The use of calcaneal stiffness index to screen for osteoporosis in HIV-infected individuals

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Background

- Osteoporosis is characterized by a reduction in bone density and deterioration in the microarchitecture leading to increased risk of fracture

Normal bone  
Osteoporosis

DEXA is gold standard for BMD measurement in Clinical Practice

WHO Criteria for Diagnosing Osteoporosis (T-scores)

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Normal</td>
<td>-1 and above</td>
</tr>
<tr>
<td>Low bone mass (osteopaenia)</td>
<td>-1 to -2.5</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>&lt;-2.5</td>
</tr>
</tbody>
</table>
### Derivation of BMD T-scores

![Graph showing BMD and T-score relationship](image)

#### Osteoporosis: T score ≤ -2.5

### Meta-analysis of risk of reduced bone mineral density in HIV and controls

<table>
<thead>
<tr>
<th>Publication</th>
<th>Number of patients</th>
<th>% ↓ BMD</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>HIV+</td>
<td>HIV-</td>
</tr>
<tr>
<td>Amiel et al 2004</td>
<td>148</td>
<td>81</td>
</tr>
<tr>
<td>Brown et al 2004</td>
<td>51</td>
<td>22</td>
</tr>
<tr>
<td>Bruera et al 2003</td>
<td>111</td>
<td>31</td>
</tr>
<tr>
<td>Dolan et al 2004</td>
<td>84</td>
<td>63</td>
</tr>
<tr>
<td>Huang et al 2002</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>Knobel et al 2001</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>Loiseau-Peres et al 2002</td>
<td>47</td>
<td>47</td>
</tr>
<tr>
<td>Madeddu et al 2004</td>
<td>172</td>
<td>64</td>
</tr>
<tr>
<td>Tebas et al 2000</td>
<td>95</td>
<td>17</td>
</tr>
<tr>
<td>Teichman et al 2003</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Yin et al 2005</td>
<td>31</td>
<td>186</td>
</tr>
</tbody>
</table>

Adapted from Brown TT & Gagish RB. AIDS 2006; 20:2165-2174
Fracture prevalence according to HIV status in men

Population-based study
8,525 HIV-infected patients
2,208,792 non HIV-infected patients

Overall comparison p=0.0001

Fracture prevalence according to HIV status in women

Population-based study
8,525 HIV-infected patients
2,208,792 non HIV-infected patients

Overall comparison p=0.002

Triant VA et al. J Clin Endocrinol Metab 2008;93:3499-3504
Background

- DEXA is the gold standard screening test and proven to correlate with fracture risk

- Disadvantages include
  - Expense
  - Extra patient attendance
  - Radiation safety approval

- The GE-Achilles Insight uses calcaneal ultrasound to calculate calcaneal stiffness index (CSI) to give an estimated t-score

- Calcaneus ideal site as weight bearing bone
  - Highly trabeculated

- CSI is proven to predict hip fracture risk and vertebral fracture in post-menopausal women

- No data of its use in HIV infected individuals
Advantages

- Portable
- Quick to perform (acquisition in 15 seconds)
- Minimal inter-operator variability
Aims

- To determine:
  - Correlation between calcaneal stiffness index and DEXA in an HIV positive population
  - Value as a screening tool for osteoporosis in order to reduce the number of DEXA scans
  - Cost effectiveness

Methods

- We performed CSI measurements on 100 subjects at random who had undergone a DEXA scan for any indication (within 6 months) using the GE-Achilles Insight®
- CSI scores were analysed to determine optimum sensitivity
- We then performed a cost effectiveness analysis
# Demographics

**Median values (IQR)**

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Gender</td>
<td>85% male</td>
</tr>
<tr>
<td>Age</td>
<td>51 years (46-58)</td>
</tr>
<tr>
<td>Duration HIV</td>
<td>15 years (11-20)</td>
</tr>
<tr>
<td>BMI</td>
<td>24 kg/m² (21-26)</td>
</tr>
</tbody>
</table>

**Ethnicity**

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Caucasian</td>
<td>83</td>
</tr>
<tr>
<td>Black African</td>
<td>10</td>
</tr>
<tr>
<td>South East Asian</td>
<td>4</td>
</tr>
<tr>
<td>Black Caribbean</td>
<td>1</td>
</tr>
<tr>
<td>Middle Eastern</td>
<td>1</td>
</tr>
<tr>
<td>Indian Asian</td>
<td>1</td>
</tr>
</tbody>
</table>
DEXA spine vs femur T-score

-1.0 osteopenia = 
-2.5 osteoporosis =
Results

- In these 100 subjects the prevalence by DEXA of
  - Osteoporosis was 15%
  - Osteopaenia was 55%
Results were analysed in a binary fashion:

- Negative (‘normal’): estimated t-score > -1.0
- Positive (‘abnormal’): estimated t-score ≤ -1.0
CSI T-score \( \leq -1.0 \) to correctly identify osteoporosis at LS or FN using DEXA

<table>
<thead>
<tr>
<th>CSI T-score</th>
<th>Osteoporosis ( (&lt;-2.5) )</th>
<th>No Osteoporosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive ( \leq -1.0 )</td>
<td>15</td>
<td>42</td>
</tr>
<tr>
<td>Negative ( &gt; -1.0 )</td>
<td>0</td>
<td>43</td>
</tr>
</tbody>
</table>

Sensitivity = 100%  
Specificity = 51%

NPV = 100%
Results

- The positive predictive value of a CSI score of \(-2.5\) for osteoporosis was 30%.

Cost effectiveness

- GE-Achilles Insight = approx £12,000
- DEXA scan = £65
- If those requiring DEXA underwent screening with calcaneal stiffness first and were only referred for DEXA if estimated T-score less than -1.0
- 324 subjects
- May be significantly less if repeat screening 3-5 yearly is performed as recommended in EACS guidelines
Conclusion

- CSI is reliable and cost effective
- If our 100 subjects undergoing DEXA were screened with CSI first using a cut-off of ≤ -1.0:
  - 43 fewer DEXA scans
  - 19 missed cases of osteopaenia
  - 0 missed cases of osteoporosis

Acknowledgements

- Thank you to all the patients at Chelsea & Westminster Hospital