More about

Technology in medicine

TECHNOLOGY IN BONE DENSITOMETRY

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Over the last few decades there have been major advances in the diagnosis of osteoporosis, not only in the definitions that are now used, but also in the technology that is available. Currently a low bone mass constitutes the most important risk factor for future fractures, and therefore its measurement forms the practical basis for the diagnosis of osteoporosis.

Many techniques are used to assess bone mass. They variously assess mineral content of regional sites, particularly sites at risk of osteoporotic fracture such as the wrist, spine and hip, but also the whole skeleton. These techniques include:

- conventional skeletal radiology
- quantitative computed tomography (QCT)
- quantitative ultrasound (QUS)
- single-photon absorptiometry (SPA)/single-energy X-ray absorptiometry (SXA) (peripheral skeleton)
- dual-energy X-ray absorptiometry (DEXA).

Conventional radiography (X-rays) detects bone loss only when the bone mineral density (BMD) has decreased by about 30 - 50% and is therefore too insensitive to be used for the assessment of bone mass.[1] X-rays are, however, essential to assess the structural impact of established osteoporosis, i.e. to detect the presence of vertebral and appendicular fractures.

QCT provides a measure of true volumetric density (g/cm^3) rather than areal density (g/cm^2) of the spine. It can discriminate between trabecular and cortical bone of the spine.[2] This technique is useful to detect early bone loss and helpful in individuals in whom degenerative changes limit the accuracy of DEXA measurements. However, it is a very expensive test with high radiation exposure and therefore its use should be limited to selected individuals in whom the DEXA finding is inconclusive.[1]

In recent years **QUS** assessment of calcaneal BMD has been introduced for the assessment of skeletal status in osteoporosis. This method is relatively inexpensive, the measuring time is short, the device is portable and it uses no radiation source. It may also provide some information with regard to the structural organisation and quality of bone in addition to bone mass. Current evidence supports the use of QUS for the assessment of fracture risk, specifically in elderly women.[3] The precision and accuracy of this method in all population groups have not been established clearly. Further studies are therefore needed to clearly define the place of QUS in the assessment of the osteoporotic patient.

SPA and **SXA** measure bone mineral at a peripheral (appendicular) site such as the heel and forearm. These techniques are accurate (2 - 5% error) and precise (1 - 2% error), have a low radiation dose and are portable and relatively cheap.[1] There is continuing interest in the development of smaller, less expensive systems for assessing the peripheral skeleton. These include peripheral DEXA, peripheral QCT, radiographic absorptiometry of the hand and techniques to measure phalangeal mineral density. All the abovementioned techniques only assess appendicular sites and cannot assess BMD of the hip and spine where most osteoporotic fractures occur.[3]

Dual energy absorptiometry using photons (DPA) or X-rays (DEXA) permits bone mineral to be measured at the hip and spine. DEXA measures the transmission of X-rays of two different photon energies through the body, allowing for the measurement of bone and soft-tissue mass.[1] The advantages of DEXA over DPA are higher beam intensity, therefore a faster scan and improved spatial resolution, with more confident identification of vertebral limits and better precision.[4]

DEXA is capable of measuring bone mass safely (radiation dose is less than 10% of a standard chest radiograph), accurately (4 - 8% error) and precisely (1 - 3% error).[1] It is reproducible and measures areal BMD (g/cm^2) in the clinically relevant areas, i.e. the hip and spine. BMD measurements obtained can be used to assess the degree of bone loss and therefore the risk of fracture, to guide the choice of treatment and to follow the response to specific therapy. However, the accuracy of this technique may be influenced by certain structural changes in a given patient. Aortic calcification in the elderly may increase the apparent density measured. Radio-opaque contrast media, metallic objects, vertebral compression fractures or degenerative changes at the lumbar spine may affect the results. A recent development to overcome some of these technical problems has been to scan the lumbar spine in the lateral position. Lateral scans eliminate the posterior arch and the spines of the vertebrae as well as aortic calcifications. Disadvantages of this imaging include an increased soft-tissue mass and more limited access to the lumbar vertebrae because of the ribs and pelvis which overlap the projected image, thereby reducing accuracy.[2]

A single screening test for BMD should be accurate and precise, require a short scanning period, be able to predict fracture risk and have a limited radiation dose. As these criteria are currently best met by DEXA scanning, this imaging technique should therefore be regarded as the gold standard to assess BMD. The use of other technology should be limited to situations where DEXA scanning is not available or proves to be inaccurate.

References

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TECHNOLOGY IN DERMATOLOGY

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According to scientists the last century saw more changes, developments and progress than all previous millennia together — a tendency which is spiralling at seemingly ever increasing speed!

The development of information technology and computer-aided technology has influenced medicine profoundly. However, what developments have there been in dermatology, a field where one can traditionally 'look and touch' to draw conclusions?

