Scottish Clinical Imaging Network

A WORK BASED MODULE FOR ASSISTANT PRACTITIONERS TRAINING IN

Dual Energy X-Ray Absorptiometry

(DEXA)

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Updated by
Scottish Clinical Imaging Network (SCIN) and Society of Radiographers (SoR)

NOTE

This guideline is not intended to be construed or to serve as a standard of care. Standards of care are determined based on all clinical data available for an individual case and are subject to change as scientific knowledge and technology advance and patterns of care evolve. Adherence to guideline recommendations will not ensure a successful outcome in every case, nor should they be construed as including all proper methods of care or excluding other acceptable methods of care aimed at the same results. The ultimate judgement must be made by the appropriate healthcare professional(s) responsible for clinical decisions regarding a particular clinical procedure or treatment plan. This judgement should only be arrived at following discussion of the options with the patient, covering the diagnostic and treatment choices available. It is advised, however, that significant departures from the national guideline or any local guidelines derived from it should be fully documented in the patient's case notes at the time the relevant decision is taken.

Contents

Aim

The aim of the module is to enable Assistant Practitioners (AP) working within a diagnostic service to develop the knowledge base, understanding and practical skills required to undertake Dual Energy X-Ray Absorptiometry imaging.
National Occupational Standards (NOS, 2022) describe the skills, knowledge and understanding needed to undertake a task or job at nationally recognised levels of competence and have underpinned the learning objectives of the module. The College of Radiographers Education and Career Framework (4th Ed, 2022) defines the necessary AP knowledge, skills, attributes and the educational standards required.

Recommended prior knowledge and experience

Assistant Practitioners wishing to undertake this module must have a Certificate of Higher Education (CertHE) in Radiographic Studies (1 year) or a Diploma of Higher Education (DipHE) (2 years). The Education and Career Framework (CoR 4th Ed, 2022) now requires graduating AP's to have a DipHE. AP's with CertHE qualifications may require additional support and training to achieve completion of the work based education package but should be seen as a role development opportunity. The AP must be able to demonstrate a minimum of two years post qualification in employment as an Assistant Practitioner in Radiography. Assistant Practitioners should be aware of the requirements of this module including the need to gather evidence, critically analyse and evaluate and report on their experiences. The evidence required is detailed in the Assessment section of this document.

Clinical Time

The Assistant Practitioner must be allocated to a DEXA site and given time to gain experience undertaking DEXA examinations. The time required to gain appropriate experience will be dependent on the individual and prior education and a collaborative agreement should be reached between the AP and the supervising radiographer as to when a suitable level of experience has been gained. The Royal Osteoporosis Society advise 6 months full time and 12 months part time is sufficient to gain insight and experience. The AP must work under the supervision of an appropriately qualified HCPC registered radiographer, with relevant training in DEXA.

Clinical Supervision, Accountability and Delegation

Once the AP is deemed competent to undertake the delegated task, they then carry the responsibility for undertaking that task (SoR Supervision and delegation 2023). The DEXA lead Radiographer will delegate work to the AP who is responsible for agreeing to undertake the task. The AP has the right to refuse to undertake the delegated task if they recognise that the patient requires support beyond their level of responsibility. Appropriate supervision should be provided to those who are delegated work. There should be a defined team structure and clear written procedures supporting constructive feedback and coaching. Clinical supervision aims to support learning and develop competency related to a specific clinical task provided by an identified trainer/expert from the skill area (SoR 2023). Assistant Practitioners working in DEXA following the completion of this module should report

to a DEXA lead radiographer established locally at each site. This radiographer has overall responsibility for DEXA and is responsible for local sign off, training, education, and competence within a framework of supervision and will delegate appropriate tasks to the AP.

Scope of practice is determined locally; however, all exposures must be Vetted and Justified by an IR(ME)R 17 entitled Practitioner. IR(ME)R regulation 11, outcome 3 considers the importance of the potential diagnostic benefits of the exposure. Nevertheless, where it is not practical for the Practitioner to also authorise an exposure as required by paragraph (1)(b) in regulation 11 of IR(ME)R, the Operator must do so in accordance with authorisation guidelines issued by the Practitioner (IR(ME)R regulation 11(5)). The Assistant Practitioner is entitled as an Operator who can authorise an exposure following guidelines issued by the Practitioner as Justification cannot be delegated.

Clear guidelines should be issued by the Practitioner regarding what exposures are appropriate for authorisation by the Operator, allowing the Assistant Practitioner to work within set parameters. The Assistant Practitioner must be able to contact the Practitioner who justified the exposure should they have any concerns regarding the examination. Protocols should be in place so that the Assistant Practitioner is not required to make a clinical judgement which they are not competent or entitled to make. This ensures that standards for Conduct, Performance and Ethics (2016), CPD (2012) and Proficiency (2013), as set down by HCPC, are met. The Assistant Practitioner should be assigned a clinical mentor to support the practical elements of their training. The clinical mentor may be the DEXA lead radiographer or an appropriately trained radiographer practicing at Band 6 or above. The mentor will teach, provide feedback, undertake clinical assessment, and support the Assistant Practitioner's completion of the module. Guidance for the clinical mentor is included within this module (Appendix 1). Therefore, responsibility for the supervision and delegation for the AP rests at all times with the nominated supervising radiographer. The level of supervision may vary according to need from direct oversight of the actions of the AP to authority for the individual to work independently of the supervising radiographer. The supervising Radiographer must have full knowledge of the examinations being undertaken and be immediately available to provide support (Society of Radiographers, 2012). During the training period, the Assistant Practitioner should be directly supervised at all times until the Assistant Practitioner achieves competence and has passed the assessments. Upon successful completion of the module the Assistant Practitioner may be authorised and entitled by their Employer to deliver the imaging service via indirect supervision of the HCPC registered radiographer. Clear, current and unambiguous policies and associated written procedures are essential for effective supervision models. Examples of good governance are provided in the SoR guidance on The Radiography Support and Assistant Workforce: regulatory compliance, governance arrangements, supervision and delegation (2023). A risk assessment has been included as part of the training package (Appendix 3).

Radiation Safety

Under IR(ME)R (2017) the Employer has a responsibility to ensure that all Operators are adequately trained and entitled to perform the tasks within their defined scope of practice. Schedule 2(1)(b) requires entitlement and the scope of practice of

operators to be clearly defined within the employer's written procedures. Appropriate governance and training records should be stored by management to allow the Radiographer to delegate tasks to an AP. The Radiographer has a professional and legal responsibility to protect both the patient and the staff to whom they are delegating to. However, the Assistant Practitioner also has a duty of care and is subject to the same liability as a registered professional.
The Radiographer, as the registered professional, has the professional and legal requirement to protect both the AP and the patient. The AP has a duty of care and is subject to the same liability as a registered professional. Although not regulated by statute, the Assistant Practitioner is accountable for their actions in the following four domains:

- To the patient/client – under civil law (by duty of care)
- To the public – under criminal law
- To the employer – under employment law
- To the Professional Code of Conduct of the profession they support

Operators should not carry out a medical exposure without receiving adequate training. The Employer must specify the scope of practice and the tasks for which an individual can act as an operator and be able to demonstrate that they are adequately trained in compliance with Schedule 3 and regulation 17 of IR(ME)R. Where any urgent or unexpected findings are discovered, the AP should immediately inform the supervising radiographer who will be able to take this forward (SoR, 2023).

Recording change to scope of practice

As part of the entitlement process, the necessary information surrounding the individual's scope of practice, the theoretical and practical training given as well as an assessment of competence must be clearly documented in the individuals training record in line with the IR(ME)R Employers Procedures. A copy should be kept by the Assistant Practitioner, and within their personal work file as evidence for clinical governance.

NHS bodies are vicariously liable for the negligent acts and omissions of their employees holding responsibility for ensuring appropriate governance to support the AP scope of practice (SoR 2023 Supervision and Delegation guidance). CoR accreditation demonstrates publicly that applicants have met the professional body's standards for APs. Those AP's awarded CoR accreditation will be eligible to be listed on the SCoR's Public Voluntary Register of Accredited Assistant Practitioners (PVRAAP) providing public reassurance, and managers with quality assurance of their staff. AP's who are SoR members will be eligible to participate in the SoR's professional indemnity insurance (PII) scheme. The PII scheme will cover APs for their accredited scope of practice. The SoR and CoR must be informed of any changes to an AP's scope of practice at the time of change or the PII cover may be affected. This may require application for re-accreditation of the new scope of practice (CoR AP Accreditation: Guidance for Applicants 2023).
A local risk assessment for service change should be completed prior to the start of this work based education package.

Audit

It is expected that there will be local variation in the services provided by different departments and that there may be a range of clinical complexity. It is also anticipated that the examinations performed at a local site may change over time to accommodate new diagnostic techniques. It is the responsibility of the employer to ensure that the AP entitled as Operator is adequately trained, assessed as competent, and undertake continuing education and training after qualification. This includes the use of new techniques (IR(ME)R regulation 6). It is good practice to support effective deployment and development of the AP to audit training records, incorporating review dates to encompass changes in systems of work and management of documentation of training and competency. Audit of examinations undertaken should be completed annually to evidence competency has been maintained. This can be facilitated with the audit tool here: DXA toolkit (theros.org.uk)

Learning Outcomes

During the APs training for this work based education package, the AP is expected to observe, and participate in DEXA examinations. The number of clinical exams completed is not critical but the AP must demonstrate that they can work unassisted through the range of examinations that will be included in their defined scope of practice. Completion of the work based education package will provide evidence that the learning outcomes have been met.
On completion of the theoretical and practical aspects of the module the Assistant Practitioner will be able to:

1) Describe the anatomy, pathology and clinical criteria relevant to DEXA scanning.
2) Demonstrate the theoretical knowledge required to operate DEXA equipment safely.
3) Prepare the patient prior to undergoing a DEXA scan.
4) Explain and demonstrate the ability to perform a DEXA scan.
5) Perform Post examination procedure.
6) Demonstrate a training record evidencing competency.

Teaching Methods

The module is predominantly work based and encompasses a variety of teaching and learning methods undertaken in the clinical setting. This will incorporate a blended learning approach comprising of in house training, support from an allocated radiographer mentor, clinical practice activities and independent learning.
The AP will have an experienced DEXA radiographer or technologist who is based in the Assistant Practitioner's own clinical service. The **qualified practice-based mentor**, the AP, along with the line manager will sign **a learning contract** (Appendix 2) that identifies the commitment that all parties will make to the process.

Teaching Method
Practical Experience The Assistant Practitioner is allocated training time in DEXA. Successful completion of this module is based on accomplishing competency assessments that you will work towards throughout the training period. Learning must be enhanced by reflective practice which is facilitated through review forms included in the Assessment section of the module.
Clinical Mentor The Assistant Practitioner will be assigned a mentor to support the practical elements of their training. The mentor will provide feedback, undertake clinical assessment, and support the Assistant Practitioner's training throughout the module. Guidance for the clinical mentor is included within this module (Appendix 1).
Practice Based Activities Practice based activities linked to each Learning Outcome are designed to provide experience and build knowledge in the necessary competency area.
Self-Directed Learning Assistant Practitioners undertaking the module are expected to undertake self-directed learning. Suggested reading activities have been provided at the end of each module and are designed to support movement towards learning outcomes. The Royal Osteoporosis Society offer a free e-learning foundation course (Bone Densitometry Foundation Course ROS (theros.org.uk)) which can be completed throughout the work based module as indicated by the practice based activities. Additionally the National Training Scheme for Bone Densitometry is an accredited course addressing theoretical and practical aspects of clinical bone densitometry. National Training Scheme for Bone Densitometry | ROS (theros.org.uk)

Course Assessment

Practiced Based Activities


Practice Activities

What is the importance of the correct placement of ROIS when performing serial BMD measurements?

