The Radiographers role in DXA: Sports medicine and MSK

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Biography

Karen Knapp is a diagnostic radiographer and an Associate Professor in Musculoskeletal Imaging at the University of Exeter. Having specialised in dual energy x-ray absorptiometry and osteoporosis, Karen obtained a PhD in Radiological Sciences from King's College London working with internationally renowned groups in osteoporosis and twin research. During her post-doctoral position, Karen honed her educational skills teaching medical students and went on to a lectureship at the University of Exeter. Karen now combines teaching both undergraduate and postgraduate students with research and links the two through research-led education. Karen's primary research interest continues to be bone health, osteoporosis and diagnostics.

DXA background and utilisation

Dual energy x-ray absorptiometry (DXA) has progressed over the last 30 years from measurements of bone mineral density (BMD) at the lumbar spine, hip and forearm to a range of additional functions including vertebral fracture assessment (VFA) and total body scans providing body composition measurements. The technological advances have underpinned the expansion of the clinical utilisation of DXA and the role of the radiographer in this speciality is expanding with it. In the United Kingdom, radiographers are reporting DXA scans, running fracture liaison services and in some hospitals, leading one-stop scanning and results clinics for fracture patients (1) .

With the advances in DXA, the role of the radiographer has been required to change to facilitate the needs of the diverse populations being referred through the services and appropriate knowledge developed through education and continuing professional development is essential to underpin practice (2). One area where there is great interest at present is understanding bone inadequacies in athletes, representing a much younger population than radiographers are used to seeing in osteoporosis services.

Bone mineral density measurements in athletes

Radiographers working in DXA where athlete populations are seen must be aware of the musculoskeletal pathologies in athletes. Stress fractures, traumatic fractures, recurrent fractures and disuse osteopenia are among a multitude of issues. Since many athletes are adolescents and young adults, in their period of bone consolidation prior to peak bone mass is achieved, it's important to identify those with bone inadequacies following injury. The female athlete triad results from endurance athletes undertaking significant training, restricted energy intake and amenorrhoea, with similar hypogonadism seen in some male athletes. This has the potential to significantly compromise bone and has been related to stress fractures; BMD measurement can provide a useful complimentary tool to assess bone health where there is a clinical suspicion and to trigger investigations for secondary causes of low BMD. It's important for radiographers in DXA services to understand the potential benefit of assessing BMD in athletes when there is a concern regarding their bone health.

Justification for exposures and pregnancy assessment

Radiographers must ensure there is appropriate justification for the use of DXA in each athlete. In some countries it is commonplace to undertake total body (TB-DXA) scans to measure body composition in athletes, but this remains an illegal practice in the UK due to the availability of other non-ionising radiation methods. In children / adolescents the total body less head and lumbar spine should be measured and in adults, this is the lumbar spine and proximal femur (3) .

Radiographers must take care when checking the pregnancy status in female athletes with amenorrhea or oligomenorrhoea who may not have had a period within the previous 28 days. Radiographers cannot assume that a pregnancy is not possible if the athlete reports unprotected heterosexual activity. Many standard protocols recall patients after their next period, but in this population this may result in an inappropriately long wait. It is therefore possible that pregnancy testing with consent prior to a DXA scan in this population is an option, but radiographers must be trained to do this and to share the results with appropriate support if they are to take on this role. In some hospitals the patient can be rebooked and the referrer can be asked to confirm the pregnancy status of the patient prior to a scan being undertaken.

Radiographers must be aware that the ability of DXA to measure short-term changes in bone, muscle or fat is limited by its precision errors. Precision errors underpin a minimum threshold for detecting changes within an individual, referred to as the least significant change (LSC). Furthermore, results from different scanners both within and between different manufacturers cannot be directly compared due to potential calibration differences (4). Precision errors vary based on the patient's size and body fat, with obese patients having the highest precision errors (3). If longitudinal DXA measurements have been undertaken, radiographers must remember to compare changes to baseline rather than just to the last measurement (see table 1) and be aware that adolescents and young adults should be in a bone accrual phase of life.

