live images on a monitor. Fluoroscopy can be used to view procedures, such as needle biopsy and nasogastric tube advancement.

Computed tomography Computed tomography (CT or CAT) is a radiographic technique that uses a special scanner to rotate x-rays around the patient, who lies on a narrow table that slides into the scanner. The x-rays passing through the patient are measured and the data are used to produce detailed cross-sectional images of the body or individual organs. The system is sensitive to differences in tissue density so it produces planar and two- or three-dimensional images. These images can be viewed on a monitor or printed on film.

As the scanning takes place, the table is moved slowly through the scanner. It is important that the patient lies still so that the images are not blurred. Complete scans usually only take a few minutes, but the latest multidetector scanners can image the entire body in under 30 seconds. CT scans are used to investigate aneurysms, brain damage, abscesses, tumours and internal injuries (eg, torn kidney). They can also be used to guide biopsies and the placement of drainage tubes and to stage tumours.

Contrast media are sometimes administered (orally, rectally or by injection) immediately, or a few hours before the CT scan, to aid the visualisation of difficult-to-see structures (see Panel 2, p575).

Mammography A mammogram is a type of x-ray used to examine the breasts. Each breast is compressed, in turn, between two perspex plates and images are taken using an x-ray pulse. Some women find the experience painful but, for most, there is no more than minor discomfort. This procedure is used to

Identify knowledge gaps

1. What does a CT scan involve?
2. What drugs can be used in a colonoscopy?
3. List two contrast media.

Before reading on, think about how this article may help you to do your job better. The Royal Pharmaceutical Society's areas of competence for pharmacists are listed in "Plan and record", (available at: www.rpsgb.org/education). This article relates to "diagnostic tests" and "therapeutic monitoring" (see appendix 4 of "Plan and record").

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Panel 1: Examples of endoscopic procedures

Arthroscopy An arthroscope is used to examine the inside of a joint for any damage, under local anaesthetic. The incision made for the arthroscope is so small that stitches may not be needed. Sterile fluid can be placed in the joint space to give a better view. Ice can be used after the procedure to help relieve any swelling or pain.

Bronchoscopy Bronchoscopy is used to inspect the trachea, bronchi and vocal cords. A flexible bronchoscope (the tube is about one centimetre wide and 50cm long) is introduced into the trachea through the nose or mouth. The patient is premedicated with a benzodiazepine or narcotic and the nasopharynx anaesthetised with lidocaine gel or spray so that the throat muscles are relaxed and the gag reflex suppressed. Lidocaine solution can also be injected through the bronchoscope to anaesthetise the trachea and bronchi. There is a risk of bleeding with this procedure and some clinics advise patients to avoid aspirin for a week before.

Specimens of lung secretions and tissue can also be taken during the procedure, flushing with saline to help cell collection.

Colonoscopy Colonoscopy is used to investigate gastrointestinal problems such as inflammatory bowel disease or unexplained rectal bleeding. It is also used after an abnormal barium contrast study. The colonoscope is inserted into the rectum to look for ulceration, haemorrhage, polyps or neoplasms and air is inserted through the scope to provide a better view. Colonoscopy can also be used in laser therapy and polypectomy.

The patient is not allowed to eat or drink for six hours before the procedure and the bowel must be cleansed thoroughly. Patients are advised not to eat solid foods for two or three days before the procedure and to take a laxative. To avoid dehydration (due to the laxative), patients should drink plenty of clear liquids (eg, juices). Iron supplements are usually stopped a few weeks before the procedure because they produce black stools, which can affect the view.

Just before a colonoscopy, enemas or other purgatives will be used to completely empty the colon and an analgesic (eg, pethidine) and sedative (eg, diazepam) given, usually intravenously. Alfentanil and propofol have been used in patient-controlled analgesia and sedation devices. Antibiotics may be prescribed for people with valvular heart disease, to prevent infection.

Cystoscopy Cystoscopy is used to diagnose lower urinary tract disease, including neurological, inflammatory or neoplastic abnormalities. This procedure examines the anterior and posterior urethra using a cystoscope. Water or saline is inserted into the bladder through the cystoscope so that the entire bladder wall can be inspected.

Gastroscopy Gastroscopy is used to examine the mucous membrane of the upper gastrointestinal tract. The back of the throat is sprayed with a local anaesthetic (eg, xylocaine) and a gastroscope inserted. Risks include perforation of the gastroinstestinal tract. Increasingly, this procedure is being used in place of barium contrast studies.

Laparoscopy Laparoscopy is used to inspect anterior intra-abdominal structures including the fallopian tubes, ovaries, uterus, small bowel, large bowel, appendix, liver and gall bladder. The laparoscope is introduced through a small cut in the abdomen and the procedure can be performed under a general or local anaesthetic. Carbon dioxide is pumped into the peritoneal cavity to raise the wall of the abdomen so that there is more room to manoeuvre the camera or to take samples. However, carbon dioxide can irritate the diaphragm so the patient can experience shoulder pain for a few days after a laparoscopy. To make the fallopian tubes easier to view, a dye may be injected through the cervical canal.

