Bone densitometry and beyond – bone mineral density plus body composition

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You thought dual energy x-ray absorptiometry (DXA) scanners were only good for bones – but DXA is for more than bone mineral density (BMD). While BMD is an important part of the clinical diagnosis and treatment of osteoporosis and the prevention of fragility fractures, there are now new clinical openings using DXA for body composition analysis (BCA).

Nutrition plays an important role in skeletal mineralisation. The nutrients known with certainty to be important are calcium, vitamin D, protein and calories. Therefore, any form of malnutrition may also affect total skeleton mineralisation. Many other conditions add to the frailty of the elderly and infirm patient which will add to their risk of fracture and falls during their illness.

By using the DXA scanner to image the whole body, data can be gathered to measure not only the BMD of the whole skeleton but related tissues such as fat and lean mass indices. Such information will inform the diagnosis of sarcopenia and lipodystrophy; help to monitor treatments for obesity and weight loss programmes; and monitor use of growth hormone treatment in children and adolescents. This uses the bone density component of scanning, but factors in changes in the fat and muscle components which give better and more relevant information to the clinician (figure 1).

The whole body scan shows the fat, lean (muscle) and bone using a graduated scale of colours to represent each area.

Sarcopenia

Sarcopenia occurs in the frail elderly and is defined as muscle loss due to a variety of reasons such as nutrition, illness and lack of exercise resulting in a decline in strength and physical function and possible quality of life. Low muscle mass will impact bone repair. As body fat increases, functionality such as leg strength and stability decreases.

Some of the results that can be used from the BCA scans:
- Total body % fat will show the amount of fat; results with high percentiles/z-scores may indicate sarcopenia obesity (figure 2).
- (Lean + BMC)/Height² ratio is considered. Low results suggest sarcopenia, more risk for loss of function due to illness-related muscle loss or age-related muscle decline or lack of mobility. Higher number is desired (20.0) as this signifies more muscle mass (figure 2).
- Appendicular (Lean + BMC)/Height² ratio. Low percentile and T-score -2.0 or below signifies lack of adequate muscle mass which may interfere with daily living issues such as lifting themselves from a chair or unsteadiness.

Subsequent lean vs age and appendicular lean/height² vs age graphs can show decline or increase of areas for a rate of change. Sub-region boxes can outline arms and legs to monitor the muscle loss for those areas as therapy is being administered.

Lipodystrophy

As a result of treatment for AIDS/HIV, redistribution of subcutaneous fat occurs from the extremities to the trunk, usually in abdominal and upper neck/shoulder area. This ultimately turns into visceral fat which presents added risk to the patient.

Lipodystrophy assessment is often made by physical assessment and is passively reported in trials of antiretroviral agents. DXA is a sensitive tool for detecting changes in peripheral fat among patients with HIV lipodystrophy.

A large study of HIV-infected men compared with controls demonstrated that the %fat trunk/%fat legs ratio measured by DXA were significantly higher for those with clinical lipodystrophy than for those without, and that treated HIV-infected men with lipodystrophy had the most elevated %fat trunk/%fat legs ratios. The authors concluded that the use of the %fat trunk/%fat legs ratio should allow a more accurate diagnosis of lipodystrophy compared to clinical examination and could help diagnose lipodystrophy earlier.

Weight management

Any weight loss programme, either by diet or by surgical intervention, needs to be monitored in order to make sure that the correct components are being decreased without detriment to the essentials such as muscle and bone mineral density.

Longitudinal scanning over regular time frames will show that fat loss is not being slowed while others are increasing and conversely weight gain in anorexia can be monitored to reassure the patient that percentage of fat gain is within correct proportions.

Compartmental trending can be useful after bariatric surgery or controlled weight loss plans to monitor changes in fat loss compared to bone loss (figure 3).

If the trending graph shows loss in the blue area (lean + BMC) then intervention will be needed to change the nutritional parameters (maintaining protein levels). Loss in the yellow area (fat) can also be documented to help confirm diet regimen is appropriate.

Body composition analysis is a new tool in the dual energy x-ray absorptiometry armoury.

References

### Adipose indices

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<thead>
<tr>
<th>Measure</th>
<th>Result</th>
<th>Percentile</th>
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<tbody>
<tr>
<td>Total body % fat</td>
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<td>7</td>
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<tr>
<td>Fat mass/height² (kg/m²)</td>
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<td>Android/gynoid ratio</td>
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<td>% fat trunk/% fat legs</td>
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<tr>
<td>Trunk/limb fat mass ratio</td>
<td>1.01</td>
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**YN** = Young normal  **AM** = Age related

### Lean indices

<table>
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<tr>
<td>Lean/height² (kg/m²)</td>
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<td>96</td>
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<tr>
<td>Appen lean/height² (kg/m²)</td>
<td>8.69</td>
<td>95</td>
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</table>

**YN** = Young normal  **AM** = Age related

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**Figure 2**

**Figure 3**

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**Figure 1**