Why is it important to ensure correct numbering of vertebral levels?

How does aortic calcification affect BMD measurements?

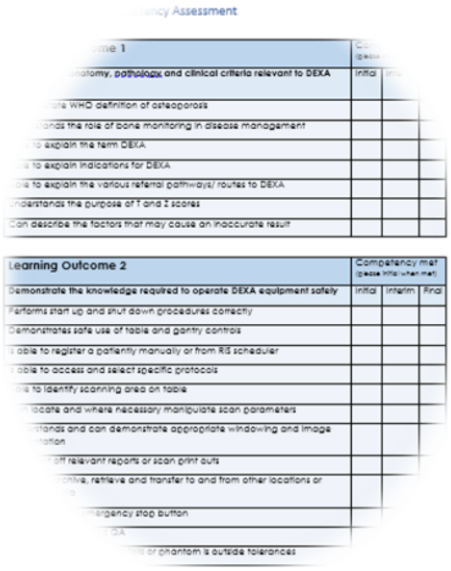
What considerations should you make in terms of patients with a moderate or severe scoliosis?

What considerations should you make if one vertebrae within a DXA scan has severe endplate sclerosis, facet joint sclerosis or presence of degenerative disc disease?

A practical assessment of clinical practice is required through a competence achievement. Assessment will be undertaken by the clinical mentor who should be an HCPC registered radiographer at Band 6 level or above. The radiographer should schedule weekly sessions with the AP to review progress, set goals, agree timeframe for continuous clinical assessment and provide professional guidance. Assessment is carried out via clinical practice with appropriate questions by the clinical mentor. Assistant Practitioners training in DEXA should work their way through practice activities outlined in the clinical workbook.

Continuous Clinical Assessment

A Continuous Clinical Assessment (CCA) located within the clinical workbook will be carried out by the clinical mentor throughout the progression of the module. Assistant Practitioners will be expected to gain competencies undertaking DEXA scans on a range of patients with varying degrees of mobility and clinical conditions. The number of clinical exams completed is not critical, but the Assistant Practitioner must demonstrate that they can work unassisted through a range of examinations. Completing the CCA will demonstrate that all evidence requirements have been met for each learning outcome.


Learning Outcome 2

Demonstrate the knowledge required to operate DEXA equipment safely

Performs start up and shut down procedures correctly

Demonstrates safe use of table and gantry controls

Able to register a patient manually or from RIS scheduler

Able to access and select specific protocols

Able to identify scanning area on table

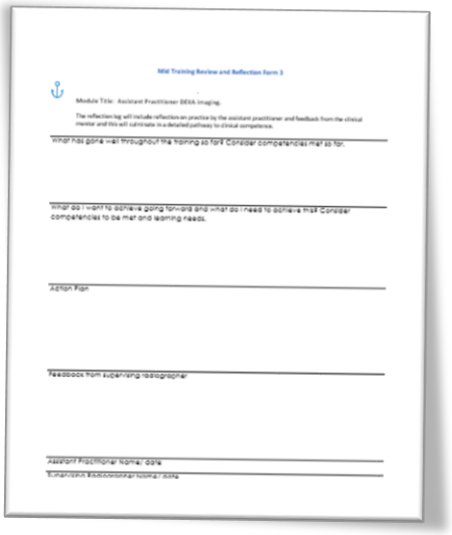
Locate and where necessary manipulate scan parameters

Understands and can demonstrate appropriate windowing and image

Of relevant reports or scan print outs

Archive, retrieve and transfer to and from other locations or

Emergency stop button



Reflective Practice

Learning and self-assessment must be enhanced by reflective practice which is facilitated through review forms included in the Assessment section of the module.

Learning Outcome 1

Describe the anatomy, pathology and clinical criteria relevant to DEXA scanning

Knowledge and Skills

- Skeletal Anatomy and bone structure
- Osteoporosis and Fragility Fractures
- Fracture Risk Assessment
- Referral Process for DEXA scans

Skeletal Anatomy

The World Health Organisation (WHO) recommend assessment of bone mineral density (BMD) by dual x-ray absorptiometry of the spine and hip (proximal femur) as the gold standard for osteoporosis. The forearm is also accepted as an alternative diagnostic site for diagnosis. You should be able to describe the skeletal anatomy of the anatomical sites involved in DEXA scanning of the hip, the lumbar spine and lateral thoraco-lumbar spine and forearm and recognise the anatomy as it appears on the DXA image.

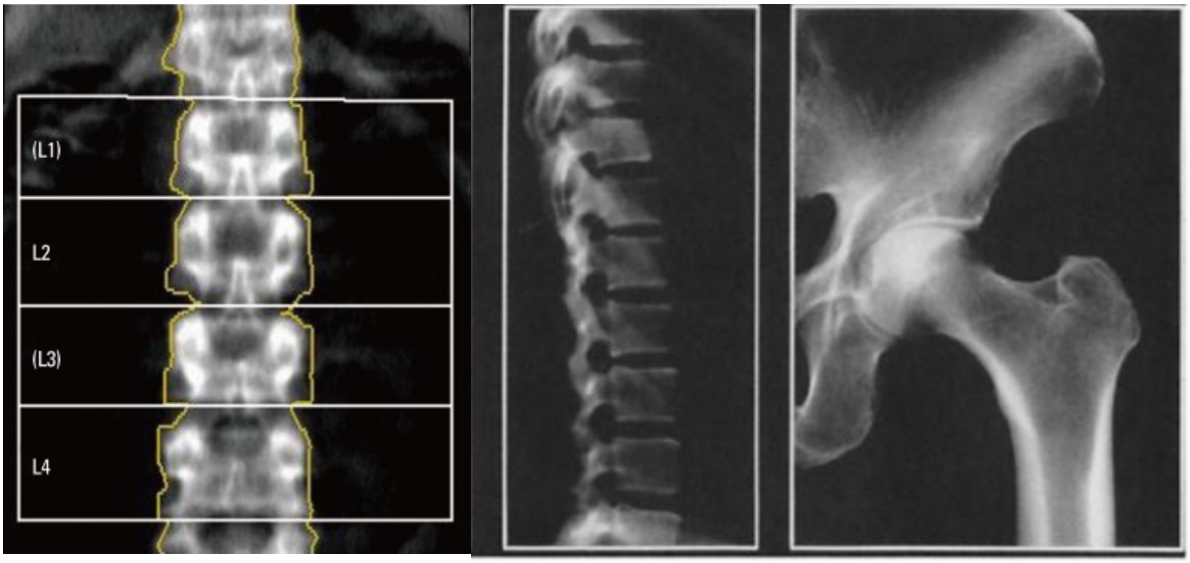


Figure 1 Adapted from Bonnick, 2010 p. 19; Jeong et al. 2014

Fragility fractures occur in areas exhibiting a greater tendency for bone loss and this includes the spine, hip, and wrist. Typically, these sites have a higher proportion of trabecular bone. Neck of femur fractures are common and tend to be sustained by the elderly population as the result of a low energy fall in the presence of osteoporotic bone and have poor outcomes for patients including increased mortality. Vertebral fragility fractures are the most common and are highly predictive of further factures, they may not come to clinical attention but increase morbidity and mortality. Osteoporotic fragility fractures frequently occur at the distal radius in ‘younger’ older adults. Osteoporosis evaluation at this site may be undertaken for certain health problems such as hyperparathyroidism or if DEXA scans are not possible at the hip or spine.

Bone Formation and Structure

Bone supports the bodies' locomotion, protects soft tissues, stores calcium and phosphate and harbours bone marrow. Bone is a mineralised connective tissue that exhibits four types of cells, osteoblasts, bone lining cells, osteocytes and osteoclasts responsible for bone turnover.

Osteoblasts – Lay down new bone.
Osteoclasts – work in concert with osteoblasts. They resorb bone that needs to be removed and replaced.
Osteocytes – sense the stresses and strains in bone and control the bone turnover rate.

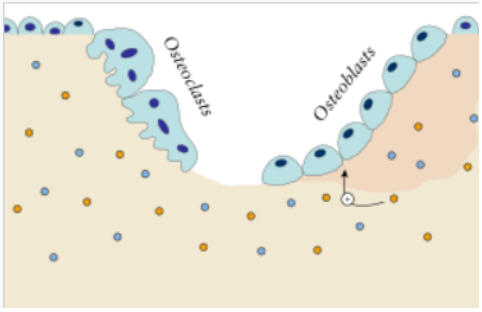


Figure 2 A diagram of osteoblasts and osteoclasts

Normal bone remodelling is necessary for fracture healing and skeleton adaption to mechanical use, as well as for calcium homeostasis. Ideally there is no net loss of bone and an imbalance of bone resorption and formation results in several bone diseases. Age related bone loss or approx. 1% per year occurs naturally from around the age of 40 in both sexes, but is accelerated to approximately 2% per year through the female menopause. Excessive resorption by osteoclasts without the corresponding amount of new formed bone by osteoblasts contributes to bone loss and osteoporosis. Treatment can reduce the risk of fracture by manipulating the cells involved in bone turnover.

Bone Healing

Ideal conditions for fracture healing are adequate blood supply, good contact between bone fragments and good fracture site stability. In the initial inflammatory stage, bleeding at the fracture site and the release of cytokines from dead cells along with fibroblasts, begin the granulation process. The second phase involves fibroblasts beginning to form cartilage and fibrocartilage, however the structure is still weak. Between 2 to 12 weeks post fracture, mineral compounds are released into the weak structure to form a hard callus over the fracture site. During the healing process, a hard callus will form which over time, is remodelled to restore the normal shape of the bone.

Physiological bone repair depends on three factors; activation of mesenchymal stem cells, release of growth factors, and production of regulatory factors.
Adequate blood supply at the fracture site, is essential to ensure the recruitment of inflammatory and mesenchymal cells. Blood supply also improves the circulation of systemic and local signalling molecules and assures access to oxygen and nutrients, essential for cellular metabolism. Good fracture reduction influences positive callus progression.

Bone Hormones

Regulatory hormones play a critical role in bone remodelling. The following are some of those hormones, with a brief description of their roles in bone development, monitoring mineral blood levels, and maintaining bone homeostasis:

Calcium Regulating Hormones:

Parathyroid hormone (PTH): controls the level of calcium in the blood and stimulates both resorption and formation of bone.

Calcitriol (1,25 dihydroxy vitamin D): produced from vitamin D and is required for calcium absorption.

Calcitonin: protects against excessive blood calcium levels during early childhood by inhibiting bone turnover and decreasing reabsorption; its role in adult calcium homeostasis is unclear.

Sex hormones:

Oestrogen: key regulator of bone remodelling on both osteoclasts and osteoblasts.

Testosterone: important for skeletal growth and is also a source of oestrogen.

Other systemic hormones:

Growth hormones: Growth hormone and its production of the insulin-like growth factor (IGF-1) influences bone formation.

Thyroid hormones: required for skeletal maturation and influence adult bone maintenance.

Cortisol: Large amounts of this adrenal gland hormone block bone growth. Glucocorticoid-induced osteoporosis is the most common secondary cause of osteoporosis.

Insulin: Important for bone growth, insulin signalling regulates both bone formation and bone resorption.

Leptin: has direct and indirect influences on bone metabolism that research continues to elucidate.

The regulatory hormones respond to changes in blood calcium and phosphorus, acting on the tissues of the bone, intestines, and kidneys. Regulation of calcium levels in the extracellular fluid (ECF) is performed by bone, intestine, and kidneys.