Laparoscopy can be used to diagnose many conditions, including cholecystitis and ovarian cysts. Antibiotics can be prescribed to reduce the risk of infection.

Sigmoidoscopy Sigmoidoscopy is used to examine the mucosal surfaces of the rectum, sigmoid colon and proximal portions of the colon.

investigate any newly appearing breast lump that could be a tumour. However, because of the high incidence of breast cancer among women, screening mammography is also recommended in asymptomatic cases. In the UK, this means that women between the ages of 50 and 64 years have a mammogram every three years. In the US, the American Cancer Society recommends a mammogram every one or two years in women aged 40 to 49, and those aged 50 years or older are advised to have an annual mammogram. Young women who are considered to be at high risk of developing breast cancer (eg, because of family history) are offered screening at an earlier age in both the UK and US.

A mammogram detects abnormalities in breast tissue, but does not necessarily show whether these are benign or malignant. Further investigations, such as ultrasound or fine needle aspiration cytology, may be required. One in 20 women who have a mammogram will be recalled for assessment. This can be either because there is a technical problem with the first mammogram or because there is a need for further investigation. However, women should be reassured that being recalled does not mean they have breast cancer. Of those recalled after the first mammogram, about one in 10 will have cancer.

Bone densitometry The density of the bone is usually measured in the lumbar region and hips. The gold standard technique is dual energy x-ray absorptiometry (DEXA), which involves the passage of a narrow beam x-ray through the bone. X-rays are collected at a detector, changed to electrical energy and sent to a computer for analysis and display. The amount of calcium in the bone is then calculated. This procedure is performed in hospital, but portable scanners that can be used in GP surgeries are growing in popularity. These measure the density of heel bone.

Bone densitometry is performed in patients considered to be at risk of osteoporosis, although its value in predicting risk of fracture is controversial. Such patients include oestrogen-deficient women with a family history or osteoporosis or other risk factors, those with primary hyperparathyroidism and those on long-term glucocorticoid therapy.

The World Health Organization has developed standards for bone density based on T scores. These compare the subject's bone density with that of a 20 to 40 year old. T scores are defined as follows:

- >–1 = normal
- –1 to –2.5 = osteopenia (decreased bone density)
- <–2.5 = osteoporosis

Z scores are also sometimes used. These compare the patient's bone density with that of other people of the same age, sex and race.

Magnetic resonance imaging Magnetic resonance imaging (MRI) does not use x-rays. Instead, it makes use of radio waves similar in frequency to those of ordinary FM radio stations and is based on the magnetic properties of atoms. Like CT scans, the patient lies on a narrow table which slides into the MRI scanner. A strong magnetic field is used to align the axis of spin of the nuclei of hydrogen atoms in the body. Brief radio frequency pulses are then applied to displace the alignment. When the displacement ends, a return signal (energy emitted in the form of radio waves) is produced, from which detailed planar and three-dimensional images can be derived. The return signal is picked up by a sensitive radio antenna and a computer is used to turn this into a three-dimensional image.

Subtle differences in the return signal enable the scanner to distinguish between organs and between benign and malignant tissue so MRI can be used to identify and stage tumours and to examine abnormal tissue in any organ of the body. Like CT, images can be cross-sectional but MRI is better at distinguishing between normal and abnormal tissue. Gadolinium is typically used as contrast media in MRI. This can interfere with the results of tests for iron and bilirubin.

Before the scan, patients are asked to remove dentures and all metallic objects from their person. Credit cards should not be taken into the scanner because the magnetic field can permanently erase information stored on them. Patients should let staff know if they have a pacemaker.

Positron emission tomography Positron emission tomography (PET or nuclear radiography) is an imaging technique that uses positron-emitting radioisotopes

introduced into the body (usually by intravenous injection or orally) to view organs and tissues. For example, to test thyroid gland function, the patient drinks radioactive sodium iodide. Side effects include nausea, headache and vomiting.

The patient then lies under the PET scanner, which can rotate around the body. As the radioisotope decays, positrons are produced, which collide with electrons to release gamma radiation. This is detected and used to produce a computerised image. PET can reveal the size, shape, position and some function of the target organs specific for a particular radioisotope. It is used to evaluate and diagnose brain tumours, heart disease, stroke and to investigate epilepsy (PET scans can show the abnormally high activation of the right part of the brain during epileptic seizure), Alzheimer's disease (PET scans can show brain cells with higher and lower metabolic activity) and mental illnesses. Generally, PET scans do not provide as much detail as x-ray, ultrasound, CT or MR images, but they can help identify and confirm disease.