QA

Radiographers undertaking DXA scans ensure that the daily quality assurance (QA) requirements for DXA scanners are undertaken. Both the operator undertaking the scans and the practitioner reporting results must be assured that the scanner is operating within its recommended limits to ensure the accuracy of the results. The daily QA data must be plotted and assessed for sudden changes or long-term slow drifts as both can impact on the accurate measurement of BMD(4).

DXA interpretation and reporting

Radiographers in the UK have extended their scope of practice to DXA reporting. The current World Health Organisation (WHO) used for the diagnosis of osteoporosis is inappropriate for use in young athletes. The International Society for Clinical Densitometry's (ISCD) definition of a Z-score of ≤-2 is an appropriate diagnostic criteria to identify low bone mass for age, gender and ethnicity, but clinical risk factors should also be considered. Radiographers undertaking these scans need to be aware that different sports have differential effects on BMD and there can even be differences between amateur and professional populations in the same sport (1). Athletes with seemingly normal BMD compared to standard reference data may still have bone vulnerability for their sport and it's important that radiographers look beyond BMD.

Clinical risk factors also needs to be considered by the radiographer. Some athletes are reported to have unhealthy behaviours which can contribute to low BMD such as smoking, excess alcohol use and low energy intake; thus the radiographer must consider these alongside the BMD results. Vitamin D deficiency or insufficiency should must be considered

in athletes who predominantly train indoors and supplementation is recommended in the UK with 10µg daily. It's important to also consider calcium intake and there are free calcium food frequency calculators. Calcium in this population should preferably be obtained from the diet and supplementation only considered if this is not possible due to the potential of side effects. Radiographers should be able to provide lifestyle advice or recommend for this be provided in their DXA reports. Collecting relevant information regarding menarche age, menstrual cycles, smoking, alcohol, exposure to sunlight, calcium intake and any drugs or diseases known to effect bone metabolism can help provide a comprehensive clinical picture.

Errors, artefacts and incidental findings

Radiographers scanning and interpreting DXA results must be able to understand the errors and artefacts which may occur. These range from avoidable artefacts such as piercings, buttons or zips on clothing to unavoidable artefacts such as metal implants or renal calculi. It's important that radiographers understand the impact of artefacts on the DXA result, for example in GE Lunar scanners, soft tissue artefacts need to be removed using the software otherwise they will impact on the BMD value, while in Hologic scanners the entire vertebral level where they sit needs to be excluded (5).

Radiographers need to ensure that protocols are adhered to for scanning athletes, particularly for total body scans for body composition where recent training can result in water retention in the muscles, with acute increases in muscle water content being demonstrated post strenuous resistance training.

While bilateral hip scans in a non-athlete population are well correlated, in the athlete population there may be differences between the dominant and non-dominant sides, which may be sport related and not pathological. It's important for a radiographer to understand the impact of disuse osteopenia post injury and the reduction in BMD may not only be at the site of fracture or injury, but proximal to the site. There is evidence that lower limb fractures and resultant off-loading causes a reduction in hip BMD at the ipsilateral hip, which recovers as the limb is loaded during recovery.

Radiographers reporting DXA scans must be aware of potential incidental findings in the athlete population. Femoral acetabular impingement (FAI) is a relatively common finding, particularly in footballers (figure 2) and these findings should be formally reported by a reporting radiographer or radiologist. While the athlete may present as asymptomatic at the

time of the scan, they may suffer symptoms at a later date, or may mask their symptoms for fear of not being able to train or play. Transitional vertebrae (figure 3) may also be detected and these may result in stiffness in the spine. While power athletes tend to have higher than average BMD, cyclists, swimmers and other non-weight-bearing athletes may have lower than expected BMD for their age. As with any clinical population bloods should be recommended to rule out secondary causes when there is concern.

In conclusion, radiographers play a key role in DXA and athletes and an extended knowledge-base is required for practice in this population compared to normal osteoporotic population. Ensuring the safe use of DXA is essential in athletes and the understanding of how precision errors and sports impact on bone and DXA results is essential.

References

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Table 1: Longitudinal changes in body composition for fat (%) and lean

Measurement	Age (years)	Fat (g)	Change vs baseline (%)	Lean (g)	Change vs baseline (%)
Baseline	19.8	6,833	Baseline	53,385	Baseline
6 months	20.4	6,012	-12.0	51,981	-2.6
12 months	20.8	4,456	-34.8*	54,263	1.6

* Change exceeds least significant change.