There is limited absorption of dietary calcium from the intestine, alongside secretion of calcium into the intestine within the intestinal juices with the result that the net amount of calcium entering the body is only a small proportion of dietary calcium, approximately 150 mg/day. In healthy young adults, the amount of calcium taken in to, and excreted from bone is in balance, as bone resorption and bone formation are

equal. A large amount of calcium is filtered through the kidney but brought back into the circulation by reabsorption.

When either calcium or phosphorus are in short supply, the regulating hormones remove them from bone to support vital functions in other body systems, which may result in weakened bone structure.

All these movements are controlled by hormones, particularly parathyroid hormone, and 1,25 dihydroxy vitamin D (calcitriol). The constant level in the ECF is essential for normal cell function and also for maintaining the right amount of calcium inside the cell (Mundy and Guise 1999).

Types of Bone

Cortical

Compact bone is also called cortical bone forms the hard outer shell of long bones and vertebral endplates. It is dense bone in which the matrix is solidly filled with organic ground substance and inorganic salts, leaving tiny spaces called lacunae that contain osteocytes. Its main function is to support and provide protection. Cortical bone has a slow turnover rate. Cortical bone is harder to modulate and influence with anti-fracture drugs. The forearm is rich in cortical bone.

Trabecular

The internal trabecular bone is also known as spongy or cancellous bone. Its functions include more active functions of bones including blood cell production and ion exchange. Trabecular bone contains a network of trabeculae while bone marrow fills in remaining spaces. Trabecular bone provides a rapid turnover source of calcium and other minerals and is easier to interact with drugs available. It is the reduction of bone mass in trabecular bone that leads to loss of structural integrity in osteoporosis and higher risk of fragility fractures.

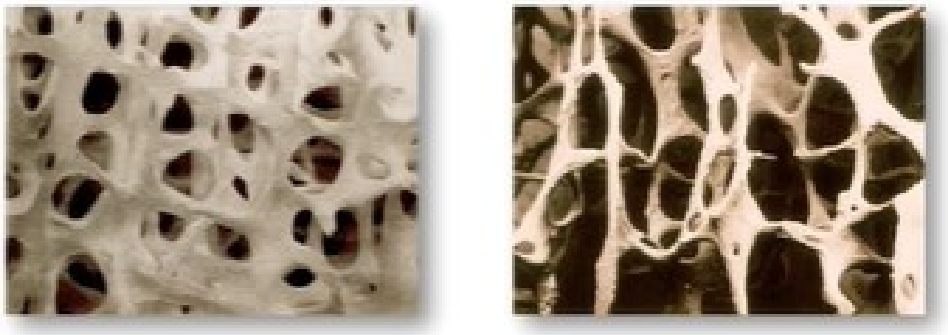


Figure 3 Changes in internal trabecular bone in osteoporosis

Osteoporosis

Osteoporosis as defined by the World Health Organisation (WHO) is a progressive systemic skeletal disease characterised by low bone mass and structural deterioration of bone tissue with a resultant increase in bone fragility and susceptibility to fracture. Bone mass increases in youth until peak bone mass is reached at approximately 20-30 years of age. This is followed by a stable period in middle age followed by a slow reduction in bone density in men and women. The decrease in bone mass becomes pronounced in women at menopause because of

the loss of bone-preserving oestrogen. If the rate is excessive at menopause, or due to other factors such as glucocorticoid use, osteoporosis may result. Men tend to have higher peak bone mass, lose bone less aggressively and are less susceptible to fractures. Osteoporosis is diagnosed operationally on the level of bone mass, measured as Bone Mineral Density (BMD) from DXA. Once the patient's BMD has been calculated, a standardised T-score can be generated for comparisons to the WHO classification at the proximal femur by comparing the patient's BMD to that of the sex matched population's peak BMD. WHO guidelines state that once a patient has been identified to have a T-score of below -2.5 osteoporosis is diagnosed. The risk of fracture increases approximately twofold for each standard deviation decrease in T-Score.

Classification	BMD T-Score (mg/cm^3)
Normal	-1.0 or greater
Low bone mass (Osteopenia)	Between -1.0 and -2.5
Osteoporosis	-2.5 and below
Severe osteoporosis	-2.5 and below + fragility fracture

A T-score is linked to the patient's age and the likelihood of fracture.

$$\text{T score} = \frac{\text{patient's BMD} - \text{population peak BMD}}{\text{Standard Deviation of population peak BMD}}$$

A Z-score is a comparison of a person's bone density with that of an average person of the same age and sex.

$$\text{Z-score} = \frac{\text{patient's BMD} - \text{population age - related BMD}}{\text{SD of population age-related BMD}}$$

A Z-score of -2 or lower may be an indication that a cause other than biological aging may be the cause for low bone density and can also put a patients BMD into context for their age, sex and clinical history. For example a 75 year old female with a T-score of -2.5 SD may have a Z-score of -1SD indicating that bone mass is within normal range for age and sex.It is important to identify those patients at increased risk of fractures and very low BMD is an independent risk factor for fragility fracture. Combined with other risk factors BMD can be used to calculate an absolute fracture risk using the FRAX tool. (frax.shef.ac.uk/FRAX/) . The outcome of FRAX assessment can guide clinicians in management decisions and support patients understanding of their risk and aims of therapy.

Serial BMD measurement over time can be used to support assessments of effectiveness of treatment, and measure changes in bone mass to direct initiation of treatment at appropriate times and monitor bone loss caused by treatments for other conditions, such as aromatase inhibitors in breast cancer treatment.

Fragility Fractures

Fragility fractures are fractures that are the result of low-level or low-energy trauma, mechanical forces that would not ordinarily result in fracture. Such as a fall from standing height or less. Although not the only factor, reduced bone density tends to equate to an increased fracture risk. Fragility fractures occur most commonly in the spine, proximal femur and wrist. They may also occur in the humerus, ribs, and

pelvis. Osteoporotic fragility fractures can cause substantial pain and severe disability leading to a reduced quality of life. Hip and vertebral fractures are associated with increased hospitalisation and decreased life expectancy (NICE, 2019).

Bone Mineral Density is a good predictor of fracture risk, but other clinical risk factors must be considered. Age is a strong predictor of fracture risk, with incidences of osteoporosis and fracture risk increasing with age in both men and women (Johansen et al., 1997).

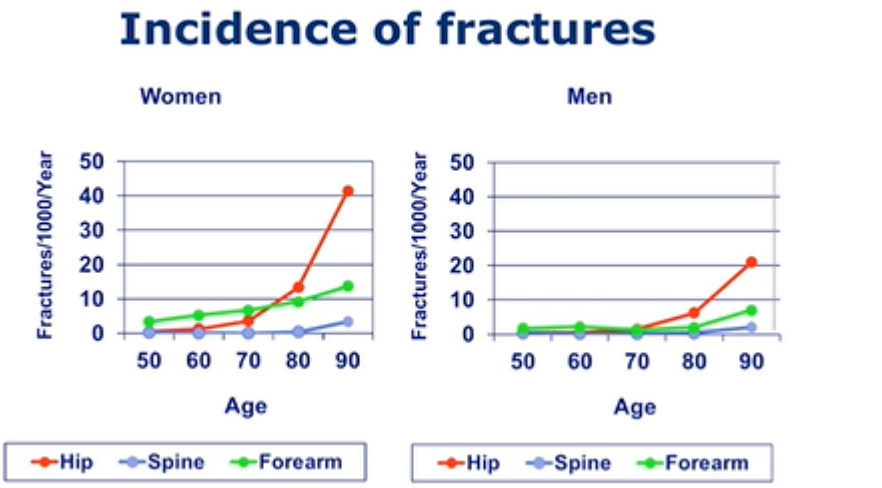


Figure 4 Incidence of fractures

The Lifetime risk of clinical fracture at age 50 the risk for women is 50% and 20% for men (Van Staa et al., 2001)

Figure 5 Lifetime risk of clinical fracture at age 50

Fracture Risk Assessment

The International Osteoporosis Foundation (Kanis et al., 2018) and the WHO recommend that risk of fracture should be expressed as an absolute risk for instance probability over a ten year interval. Fracture risk assessment should be carried out prior to DEXA in patients with clinical risk factors for osteoporosis and in whom anti-osteoporosis treatment is being considered. QFracture is a fracture risk assessment tool which can be used for people aged between 30 and 84 years and has been developed for the UK population.

In individuals at intermediate risk, bone mineral density measurement should be performed using DEXA and fracture probability re-estimated using FRAX. FRAX is a fracture risk assessment tool, recommended by SIGN Guidance, that uses risk

factors in addition to DEXA scan measurements to estimate fracture risk and aid clinical decision making regarding the use of pharmacologic therapies in patients with low bone mass.

QFracture is recommended for use in Scotland under SIGN guidelines (SIGN 142, 2019). Fracture risk assessment should be considered in patients with one of the following risk factors or relevant co-existing disease/drug therapy. NICE guidance also supports the use of FRAX Recommendations | Osteoporosis: assessing the risk of fragility fracture | Guidance | NICE

Non modifiable Risk Factors

- Men and women over the age 50 with parental history of osteoporosis
- Women over 50 with menopause age less than 45 years

Modifiable Risk Factors

- BMI <20kg/m2
- Smoking
- Alcohol intake >3 units/day (>14 units per week for men and women)

Coexisting diseases

- Diabetes mellitus
- Inflammatory rheumatic disease
- Inflammatory bowel disease
- Malabsorption
- Institutionalised patients with epilepsy
- Endocrine disease (including primary hyperparathyroidism)
- Chronic Liver disease
- Neurological disease (Including Alzheimer's, Parkinson's, Multiple sclerosis and stroke)
- Moderate to severe chronic kidney disease
- Asthma

Drug Therapy

- Long term anti-depressants
- Anti-epileptics
- Aromatase inhibitors
- Long term (more than 5 years) depot progesterone therapy
- GnRH agonists (in men with prostate cancer)
- Proton pump inhibitor
- Oral glucocorticoids
- Thiazolidnediones
- Anti-retroviral therapy

Other factors could include, for example: previous fragility fracture; history of falls; family history of hip fracture; secondary osteoporosis from; haematological (multiple myeloma; haemoglobinopathies; systemic mastocytosis); respiratory (cystic fibrosis; chronic obstructive pulmonary disease); metabolic (homocystinuria); and immobility (due for example to neurological injury or disease).

DEXA Referral Process

There are various clinical indications for a DEXA scan. Referrals for DEXA scans are often made as the result of the patient being treated for a fragility fracture, identified through fracture clinic or fracture Liaison Service, or GP. Due to the exposure to radiation, you should be able to describe when the examination can be justified (Using local IRMER Authorisation Guidelines used by the Operator (the AP)), and when it cannot. Under IR(ME)R 2017 requests specifically for DEXA may only be made by staff who have been “Entitled” as a “Referrer”. (And must be a registered healthcare professional, AP’s cannot do this nor can they justify requests as the IRMER Practitioner must also be a registered professional.)

Fracture Liaison Service

The Fracture Liaison Service is an service that identifies all new fragility fracture patients (men and women over the age of 50), and offers investigation and assessment for osteoporosis and fracture risk with a view to targeting treatment for those who will benefit from it. All patients in the health board area who have a minor or low trauma fracture are automatically contacted and invited to attend for an assessment by the service. Where appropriate they are offered a DEXA scan to assess for underlying osteoporosis. Following the assessment and results of the scan patients are provided with a management plan which may include drug treatment, lifestyle advice and education with the aim of reducing the risk of future fractures.

