HR-pQCT and DXA Changes in Bone Density and Microarchitecture Over Two Years in Young Adults

David AHanley1, Lauren A Burt2, Sarah L Manske3, Jennifer L Bhatia2, Steven K Bloyd2

1Cobb’s Centre for Bone and Joint Health, Department of Orthopedics, University of Calgary, Calgary, Canada.
2McGill Institute for Bone and Joint Health, Department of Radiology, McGill University, Montreal, Canada.
3McGill Institute for Bone and Joint Health, Department of Physical Therapy, University of Calgary, Calgary, Canada.

INTRODUCTION

- Peak bone mineral density (PBMD) occurs by late adolescence or early adulthood, and its timing has mainly been assessed using dual x-ray absorptiometry (DXA).
- PBMD measured with high resolution peripheral quantitative computed tomography (HR-pQCT) may differ from DXA due to resolution or skeletal site differences.
- If HR-pQCT can be used as a clinical assessment tool, identifying individuals with osteoporosis and increased fracture risk, normative data illustrating PBMD is important to implement a reference classification system.

OBJECTIVE

In our population-based cohort we aimed to assess differences in timing of peak values for microarchitecture and bone density using HR-pQCT and DXA.

METHODS

Participants
- Females (n=69, mean age 21.4 yrs) and males (n=51, mean age 21.5 yrs) from the Calgary youth cohort of the Canadian Multicentre Osteoporosis Study (CaMos) participated in a 2-year follow-up study.
- Aged 16 to 25 years at study initiation.

Anthropometric Outcomes
- Standing height (m), weight (kg), BMI (kg/m²)
- DXA
  - Hologic (Holoscan Medical), 82 μm voxel size, 110 slices of the non-dominant or non-fractioned distal radius and left tibia.
  - Scans were excluded if there was a motion score of 4 or more and if the common region between baseline and follow-up scans was less than 75%.
- To compare repeat scans, automated 3D image registration was conducted (IPL software) and masks of the common region were applied for data analysis.
- Measurements
  - Areal bone mineral density (aBMD):g/cm².
  - HR-pQCT
    - HR-pQCT (XtremeCT; Scanco Medical), 82 μm voxel size, 110 slices of the non-dominant or non-fractioned distal radius and left tibia.
    - Scans were excluded if there was a motion score of 4 or more and if the common region between baseline and follow-up scans was less than 75%.
- To compare repeat scans, automated 3D image registration was conducted (IPL software) and masks of the common region were applied for data analysis.
- Measurements
  - Standard HR-pQCT measures of total (Tt.BMD; mg HA/cm²) and trabecular (Tb.BMD; mg HA/cm²) volumetric BMD.
  - Automated HR-pQCT segmentation of total area (Tt.Ar; mm²), cortical BMD (Ct.BMD; mg HA/cm²) and cortical porosity (Ct.Po); %.

Statistical Analysis
- Baseline and follow-up means were compared using a repeated measures ANOVA with Bonferroni adjustment for multiple comparisons.
- Change per year was calculated for all participants. Mean percent change was assessed with a one-sample T-test.

RESULTS

Participants were approximately 22 years at study initiation (males: 21.5 yr ± 2.1 SD; females: 21.4 yr ± 2.2 SD).
- The average time between scans was 2 years (± 1.42 SD).
- Height, weight and BMI did not change significantly over study duration (p>0.05).

Figure 1: Image registration of a tibia scan
- Female 21 yr at baseline
- 85% overlap via registration
- Red: baseline scan
- Green: follow-up scan
- Purple: scan overlap
- Average percent overlap between scans was 92%

• DXA aBMD results (males n=32; females n=42) decreased at the hip. Males lost -0.76 (FN) to -0.97 (TH) %aBMD per year (p<0.05). Females lost -0.50 (FN) to -1.14 (TH) %aBMD per year (p<0.05). At the LS there was a non-significant trend for aBMD to increase in both males and females.

Table 1: HR-pQCT parameters at the distal radius [Mean (% CI)].

<table>
<thead>
<tr>
<th>Site</th>
<th>Females (n = 66)</th>
<th>Males (n = 49)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tl.BMD</td>
<td>Mean % change</td>
<td>95% CI</td>
</tr>
<tr>
<td>CL.BMD</td>
<td>0.31</td>
<td>0.09 – 0.54</td>
</tr>
<tr>
<td>Tb.BMD</td>
<td>0.77</td>
<td>0.59 – 0.95</td>
</tr>
<tr>
<td>Ct.BMD</td>
<td>0.06</td>
<td>0.35 – 0.47</td>
</tr>
<tr>
<td>Ct.Po</td>
<td>3.18</td>
<td>0.45 – 10.81</td>
</tr>
<tr>
<td>Tl.Ar</td>
<td>-0.03</td>
<td>-0.20 – 0.15</td>
</tr>
</tbody>
</table>

DISCUSSION

• Our results are consistent with known DXA peaks in aBMD occurring before 20 years at the FN and TH; and that PBMD may occur later than 20 years at the radius.
• Our 3D measures reflected an increase in HR-pQCT-derived BMD parameters at the radius, suggesting PBMD at the radius occurs at an age greater than 22 years in both males and females. At the tibia, total and trabecular BMD parameters remained stable suggesting PBMD at this skeletal site may occur before 22 years in females, similar to hip aBMD.
• Tibial Ct.Po increased in males (data not shown): further evidence that tibial bone density reaches a peak before 22 years in males.
• Like DXA (hip vs. spine), timing of PBMD assessed using HR-pQCT differs according to skeletal site (radius vs. tibia).
• Conflict of interest declaration: The authors have nothing to disclose.

REFERENCES


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P34 Contact: David Hanley davidhanley@ucalgary.ca Steven Bloyd aiblloyd@ucalgary.ca