Figure 1: A total body DXA scan. Bone, lean and fat can be measured from these scans.

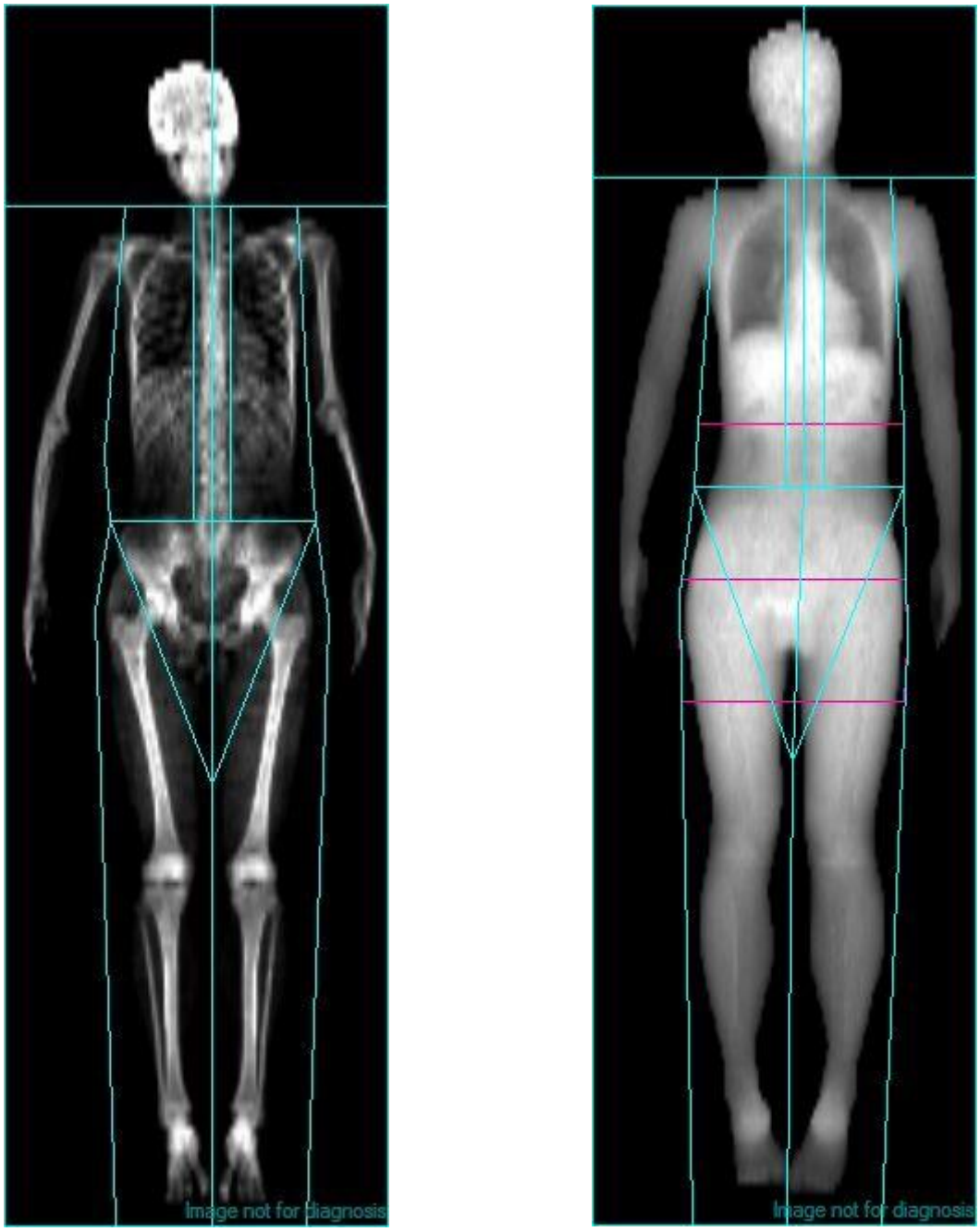

Figure 2: Right pincer-type femoral acetabular impingement in an adolescent footballer

Figure 3: Transitional vertebrae in an adolescent footballer