Direct Access DEXA Service

In 2004, NHS Quality Improvement Scotland funded a project to assess the effectiveness of strategies for the secondary prevention of osteoporotic fractures in Scotland. Nine Scottish centres provided Axial DXA to NHS patients; 9 centres provided access for patients in secondary care. Western Infirmary, Glasgow provided secondary care within the Fracture Liaison Service (FLS), offering assessment for osteoporosis to all women and men over the age of 50yr (Inpatient or Outpatient), who sustain a fracture at any skeletal site (not associated with RTA or fall from height). Six centres participated in the audit; chosen to demonstrate a range of services from none to multiple options. Patients referred from primary care on the basis of ‘open-’ or ‘direct-access’ (hereafter ‘open- or direct access’ DXA services will be referred to as DADS). Specialist osteoporosis secondary care clinics were available in 2 health board areas (Grampian and Greater Glasgow), providing another route to DXA assessment.
Direct Access DEXA service (DADS) is available to GP’s or AHPs to refer patients for assessment of osteoporosis and fracture risk on the basis that they have more than one agreed specific referral criterion. Referral leads to Osteoporosis Nurse Specialist clinic consultation with one-stop DEXA scanning to assess those whose fracture risk merits treatment. This service is currently available in Aberdeen and Glasgow.
The following list is not conclusive, and may be expanded depending on setting:

- Men and women over 50 (at time of fracture) with a fracture at any site (not attributable to RTA or skull fracture nor a fall from above head height)
- Steroid > 7.5mg prednisolone or equivalent per day for more than 3 months. The indication for steroids should be detailed.

- Monitoring as recommended by DADS or Bone Mineral Metabolism Clinic or Fracture Liaison Nurse Service. This is usually 5 years from previous scan but 3 years following initiation of Denosumab injection (Romosozumab and Teriparatide are also prescribed throughout NHS Scotland).
- A 10 year risk of fracture of more than 10% assessed by Qfracture or FRAX.

Bone/Mineral Metabolism Clinics

Bone/Mineral Metabolism Clinics assess patients at risk of osteoporosis and other metabolic bone disease referred by GPs and secondary care clinicians – where these patients are not suitable for the services described above. Patients with particularly severe or complex osteoporosis identified via the FLS / DADS are referred automatically to the Bone / Mineral Metabolism Clinics.

Secondary Care DEXA service

The Secondary Care DXA Service is a DEXA scan only service addressing the needs of Secondary Care Specialist Clinics who have patients at high fracture risk.

Practice Activities:

Learning Outcome 1

List the risk factors linked to developing osteoporosis

What are the hormones which affect bone remodelling?

What factors affect the repair and maintenance of bone tissue in fractures?

At what age is peak bone mass reached?

What factors affect bone mass?

What measures can prevent / delay osteoporosis?

What clinical risk factors influence fracture risk?

Why are the spine and hip used to measure/monitor bone density?

Summarise the role of the Assistant Practitioner or radiographer in fracture risk assessment?

What are three reasons for requesting a bone mineral density scan?

Resources

Royal Osteoporosis Society – Bone Densitometry Foundation Level Course Module 1 – Understanding, treating, and preventing osteoporosis.
https://osteoporosis.co.uk/mod/page/view.php?id=16

NATIONAL OSTEOPOROSIS GUIDELINES GROUP, 2017. Clinical guideline for the prevention and treatment of osteoporosis.

Available from:
https://www.sheffield.ac.uk/NOGG/NOGG%20Guideline%202017%20July%202019%20Final%20Update%20290719.pdf

SCOTTISH INTERCOLLEGIATE GUIDELINES NETWORK, 2021. SIGN 142. Management of osteoporosis and the prevention of fragility fractures. Edinburgh: SIGN: 2021.

Available from: https://www.sign.ac.uk/media/1812/sign-142-osteoporosis-v3.pdf

Leaning Outcome 2

Demonstrate the theoretical knowledge required to operate DEXA equipment safely.

Knowledge and Skills

- Principles of DEXA Scanning
- Scan Equipment
- Protocol selection
- Radiation Protection
- Quality Assurance

Principles of DEXA Scanning

Dual Energy X-ray Absorptiometry (DEXA or DXA) provides accurate, painless, and non-invasive information about bone mineral density. It is low dose and widely available with a fast scanning time. DXA BMD measurements can be used to diagnose osteoporosis, predict fracture risk, and monitor response to treatment. The scanners emit x-rays at 2 energy levels, high energy of > 70kev and a lower one of 30-50 keV. The differing energies allow calculation of absorption of x-ray photons by the patient's soft tissues. Using two x ray beams with different energy levels a measurement can be taken of how much of each beam is absorbed by bone and soft tissue. Subtraction of the soft tissue amount from the total results in the calculation of bone mineral density. (Hologic, 2022).

Figure 6 DEXA scanning equipment

This allows the x-ray attenuation of bone to be measured alone by mathematically manipulating the recorded signal by using the different attenuation properties of soft tissue and bone at the two energies. The density of bone is calculated on the basis that denser, more mineralized bone attenuates (absorbs) more x-ray. Having adequate amounts of artefact-free soft tissue is essential to help ensure the reliability of the bone density results. A single energy source would not allow for attenuation coefficients to be extracted to identify specific bone density.

The DEXA scanner

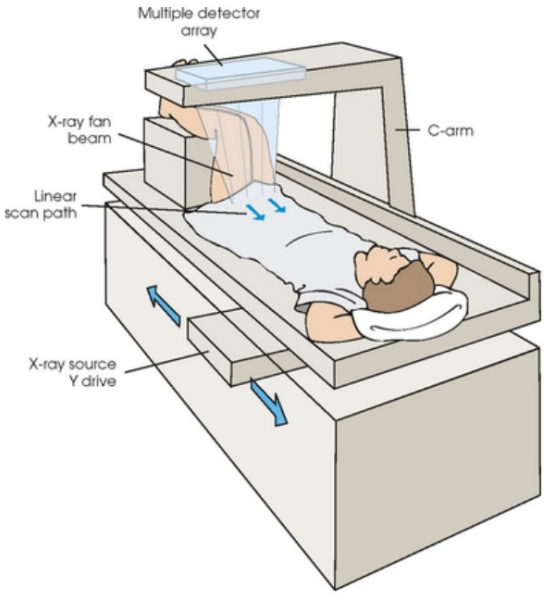


Figure 7 An illustration of a DEXA scanning process

The X-ray tube is situated underneath the bed. The C-arm connects to the detector system above the bed. The detectors move in the same direction and speed as the x-ray tube. A collimator within the x-ray tube housing shapes the x-ray beam which reaches the detectors. Modern scanners have a high resolution multi-detector array, fan beam system. The collimators allow a fan shaped x-ray beam to reach the array of detectors. The diverging beam created in fan beam systems can lead to magnification of the body's structures.

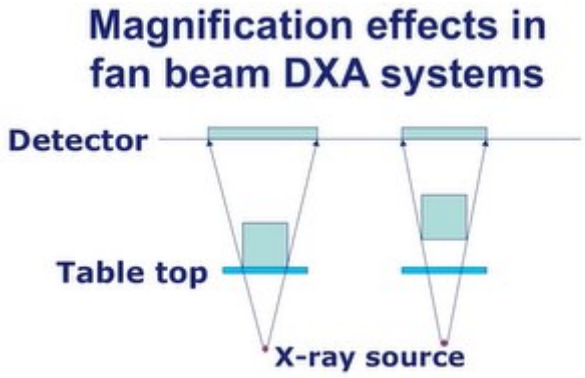


Figure 8 Magnification effects in fan beam DXA systems

As the projected area is used in the calculation of bone mineral content it is important to place the patient on the scanner table in the same position at each visit to make sure changes in BMD are accurate and not artificially created. For example, using the positioning box under the legs for lumbar spine measurements will minimise the magnification effect, improve visualisation of the intervertebral levels for segmentation by reducing the lumbar lordosis.

Dose

The average UK natural background dose is 2mSv per year. The radiation dose from x-rays from a DXA scan is similar to the average UK natural background dose of radiation for a day or two (0.001mSv). When comparing typical effective doses, a bone density scan has a lower effective dose than a chest x-ray or a flight to Spain (Royal Osteoporosis Society, 2021).

Protocols performed

DEXA technology can measure any skeletal site however the gold standard for diagnosing osteoporosis is an axial scan of the PA spine and proximal femur. The femoral neck is the preferred site because of its higher predictive value for fracture risk. The spine is not always suitable for diagnosis in older people because of the high prevalence of degenerative changes, which artificially increases the BMD value, however it is the preferred site for assessing response to treatment.. If neither hip nor spine measurements are possible BMD at the distal radius may be considered.

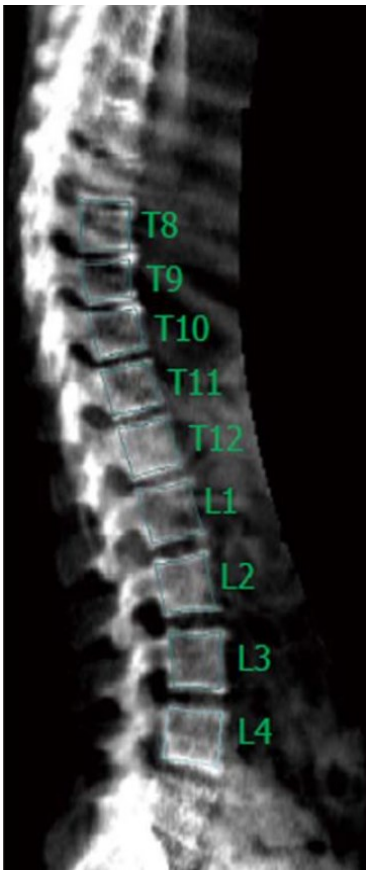


Figure 9 A scan of a spine

Forearms may be scanned in patients who have hyperparathyroidism where this is local protocol. The forearm is made up of more cortical bone compared to the hip and spine which have more trabecular bone. Cortical bone is affected by hyperparathyroidism and therefore scanning the forearm may be useful in these patients.

A vertebral fracture is the most common osteoporotic fracture and a strong predictor for sustaining future fragility fractures. Osteoporosis medications are particularly effective in reducing the risk of vertebral fractures in postmenopausal women. Vertebral fracture assessment (VFA) is a specialist an additional DXA scan used to assess vertebral body dimensions and identify vertebral fractures. The inferior and superior endplates of each vertebrae are identified, and vertebral heights calculated and compared with each other as well as to the expected normal dimensions. With the advent of higher resolution DEXA systems, visual assessment of fractures is also possible from lateral spine images.

(Drampalos et al. 2015)

Radiation Protection

Employers must comply with the Ionising Radiations Regulations 2017 (IRR 17) and the Ionising Radiation (Medical Exposure) Regulations 2017. Assistants Practitioners must comply with all aspects of IRR 2017 and IR(ME)R 2017 regulations. The Assistant Practitioner should ensure the radiation safety of all individuals in the working environment they are responsible for. They should practice within a risk-benefit framework, having regard to the biological effects of radiation working within a defined scope of practice. The AP should understand the local rules and how to contact the Radiation Protection Supervisor (RPS), know the specific responsibilities for radiation protection of patients, employees and the public, how to manage radiation incidents and near misses, and support training of other learners (such as trainee APs) in radiation safety.

Under IRR17 all radiology staff using ionising radiation should complete training in the basics of radiation physics, radiation effects and the legislation.