If one would wish to arbitrarily divide our field into two, then there is 'real dermatology', dealing with problems such as infections, genetic disorders, allergies and skin cancers, and 'cosmetic dermatology'. More than ever success is measured by appearance, and men and women strive for the 'healthy look' and request methods to stop or retard the inevitable ageing process. This is where technology can make a difference.

Lasers

They provide an accurate, non-scarring procedure improving all types of ailments. Vascular lasers not only target port wine stains and other congenital vascular malformations, but also remove facial spider veins, haemangiomas and even leg veins or keloids.

Different laser types can be used to treat anything, from tattoos and sunspots to unwanted hair. The problem is that one laser is more or less specific for one indication and in order to cover the whole spectrum of treatable conditions, one needs an entire centre with different machines. Furthermore, technology improves constantly and what seems to be a good laser type now will be obsolete in the near future.

Rejuvenating procedures

Erbium or CO_2 lasers can be used for resurfacing, a very successful but somewhat drastic procedure in which the entire epidermis is removed. These lasers are also used to reduce acne scarring and have practically replaced dermabrasion because it is a perfectly accurate procedure. However, patients often do not want to go to that extreme to have their wrinkles treated, which led to the development of the IPL photorejuvenation: an intense pulse light technology which gives an instant result — not as dramatic as resurfacing but it is not associated with all the pain, and it can be repeated many times.

Medical indications

With regard to more strictly medical indications the final quest is always for better, faster and more effective therapy, and fewer side-effects. Traditional psoralen plus ultraviolet A (PUVA) used for the treatment of psoriasis and eczema has been modified to topical or bath PUVA, with marked improvement in safety and patient acceptance. Broad band UVB treatments done in hospital are more frequently being replaced by out-patient narrow band UVB, made possible by the development of a machine which emits only 311 nm — a wavelength which accurately targets immune suppression necessary to stop the psoriatic process.

Skin cancer

'Mole Max' is a state of the art technology used for early detection of skin cancer. A hand-held digital microscope allows the physician to look at the subsurface layer of the skin. The 90 times magnification gives an in-depth view of morphological features, colours and patterns not seen using traditional skin surface microscopy. The hard disk drive can store thousands of images, immediately available for on-screen observation or to be called up at follow-up for side-by-side comparison. The ability to view images in more detail not only allows for greater reliability and better detection of early tumours, but also translates into fewer unnecessary operations to remove pigmented skin lesions subsequently identified as benign.

The ever-increasing incidence of skin cancer, combined with an increased awareness of the problem by the public, has resulted in a rising demand for more effective therapies. Patients expect a practical treatment which offers good clearance and the best possible cosmetic outcome. Again, technology comes to the rescue in the form of topical photodynamic therapy (PDT) which promises to be an effective alternative to surgery or other destructive therapies in certain non-melanoma skin cancers. PDT is a two-step process involving the application of a topical, light-sensitive substance followed by activation of this chemical through illumination with a very specific LED red light. This light source must have the highest spectral purity to provide photo-excitation of the aminolevulaenic acid (ALA) or its esters. In the presence of oxygen, reactive oxygen radicals are formed which damage cellular membranes, in particular mitochondria, resulting in selective cell death, as cancerous cells accumulate more porphyrins than normal tissue. Healthy surrounding tissue remains undamaged in this process, providing the basis of healing without scarring after treatment. PDT is another example of a novel treatment of non-melanoma skin cancer, offering an effective and cosmetically superior result.

'Advancement through technology' does not only apply to Audis but also to medicine! But, although our diagnostic and therapeutic options have improved dramatically one should bear in mind that it is still the physician who needs to be in charge and control all the available facilities — no matter how advanced a computer program is it cannot and should not replace the human touch which is an essential part of practising medicine.

SINGLE SUTURE

Honey kills antibiotic-resistant Gram-positive cocci

The use of honey to treat wounds has been written about since ancient Egyptian times. It was always thought that honey's syrupy consistency kept air out of wounds, and that its high sugar content slowed bacterial growth. New evidence suggests that honey must also have other properties that kill bacteria (*Nature* 19 November 2002). The results of a study were recently reported in the *Journal of Applied Microbiology* (2002; **93**(5): 857) in which the investigators compared natural with artificial honey. Methicillin-resistant *Staphylococcus aureus* and vancomycin-sensitive enterococci were isolated from infected wounds and hospital environmental surfaces. Their sensitivity to two natural honeys was established and compared with an artificial honey solution. For all of the strains tested, the MIC values against manuka and pasture honey were below 10%. However, concentrations of artificial honey at least three times higher were required to achieve equivalent inhibition *in vitro*. Comparison of the MIC values of antibiotic-sensitive strains with their respective antibiotic-resistant strains demonstrated no marked differences in their susceptibilities to honey. The authors conclude that inhibition of bacteria by honey is not exclusively due to osmolarity. A possible role for honey in the treatment of wounds colonised by antibiotic-resistant bacteria is therefore indicated.

Reminder

The January 2003 issue of *CME* was accredited for 4 CPD ethics points. The accreditation number is A001/483/01/2003.