Radioactive materials decay (release energy to become non-radioactive atoms) at specific rates as the body continuously removes them (usually filtered by the lungs, kidneys or liver, depending on the compound used). Thus, all radioisotope activity eventually ends, usually within a few days.

Panel 2: Contrast media

Barium sulphate suspension is typically used for computed tomography scans of the gastrointestinal tract, but should not be given to patients with intestinal obstruction. Barium blocks x-rays and this allows the internal structure of a hollow organ to be revealed. The dose given depends on the part of the gastrointestinal tract to be examined. For example, up to two litres of the suspension can be given as an enema if the colon is to be examined.

Amidotrizoates, such as meglumine amidotrizoate, are also typically administered for CT scans. These are iodinated contrast dyes that are usually given intravenously. The patient may initially feel a slight burning sensation in the arm receiving the injection. Other side effects include a metallic taste in the mouth and warm flushing. These sensations are normal and usually disappear in a few seconds.

Patients who are allergic to iodine (such as those with seafood allergies) can experience nausea, sneezing, vomiting, itching or hives. If contrast media is essential for a procedure but the patient has any of these reactions, he or she can be given a short course of immune-suppressing steroids and an antihistamine. Furthermore, because the dye can, rarely, cause anaphylaxis patients are instructed to notify the radiographer (via an intercom) if they have difficulty breathing during the scan so that they are treated rapidly. Alternatively, other contrast media or other imaging techniques may be used.

Iodine-based contrast media are mainly excreted by the kidneys, so patients with diabetes or renal disease require continuous hydration and close monitoring. Such patients should speak to their doctor regarding stopping any medicines (eg, metformin) or the scheduling of the CT scan in conjunction with dialysis.

Mike Wyndham Medical Picture Library

The density of bone in the lumbar region is commonly measured

Ultrasonography Ultrasonography uses high frequency sound waves to create images of organs and vessels. A water-based conducting gel is applied over the area to be examined to help with wave transmission and a hand-held probe is then moved over the area.

Ultrasound can be used to assess the growth and development of a foetus, to detect malignancies, stage tumours and to diagnose conditions in many areas of the body (eg, abdomen, heart, liver and kidneys).

Echocardiography Echocardiography is essentially a type of ultrasound. It is used to evaluate the size, shape and motion of the valves, septum and walls of the heart as well as changes in chamber size during the cardiac cycle. Ejection fraction (a measure of the effectiveness of the heart as a pump) can also be calculated. The procedure involves the transmission of high frequency sound waves through the heart. The different "echoes" that result are recorded on a transducer and used to build images that can be viewed on a monitor. Echocardiograms can be performed on infants (including fetuses) and adults, and is of particular value when inborn heart defects (eg, hole in the heart) are suspected.

Doppler ultrasound is a method that uses a beam of sound waves to detect the flow of blood through the heart. This allows the measurement of the speed and direction of blood flow. Narrowed valves will cause the blood to flow faster, while leaking valves can be detected because the blood flows in the wrong direction.

Risks of body imaging During an x-ray, some electromagnetic radiation is absorbed by body tissues. This energy can cause cell damage. The body can repair cells, but some damage is permanent. In conventional radiography, the risk of cancer or heritable defects (eg, due to damaged ovarian cells or sperm cells) is low. According to most experts, this low risk is outweighed by the benefits of information gained.

X-ray machines are monitored and regulated to provide the minimum amount of radiation exposure needed to produce the image. However, young children and fetuses are more sensitive to the risks. Women should tell health care providers about suspected pregnancy and a more appropriate alternative imaging procedure, such as ultrasound, may be recommended.

CT scans and other x-ray imaging techniques are also controlled so that the minimum amount of radiation exposure needed to produce the image occurs, but risks increase as a person is exposed to more imaging studies.

In nuclear radiography, the target organ will receive most of the radiation dose. The energy emitted is similar to that of x-rays and CT scans so there is still a potential for cell damage and mutations in egg or sperm cells. It should be noted that radiation doses used for treating disorders (eg, iodine for thyroid disease) are many times greater than those used for imaging and will require additional instructions regarding protection from risks.

Action: practice points

Reading is only one way to undertake CPD and the Society will expect to see various approaches in a pharmacist's CPD portfolio.

1. Find out more about cervical smear tests and consider how you might advise a woman who is anxious about these tests.
2. Read the information in Martindale the complete drug reference on contrast media (p1030).
3. Read the chapter on radiopharmaceuticals in Martindale (p1448).

Evaluate

For your work to be presented as CPD, you need to evaluate your reading and any other activities. Answer the following questions: What have you learnt? How has it added value to your practice? (Have you applied this learning or had any feedback?) What will you do now and how will this be achieved?