It is recommended that these resources found in TURAS are completed:
1. Radiation Protection: The Ionising Radiation Regulations 2017 (IRR2017)
2. Radiation Protection: Biological effects, dose and risks
3. Radiation Protection: Introduction to Radiation Physics

The fundamental principles of radiation protection are:

- Justification – the benefit of the dose of radiation must outweigh the risk of the exposure.
- Optimisation – the exposure must be kept as low as reasonably practicable (ALARP)
- Dose Limits – Staff and public must not exceed legal limits; however, dose limits do not apply to justified medical exposures.
- Regulatory guidelines reduce workers exposure to radiation through 3 main principles.
- Time – Limit time spent near the source.
- Distance – scatter radiation reduces as distance increases from the patient and source. The Inverse square law is used to calculate the intensity of any given radiation or distance. When undertaking decubitus views, room design should be a significant consideration.
- Shielding – PPE such as lead rubber apron, thyroid collar, protected eye wear, lead shields, table drapes are used to minimise radiation exposure.

Quality Assurance

Daily, Weekly and Monthly QA may be undertaken on the DXA scanner using phantom scans. This is in order to assess for machine reliability as drift so that an early maintenance inspection may be carried out before a failure or significant drift can be allowed to affect the accuracy of DXA measurements. The results may be saved on the machine or documented locally. You should be able to describe your local department's QA procedures for each scanner and what protocol to follow if results are out with expected values.

Why would dual energy x-ray absorptiometry be used instead of single energy x-ray absorptiometry?

DEXA measures bone density through the attenuation of x-ray photons. What photon energies are used?

Describe the component parts of the DEXA scanner

What daily QA is undertaken on the DEXA Scanner?

What weekly QA is undertaken on the DEXA scanner?

What monthly QA is undertaken on the DEXA scanner?

What action is required if the results are out with the required standards?

As the operator within a DEXA unit, what radiation protection measures must be in place before exposing radiation?

What are the contraindications for DEXA scanning and why?

What should you do if a high or over exposure occurs?

Resources

Royal Osteoporosis Society – Bone Densitometry Foundation Level Course Module 2 – Radiation and Regulation https://theros.org.uk/healthcare-professionals/courses-and-cpd/bone-densitometry-foundation-course/

Royal Osteoporosis Society- Bone Densitometry Foundation Level Course Module 3 -DXA and Dual Energy Absorptiometry https://theros.org.uk/healthcare-professionals/courses-and-cpd/bone-densitometry-foundation-course/

Learning Outcome 3

Prepare the patient prior to undergoing a DEXA scan

Knowledge and Skills

- The process of Justification by an IR(ME)R entitled practitioner and the authorisation process in the assessment of patient suitability for undergoing a DEXA scan
- Communication and Patient Centred Care
- Pre-examination measurements
- Contraindications, artifacts and recent contrast imaging
- Health and Safety

Justification and Authorisation Process

Justification must be performed by registered health professionals who are entitled by the employer as a Practitioner to take responsibility for an exposure (IR(ME)R regulation 2).

AP's cannot be entitled as Practitioners, meaning they cannot justify exposures, they can however, authorise exposures in accordance with guidelines issued by the IR(ME)R Practitioner. Those exposures falling outside authorisation guidelines must be justified by a trained and entitled Practitioner.

Assess the suitability for patients undergoing a DEXA scan

The Assistant Practitioner entitled as Operator under IR(ME)R can perform defined aspects of radiation equipment Quality Control and be able to prepare the equipment prior to each examination. The AP must be able to assess the ability of the patient to move onto the scanner couch, utilising appropriate equipment and techniques to aid the patient. If the patient does not have the ability to move onto the couch, or presents with characteristics that sit outside the scope of practice of the AP, then the examination must not continue without discussion with the senior radiographer (SoR 2023). Assistant Practitioners must follow defined protocols and written procedures, escalating issues outside of their scope of practice to the registered radiographer.

Communication and Patient Centred Care

"[Patients] have a right to expect that everyone working in the NHS has the appropriate skills and training for their job and that care and treatment is provided with reasonable care by properly qualified NHS staff" (Charter of patient rights Gov.Scot 2022). The Assistant Practitioner should work individually, collaboratively and/or in partnership to deliver person-centred care. They should meet the care needs of individuals sensitively and respectfully having regard to the impact of illness and trauma, and to socio-cultural differences. The patients identity must be confirmed as per IR(ME)R employers procedures. Where appropriate pregnancy must be confirmed, including inclusive pregnancy and breast/chest feeding status. The referral and clinical history should be confirmed with the patient. Patients require to be given a clear explanation of what is involved and what is expected of them and

gain consent prior to undertaking the imaging examination. The AP should communicate the risks and benefits of doing the exam (as required by IR(ME)R).

Pre-Scan Measurements and Questionnaire

The patient's date of birth, sex, weight and height must be obtained, and a clinical questionnaire completed. Recording of the patient's height and weight are essential pieces of information required for the scan software prior to undertaking the scan. This is used to calculate a FRAX score.

The questionnaire is used to help determine fracture risk, interpret the BMD measurements and the best treatment plan for each individual patient. For example, a patient with a history of stomach ulcers would not be recommended Alendronate. The questionnaire may also detail fracture risk factors including family history. The questionnaire gives the opportunity to find out about any previous operations or procedure that may affect the DXA scan. The Assistant Practitioner should make sure that the questionnaire is completed. If a patient has answered "yes" for any questions, ask them to expand on their answer.

Contraindications, artefacts, and recent contrast imaging

Artefacts can affect the BMD measurements regardless of whether it overlies the bone or soft tissue. This includes contrast media from recent imaging studies, clothing artifacts, implantable devices and internal fixation and protheses. It is essential that the Assistant Practitioner checks the patients and their clothing for any metal artefacts, which may affect the quality of the image, and investigate recent contrast imaging. Differences in thickness of clothing affects the accuracy of the scan, especially when scanning follow ups. Reproducibility is very important and the patient should be asked to change into a gown for scanning.

Figure 10 A scan of a replacement hip joint

Health and Safety

The Assistant Practitioner should help with moving and handling where necessary. Any problems encountered during positioning of the patient should be recorded.

Proficiency in infection control procedures is essential. Standard Infection Prevention Control – infection control precautions that should be applied as principles by all healthcare staff to the care of all patients at all times.

Proficiency in basic life support techniques and moving and handling is essential.

What is the importance of the pre-examination questionnaire?

Locate the patient questionnaire at your local site. Give examples of three questions included on the form and state their relevance.

1.

2.

3.

Why is it important to change the patient for their DEXA scan?

In terms of positioning, what factors can affect BMD?

What are your responsibilities in infection prevention and how do you carry these out?

What is the importance of recording the patients' height and weight prior to the DEXA scan?

What external artefacts may affect the DXA scan?

Resources

Successful completion of the following learn pro modules is mandatory prior to commencement of practical training in diagnostic DEXA examinations.

- GGC: Standard Infection Control Precautions
- GGC: Manual Handling Theory
- Awareness and understanding of GGC Consent Policy on HealthCare, Care and Treatment and its relevance to seeking consent prior to undertaking DEXA examinations.

Inclusive pregnancy status guidelines for ionising radiation: Diagnostic and therapeutic exposures | SoR

Have you paused and checked? IR(ME)R | SoR

Learning Outcome 4

Demonstrate the ability to perform a DEXA Scan
DEXA is subject to IR(ME)R regulations and quality acquisitions are wholly reliant on Operators training and expertise in technique. If repeat imaging is required due to poor technique, Optimisation, which is an integral element of IR(ME)R would not be achieved.

DXA measurements are prone to error; precision errors must be reduced as far as is practical. Precision error may be reduced by:

- Scans only being performed by a small team of well trained and skilled operators.
- Robust protocols and standard operating procedures.
- Routine evaluation, audit and review cycles of clinical practice embedded as culture.

To minimise Precision error, and increase the reliability of data and scan measurements, DEXA teams should:

- work within the confines of written local standard operating procedures for scan acquisition and analysis to support precision error reduction and promote reliability of measurements.
- measure performance against the standards and integrate with quality improvement programmes.
- maintain knowledge and understanding using ROS DEXA Quality Standards checklist and DEXA scan technique audit tool.

Knowledge and Skills

- Positioning of patient and centring the scanner
- Scan acquisition
- Radiation protection of patient and staff

Patient positioning is a major source of error in repeat bone density. Positioning should be standard to allow reproducible results. A few degrees of difference can influence the T-scores. Precision errors can be caused by

- Too many operators not following tight protocols
- Equipment drift
- Patient condition
- Obesity may increase inhomogeneity to the spine
- Hip-fat panniculus

Proximal Femur

The patient should be lying along the centre of the table. Abduct the leg so that the femoral shaft is positioned parallel to the long axis of table. Internally rotating the femur 15-20 degrees will bring the femoral neck parallel to the plane of the scan table. Internally rotate the whole leg, rather than just the ankle. This amount of internal rotation presents the long axis of the femoral neck perpendicular to the x-ray beam, providing the greatest area and the most accurate measurements of BMD. Positioning aids should be used for consistent positioning.

Adapted from Ramos et al., 2011.

Figure 11 A patient getting a scan of a proximal femur

The scanning arm must be centred over the femur, below the greater trochanter (15cm below ASIS) and in the midline of the femur. The femur should be vertical in the field of view. The acetabulum should be demonstrated fully. There should be little or no lesser trochanter demonstrated. The lesser trochanter is an important anatomic structure from the perspective of recognising the degree to which the femur has been rotated during positioning for a proximal femoral bone density study. It should be remembered that individual anatomy does vary person-to-person.

Positioning- the proximal femur scan

- The femur is projected vertically in the Field of View (FOV)
- The scan ends with the acetabulum fully visualised appropriate to manufacturer
- Little or no lesser trochanter is visible
- The scan starts below the ischium appropriate to manufacturer

Analysis- the proximal femur scan Bone mapping and edge detection accurately reflects bone

- The mid femoral line evenly bisects the femoral head
- GE LUNAR: the femoral neck box is 90o to the mid femoral line HOLOGIC: the femoral neck box is 90o to the mid femoral line and is moved to be adjacent to the medial portion of the greater trochanter
- There is no bone projected in the femoral neck box except for femoral neck

PA Spine

The patient should be lying supine along the centre of the table with their spine within the scan area marked on the table top. The patient should be lying straight and central with legs elevated so that the block is beneath the knees with hips flexed at 70 – 90 degrees to reduce lumbar lordosis.
Note should be taken at which height the block is used, and if extra pillows are used. This position can then be repeated for any future scans, to ensure good precision and therefore any rate of change shown to be true to the patient changes and not to changes in operator.

Centre the laser cross level with the anterior superior iliac spine in the midline. the scan should start in the body of L5 and iliac crest may be evident. The scan should end in the body of T12, ribs may be evident. The spine should appear straight and central within the field of view.

Adapted from Ramos et al., 2011.

Figure 12 A patient getting a scan of PA spine

Positioning the lumbar spine

- The spine scan starts in the body of L5
- The spine is straight/vertical in the field of view (FOV)
- The spine is central in the FOV
- The spine scan ends in the body of T12

Analysis of lumbar spine scan

- Bone mapping and edge detection accurately reflects bone
- Vertebral levels are accurately identified and labelled
- Intervertebral markers are equidistant and parallel to vertebral endplates inferiorly and superiorly
- Vertebral fractures, sclerotic an degenerative changes are excluded and artifacts managed appropriately

Forearm

The non-dominant forearm is scanned assuming there has been no previous fracture. Measure the forearm length from olecranon to the ulna styloid process. Sit the patient on an armless, stable chair as close to the table as possible.

The forearm needs to be in the centre of the table and parallel to the long axis of the table top. The patient should form a loose fist and the styloid processes are equidistant from the table top. Centre 2-3cm distal to the styloid processes at the midpoint between.
The first row of carpal bones should be visualised and the forearm vertical in the field of view.

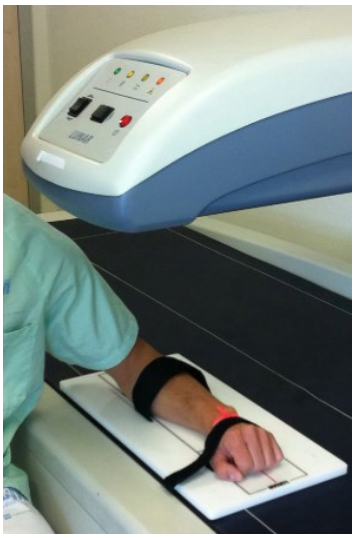


Figure 13 A patient getting their forearm scanned

Adapted from Ramos et al., 2011

Vertebral Fracture Assessment

Vertebral fracture assessment can be performed with either supine lateral scanning or lateral decubitus depending on the system.

C-arm machine specific

The patient should be lying along the centre of the table with their spine in the middle third. The patient should be lying straight with legs elevated so that the block is beneath the knees with hips flexed at 70 degrees. Have the patient raise the arms above head and rest on pillow. The patient's shoulders should be below upper border of scan area.
Centre the laser over L5 approximately 10cm inferior to the iliac crest and 10cm anterior to the posterior skin surface.
The patient should breathe normally.

Figure 14 A scan of a spine

The Royal Osteoporosis Society provide DEXA toolkits to support optimisation of scans.
Guidance on Vertebral Fracture Assessment sets standards for scan positioning. It is designed to support DEXA teams to:

- Make reliable VFA scans.
- Write and develop local standard operating procedures for scan acquisition.
- Measure performance against the standards and integrate with quality improvement programmes.
- Support delivery of quality improvements in VFA scanning technique.

So that:

VFA scans are optimised and provide the best opportunity to identify vertebral fractures in appropriate patients and that they can access appropriate care to reduce the risk of further fractures.

VFA positioning guide

Positioning- lateral decubitus

Royal Osteoporosis Society
Better bone health for everybody

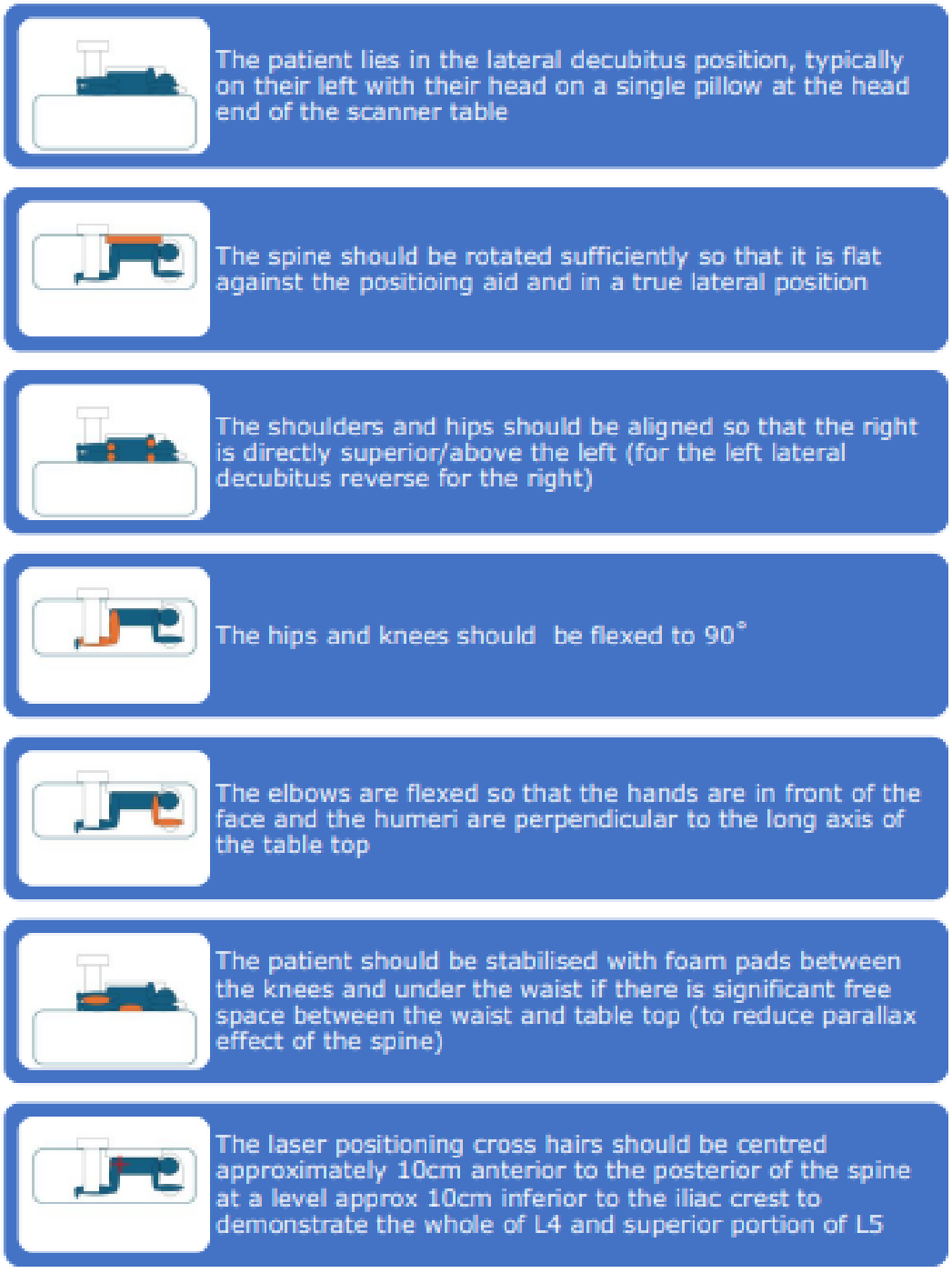


Figure 15 VFA positioning guide

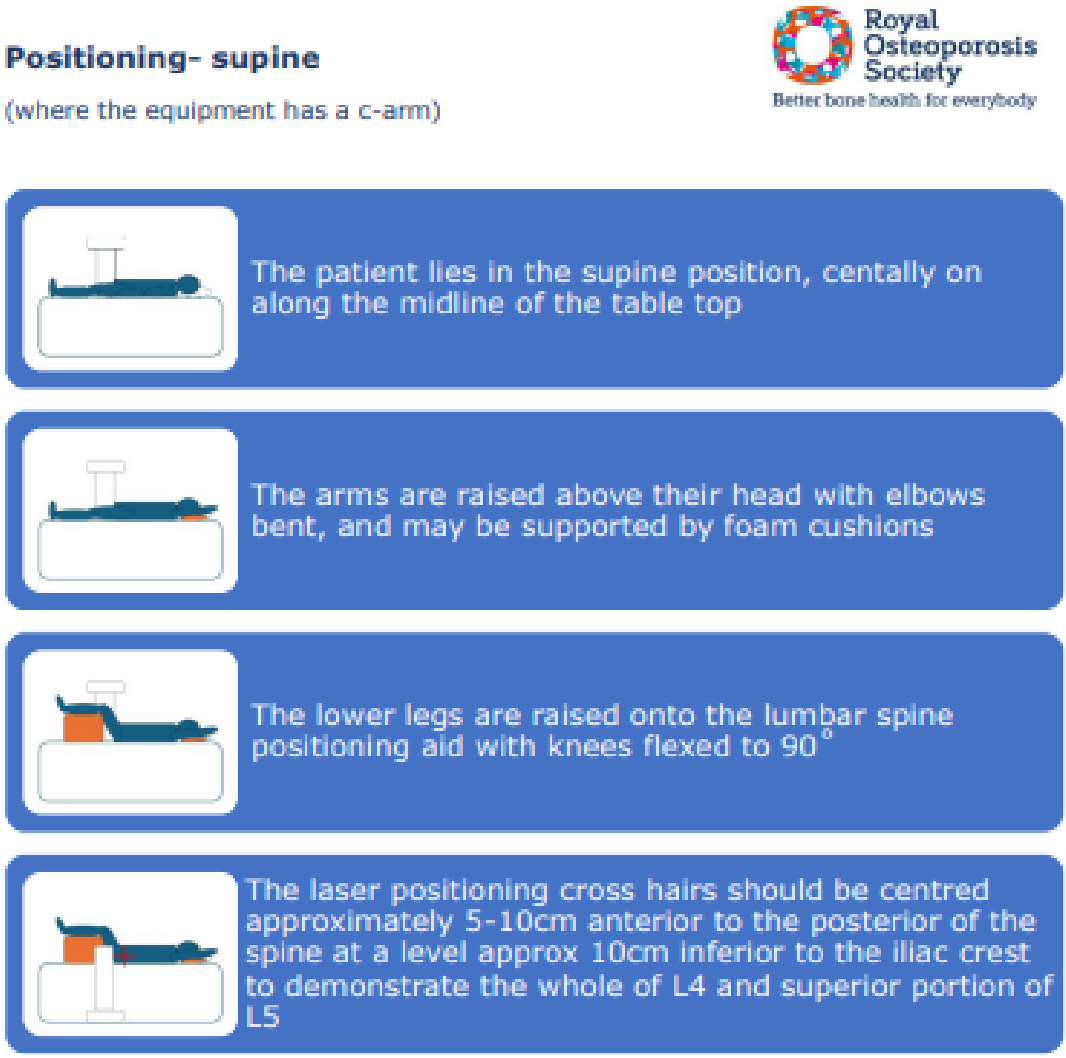


Figure 16 Positioning - supine

References:
DXA quality standard checklists DXA toolkit (theros.org.uk)

Radiation Protection of Patient and Staff

Scattered radiation is the primary source of radiation dose to members of staff. The key determinants for any radiation dose to staff are workload and the size, design and location of the room that houses the DXA scanner. The compact nature of many scanners often results in installation into a small room. The Radiation Protection Advisor (RPA) should be consulted at all stages of the planning process, critical examination and installation with regular review of workloads and doses to staff. Manufacturer guidelines will suggest optimum distances for Operators of DEXA scanners and additional shielding may be required dependent on room size to keep staff doses ALARP (IRR17).

Patient dose is dependent on a wide range of factors such as age, sex and body size, whilst others are related to the scan itself, such as beam filtration, tube current, tube potential, imaging speed, scan length and width, number of images and the selected imaging protocol. The protocols may be pre-set by the manufacturer and should be reviewed by the RPA on installation and at regular intervals to assess suitability and radiation dose. The reliability of the DEXA unit is assessed with a thorough Quality Assurance programme. Manufacturers often provide a test object used for daily QA to ensure the consistency of the results obtained.

Describe the patient positioning for an examination of the proximal femur?

Why is this position important?

What immobilisation aids are available and how are they used?

If pain prevents rotation of the femur to attain position what should you do?

What is an average radiation dose for the following procedures?

- Proximal femur
- Spine
- Forearm

What radiation safety procedures are in place within your local DEXA suite? For example warning lights/QA

Resources

EL-MAGHRAOUI, A., & ROUX, C., 2008. DXA scanning in clinical practice. *QJM International Journal of Medicine*. 101(8), pp. 605-617. Available from: https://academic.oup.com/qjmed/article/101/8/605/1538763

Ionising Radiation (Medical Exposure) Regulations (IR(ME)R), 2018. https://www.healthcareimprovementscotland.org/our_work/inspecting_and_regulating_care/ionising_radiation_regulation.aspx

Ionising Radiations Regulations, 2017. https://www.legislation.gov.uk/uksi/2017/1075/contents/made & also L121 HSE publication

Learning Outcome 5

Perform post examination procedure

Knowledge and/or skills

- Exam data entry
- Asses correct positioning of Region of Interest
- Result distribution

Image Critique

Critical Evaluation of the technique for the DEXA scan image should be reviewed to check that the patient is positioned correctly before the patient leaves. The DEXA scan should be assessed for visible artefacts that may impact on the BMD measurements such as aortic calcification. Improper patient positioning and scan analysis may result in poor precision or poor reproducibility.

Regions of Interest

The scanner software marks the regions of interest in the spine and hip, but the operator should critically assess this process. The correct regions of interest should be selected that facilitate computerised analysis of data and recording of results. T-scores and Z-scores are found on the computer generated bone densitometry report. The individual BMD values for each vertebrae are listed as well as the BMD values for each possible combination of contiguous vertebrae.

Spine

The spine region of interest consists of the L1 – L4 vertebrae. Correct placement of the top and bottom of the spine "box" is critical. The intervertebral lines can be moved or angled, if necessary. There should be sufficient soft tissue on both sides of the spine otherwise BMD will be under estimated. The scanner software may have low density software/auto-low density software that automatically facilitates edge detection.

Correct placement of the ROI
Correct numbering of lumbar vertebral levels
Ensure vertebral markers are equidistant from the superior and inferior endplates of adjacent vertebrae

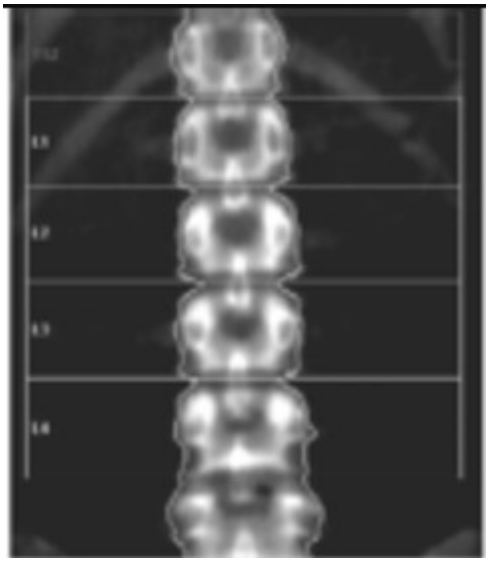


Figure 17 A scan of L1 - L4 vertebrae

Scoliotic Patients

You may have to angle the intervertebral markers between the disc levels in patients who have a scoliotic spine. If the joint space is divergent you can use a diverging line technique to differentiate levels more accurately.

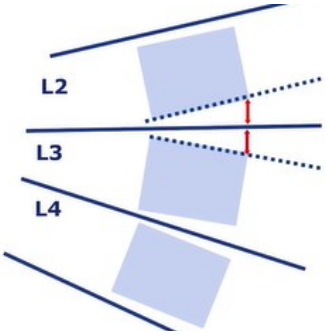


Figure 18 Angles of intervertebral markers

Exclusion of Vertebral Levels

Exclusion of vertebrae should be considered when there is an obvious fracture, severe osteoarthritis or other artefacts. A fracture can artificially raise the average T-score recorded. A vertebral level which has more than a one standard deviation difference in T-Score between the adjacent vertebrae and evidence of defect or artefact on the image should be excluded to give a more accurate result. If in doubt this should be checked with a DEXA Lead Radiographer. There must be a minimum of two vertebral levels included to facilitate a diagnosis.

Proximal Femur

The proximal femur is divided into specific regions of interest. Wards triangle is an anatomic region in the neck of femur that is formed by the intersection of three trabecular bundles. In densitometry it is a calculated region of low density in the femoral neck rather than a specific anatomic region. The total femur region of interest encompasses all of the femoral neck, wards area, the trochanteric region and the shaft.

The hip regions of interest include the femoral neck, trochanter and total hip. Ward's region and the inter-trochanteric region are not excluded from analysis. The default hip analysis includes a midline that must be placed correctly.

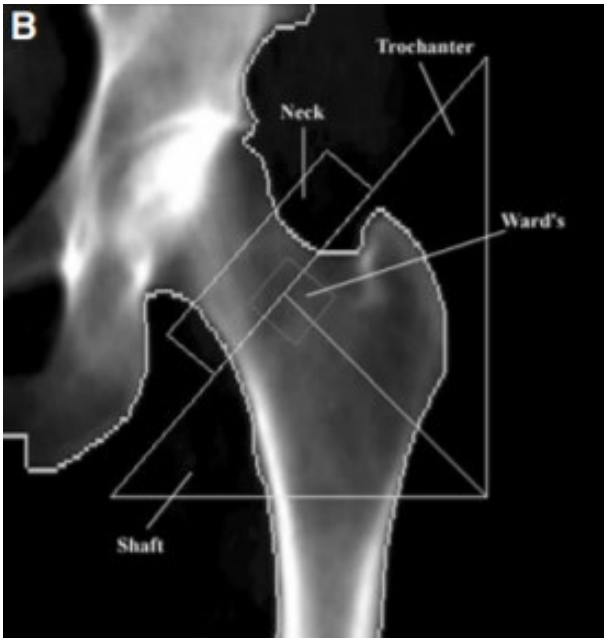


Figure 19 Scan of a proximal femur

The femoral neck box should be anterior to the greater trochanter at the base of the femoral neck. This same size analysis box or a compare facility should be used for follow up scans. A mid femoral line should bisect the head of femur. The femoral neck box is at 90 degrees to the mid femoral line with 4 corners in soft tissue. There should be no additional (such as ischium) bone projected within the femoral neck box.

Forearm

Global ROI – place the reference line on the ulnar styloid tip so that the box sits on the ulna styloid process as shown. The ultra-distal line sits immediately inferior to the radial end plate. The central vertical division should be between the radius and ulna.

Figure 20 Scan of forearm

Exam Data Entry

All relevant details of the DEXA examination should be entered on to the Radiology Information System and images sent to PACS, to be reported.

Results

Detail the various routes for distribution of results and information to the patient. The patient needs a clear explanation about what will happen next and where they should get the result of their scan.

What is the importance of the correct placement of ROIS when performing serial BMD measurements?

Why is it important to ensure correct numbering of vertebral levels?

How does aortic calcification affect BMD measurements?

What considerations should you make in terms of patients with a moderate or severe scoliosis?

What considerations should you make if one vertebrae within a DXA scan has severe endplate sclerosis, facet joint sclerosis or presence of degenerative disc disease?

What other internal radiopaque artefacts may increase the measured BMD if included in the ROI?

What is Ward's triangle?

Describe the electronic post examination procedures required to ensure the results are communicated to the relevant people and systems.

Describe the verbal explanation given to patient at the end of their scan regarding access to results.

Resources

JACOBSON, J., JAMADAR, D and HAYES, C., 2000. Dual-X-Ray Absorptiometry: Recognising Image Artifacts and Pathology. The American Journal of Radiology. https://www.ajronline.org/doi/pdf/10.2214/ajr.174.6.1741699

ROS, ros-dxa-scan-quality-standard-checklist-v1.pdf (windows.net)

Learning Outcome 6

Demonstrate a training record evidencing competency

Continuous Clinical Assessment

Assessment will take the form of continuous assessment of clinical competency in DEXA imaging under the supervision of a designated clinical mentor. This assessment should be regularly reviewed throughout the training period by both the training Assistant Practitioner and the clinical mentor to monitor and identify learning needs throughout the training process.

The Continuous Clinical Assessment also consists of 3 training review forms that should be completed by the Assistant Practitioner and clinical mentor. The review forms should be spread out over the course of their clinical time in DEXA. The Assistant Practitioner should critically analyse their own performance, identify areas of improvement and discuss their learning needs with their assigned clinical mentor. At the end of clinical training the Assistant Practitioner and clinical mentor should complete the Competency Assessment form to evidence that the Assistant Practitioner has met the set learning outcomes and competency attainments of this work based module.

Scottish Clinical Imaging Network
A WORK BASED MODULE FOR ASSISTANT PRACTITIONERS TRAINING IN Dual Energy X-Ray Absorptiometry (DEXA)
Mid Training Review and Reflection Form 1

Module Title: Assistant Practitioner DEXA imaging.

The reflection log will include reflection on practice by the assistant practitioner and feedback from the clinical mentor and this will culminate in a detailed pathway to clinical competence.

What has gone well throughout the training so far? Consider competencies met so far.
What do I want to achieve going forward and what do I need to achieve this? Consider competencies to be met and learning needs.
Action Plan
Feedback from supervising radiographer
Assistant Practitioner Name/ date
Supervising Radiographer Name/ date

Mid Training Review and Reflection Form 2

Module Title: Assistant Practitioner DEXA imaging.

The reflection log will include reflection on practice by the assistant practitioner and feedback from the clinical mentor and this will culminate in a detailed pathway to clinical competence.

What has gone well throughout the training so far? Consider competencies met so far.
What do I want to achieve going forward and what do I need to achieve this? Consider competencies to be met and learning needs.
Action Plan
Feedback from supervising radiographer
Assistant Practitioner Name/ date
Supervising Radiographer Name/ date

Mid Training Review and Reflection Form 3

Module Title: Assistant Practitioner DEXA imaging.

The reflection log will include reflection on practice by the assistant practitioner and feedback from the clinical mentor and this will culminate in a detailed pathway to clinical competence.

What has gone well throughout the training so far? Consider competencies met so far.
What do I want to achieve going forward and what do I need to achieve this? Consider competencies to be met and learning needs.
Action Plan
Feedback from supervising radiographer
Assistant Practitioner Name/ date
Supervising Radiographer Name/ date

Learning Outcome 1	Competency met (please initial when met)		
Describe the anatomy, pathology and clinical criteria relevant to DEXA Scanning	Initial	Interim	Final
Able to state WHO definition of osteoporosis			
Understands the role of bone monitoring in disease management			
Able to explain the term DEXA			
Able to explain indications for DEXA			
Able to explain the various referral pathways/ routes to DEXA			
Understands the purpose of T and Z scores			
Can describe the factors that may cause an inaccurate result			

Learning Outcome 2	Competency met (please initial when met)		
Demonstrate the knowledge required to operate DEXA equipment safely	Initial	Interim	Final
Performs start up and shut down procedures correctly			
Demonstrates safe use of table and gantry controls			
Is able to register a patiently manually or from RIS scheduler			
Is able to access and select specific protocols			
Able to identify scanning area on table			
Can locate and where necessary manipulate scan parameters			
Understands and can demonstrate appropriate windowing and image presentation			
Can print off relevant reports or scan print outs			
Is able to archive, retrieve and transfer to and from other locations or storage media			
Able to identify emergency stop button			
Can perform required QA			
Able to identify if QA tests fails or phantom is outside tolerances			

Learning Outcome 3	Competency met (please initial when met)		
Prepare the patient prior to undergoing a DEXA scan	Initial	Interim	Final
Identify the patient			
Provides explanation of the procedure to obtain consent			
Ensure patient questionnaire is complete			
Identifies any individual needs, manual handling of further requirements			
Relevant patient preparation undertaken in including changing clothes whilst ensuring patient privacy			
Obtains height and weight and correctly enters into software			
Enters fracture risk assessment			

Understanding of contra-indications for performing hip or spine scans			
Understanding of circumstances when scan mode should be changed			
Patient is positioned appropriately			
Ensures that Radiation protection measures are in place			
Undertakes scanning procedure, observing and communicating with patient throughout			
Safely assists the patient from the scanning bed and provides information on what happens next			
Infection control precautions are used appropriately			
Can describe the factors that may cause an inaccurate result			

Learning Outcome 4	Competency met (please initial when met)		
Explain and demonstrate the ability to perform a range of DEXA examinations	Initial	Interim	Final
Select correct scan parameters for the examination			
Correctly positions patient on scanning table			
Is aware of protocol variations for example THR, spinal surgery, patient condition			
Can demonstrate how to change scan mode were necessary			
Correctly positions the anatomical are under examination (as per local protocol) -Lumbar spine -Proximal femur -Forearm -IVA Other (please detail)			
Can demonstrate when to reposition scan and how			
Can manipulate automatic image produced when necessary			
Reviews images for quality, patient movement, artefact, pathology			
Scanner is centred and start and end points set as per protocols			

Learning Outcome 5	Competency met (please initial when met)		
Perform post examination procedure	Initial	Interim	Final
Attends to patients post examination needs and explains process for results			
Verifies correct positioning of anatomical area scanned			
Reviews images for quality, movement, artefact and so on.			
Positions the regions of interest (ROI) correctly			
Identifies vertebral levels and knows when to exclude			
Sends scan to PACS with correct comparisons			
Performs analysis of scans			
Can discuss the result			

Documents any further comments within patient record			
Saves patient data			

Final Assessment

All competency assessments included within the work based module have been met.	Date completed:	Signature of clinical mentor

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Appendices

Appendix 1: Guidance for the Clinical Mentor, Line Manager and Assistant Practitioner

Guidance for the Clinical Mentor, Line Manager and Assistant Practitioner

In the context of the integration of health and social care services in Scotland and wider public sector reform, AHP staff are being asked to work in new roles and deliver new models of service. This requires robust clinical and professional governance arrangements to be in place to support staff. Clinical supervision ensures staff practice safely and effectively while maintaining high professional standards of professional conduct. The purpose of this document is to provide guidance for the clinical mentor supporting the Assistant Practitioner training in DEXA/DXA. The document focuses on the purpose of supervision within the healthcare environment underpinned by an evidenced based framework, the expectations of both the assistant practitioner and clinical mentor and the responsibilities included within the clinical mentor role.
The identified clinical mentor, assistant practitioner and line manager will sign **a learning contract** (Appendix 2) that identifies the commitment that all parties will make to the process. The expectations of the above parties are outlined in this document.

Purpose of Supervision

Professional supervision is defined as “a formal process of professional support and learning, which enables individuals to develop knowledge and competence, assume responsibility for their own practice and enhance consumer protection and safety of care in complex situations” Department of Health (1993). Clinical supervision is a formal/informal arrangement that enables a practitioner to discuss his or her own work performance in a safe environment with someone who is more experienced (DHSSNI, 2014). The overall intention of supervision is to improve professional self through lifelong learning, improve professional practice and to feel, and be supported as a member of staff (NHS Lanarkshire, 2010). This is with the aim of ultimately supporting the delivery of safe, effective, and person-centred care to the people who use health and social care services. (NHS Education for Scotland 2018).

Supervision Training

NHS Education for Scotland (NES) Clinical Supervision is an online training resource available at TURAS and Units 1-4 are designed for Supervisors. The resource is designed to support practitioners to develop relevant knowledge and skills for participating in clinical supervision.

https://learn.nes.nhs.scot/3580/clinical-supervision

Expectations of the Line Manager

Professional and / or service manager with supervisory authority. The line manager will:

1) Identify a local clinical educator who will provide guidance and supervision throughout the practical training. A DEXA lead radiographer or employees line manager should ensure that the Assistant Practitioner is appropriately clinically supervised throughout their training. This may involve one to one supervision with the identified clinical mentor or ensuring that a team of suitably qualified and experienced radiographers are available to provide supervision if the clinical mentor is not present.
2) Allocate the Assistant Practitioner an adequate allowance of clinical time and independent study time. The Assistant Practitioner must be allocated to a DEXA site and given time to gain experience undertaking DEXA examinations.

To allow for provision of supervision, it is anticipated that managers/leads will commit to offering protected time so that staff can plan for and engage meaningfully in their supervision sessions (NHS Education Scotland 2018).

Expectations of the Clinical Mentor

As a clinical mentor your role is to support the Assistant Practitioner with their practical training in DEXA/DXA and help the individual to meet the learning outcomes outlined within this module. From the outset the clinical mentor and Assistant Practitioner should be clear about their expectations and agree and maintained their roles and responsibilities.

Proctors Model of Supervision is a framework used to underpin the key components of effective clinical supervision: accountability, learning and support (Supervision Toolkit Helen and Douglas House, 2014).

Diagram 1 Proctor's model of supervision

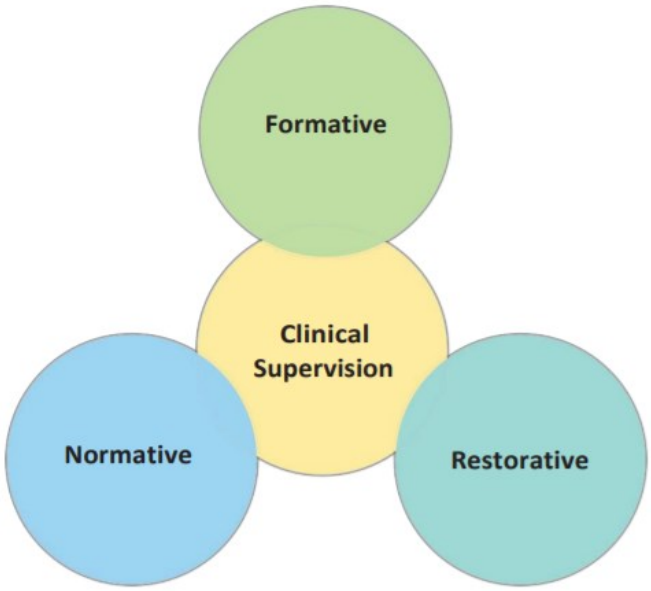

Figure 21 Diagram of Proctor's model of supervision

Normative (Accountability): This element focuses on supporting individuals to develop their ability and effectiveness in their clinical role, enhancing their performance for and within the organisation. The aim is to support reflection on practice with an awareness of local policy and codes of conduct.

Formative (Learning) is also referred to as the educative element. It enables participants to learn and continually develop their professional skills fostering insightfulness through guided reflection within the supervision process. It focuses on the development of skills knowledge, attitudes and understanding.

Restorative (support), this element is concerned with how participants respond emotionally to the work of caring for others. It fosters resilience through nurturing supportive relationships that offer motivation and encouragement and that can be drawn upon in times of stress.

These have been used to shape the goals and outcomes of clinical supervision within the work-based module. The role of the clinical mentor is multi-faceted and involves supporting the quality of work undertaken by the participant, being an educator and role model and providing support throughout the training. There is also a need to motivate and empower participants to take responsibility for the development of their understanding and practice (Helen and Douglas 2014).

Responsibilities of the Clinical Mentor

1. The Clinical mentor should be an experienced DEXA radiographer who is based within the Assistant Practitioner's own clinical service. The mentor should provide adequate supervision to support the development of knowledge, skills, values and best practice. They should provide a supportive environment for professional development and growth, facilitating questioning and structured reflection.
2. Support the Assistant Practitioner in reflecting on the effectiveness of their clinical time. The clinical mentor and trainee should meet on a regular basis to discuss training progress. The mentor should make use of the Training Review Forms located within the module. These forms are designed to facilitate the Assistant Practitioner to reflect on their training progress, identify areas of improvement and learning needs. These should also be used to facilitate a discussion between the assistant practitioner and mentor and provide an opportunity for constructive feedback.
3. Assess the Assistant Practitioner's ability to undertake clinical work in DEXA imaging to a satisfactory standard. The mentor will undertake the Assistant Practitioner's Continuous Clinical Assessment located within the module. The mentor should review the required competencies required of the Assistant Practitioner and may use this as a guide to structure the training period. Competencies are designed to ensure that the Assistant Practitioner has met all the module's Learning Outcomes.

Expectations of the Assistant Practitioner

1. Commit the necessary effort and time to undertake the course activities. The Assistant Practitioner should take responsibility for making effective use of time, and for the outcomes and actions taken as result of the supervision
2. Complete the required competencies They should take an active role in their own personal and professional development in order to meet the learning outcomes of the module and meet competency attainments.
3. Undertake the clinical practice requirements of the module. Practice based activities are linked to each learning outcome and are designed to build knowledge and experience in the necessary competency area.
4. Plan and undertake appropriate action to meet personal learning needs required to develop knowledge and skills in DEXA imaging. This includes preparing for supervision sessions and identifying issues from their practice for discussion with the clinical mentor.

Appendix 2 Learning Contract

NHS Greater Glasgow and Clyde: Learning Contract

This Learning Contract defines the agreement between the selected Assistant Practitioner, the clinical mentor and line manager in relation to the Assistant Practitioner's completion of DEXA imaging work based module.

Line Manager: Professional and / or service manager with supervisory authority. The **Line manager will**

1. Identify a local clinical mentor who will provide guidance and supervision throughout the practical training.
2. Allocate the Assistant Practitioner an adequate allowance of clinical time and independent study time.

Clinical Mentor

1. An experienced DEXA radiographer or technologist who is based in the Assistant Practitioner's own clinical service.
2. Support the Assistant Practitioner in reflecting on the effectiveness of his/her clinical time.
3. Assess the Assistant Practitioner's ability to undertake clinical work in DEXA imaging to a satisfactory standard.

The Assistant Practitioner will

1. Commit the necessary effort and time to undertake the course activities.
2. Complete the required competencies.
3. Undertake the clinical practice requirements of this module.
4. Plan and undertake appropriate action to meet personal learning needs required to develop knowledge and skills in DEXA imaging.

Additional Local Agreements

If appropriate, please include any locally agreed responsibilities and/or requirements below:

Line Manager

Name Sign	Date

Clinical Mentor

Name Sign	Date

Student

Name Sign	Date

Appendix 3: Risk Assessment for Assistant Practitioner as Authorising Operator

The Assistant Practitioner must be supported by a diagnostic radiographer registered with the HCPC with experience at assessor or supervisor level. In line with normal clinical practice, a record of completion of Manual Handling, Infection Control and Health and Safety policies must be in place to underpin the APs ability to be able to work within their defined scope of practice in regard to the patient's condition, manual handling, and equipment requirements.

Assistant Practitioners are responsible for the tasks they undertake, if a situation arises that they consider outside their competency or scope of practice, they should inform the supervising radiographer immediately (SoR 2012).

Assistant Practitioners must be aware of their responsibility regarding radiation protection legislation IRR17 and IR(ME)R17. They must assess the situation with regards to the patient, carers, the public and other staff members.

Concern/Risk	Who could be affected	Risk controls in place	Risk assessed as	Further actions to control risk
Assistant Practitioner is not registered with HCPC	Staff and patients	Training programme and Experiential learning. Scope of Practice. Supervision by a Radiographer. Competency sign off.	Low	Accredited with College of Radiographers. Extended Scope of Practice submitted to Accreditation and Approval panel
Radiation risk from unjustified examination being performed	Patients	Training Programme and experiential learning >2year. Supervision by a radiographer. Competence Assessment of Authorisation	Low	
Investigation risk from lack of understanding of Authorisation guidelines	Patients	Assistant Practitioner is > 1 year in post and has undergone experiential learning during this time	Low	Training will be provided to promote understanding of following guidelines issued by the Practitioner to support AP

				authorisation of exposures in accordance with IR(ME)R.
Uncertainty regarding referral history	Patients	Indirect supervision by radiographer. >2 year experiential learning.	Low	Training will be provided to promote understanding of following guidelines issued by the Practitioner to support AP authorisation of exposures in accordance with IR(ME)R.
Risk Assessment performed by:				
Date:				