Intra- and Inter-Operator Variability in HR-pQCT Scan Positioning

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BACKGROUND

• The role of the operator is critical for comparability of data in cross-sectional studies, in particular multicenter studies
• The operator acquires a projection of the limb (scout view), and s/he visually identifies an anatomical landmark that determines the region to be scanned
• Variability in landmark identification impacts bone measurements, especially in the radius

AIM

• To quantify long-term and short-term intra-operator, and inter-operator precision
• To quantify effects of operator precision on bone parameters

REFERENCE LINE POSITIONING

• We reproduced the acquisition interface of the HR-pQCT system (XtremeCT, Scanco)
• We used scout-view images corresponding to double-stack (220 slices) HR-pQCT scans
• We virtually localized standard 110-slice volume based on each operator’s positioning

POSITIOING PRECISION AND IMPACT ON BONE PARAMETER MEASUREMENTS

• Positioning for the tibia was highly reproducible
• Errors were greater for the radius and for inter-operator reproducibility
• Ct.Th was the most sensitive bone measurement to precision variation

<table>
<thead>
<tr>
<th>RADIUS</th>
<th>Precision SD RMS [mm]</th>
<th>Impact on Bone Parameter Measurements CV RMS [%]</th>
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<tbody>
<tr>
<td></td>
<td>Jt.BMD</td>
<td>Cl.BMD</td>
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<tr>
<td>Short-term intra-op</td>
<td>(0: 8; i: 15x3) 0.25</td>
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<td>Scan/rescan</td>
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<td>0.89</td>
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TIBIA

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<tr>
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<td>Short-term intra-op</td>
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<tr>
<td>Long-term intra-op</td>
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<td>0.61</td>
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<tr>
<td>Scan/rescan</td>
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<td>0.43</td>
</tr>
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O = Number of Operators. I = Number of Images.

DISCUSSION

• HR-pQCT positioning for the tibia is highly reproducible over time and across operators
• Greater position variability is observed for the radius, leading to high precision errors which exceed errors related to patient motion.
• There is a need for more reproducible landmarks, fully automatic scan positioning, and standardized training for operators

NEXT STEP: TRAINING AND EVALUATION

• We adapted the simulation user interface into a platform to train and evaluate HR-pQCT operators
• Operators position reference lines on scout view images grouped by bone laterality and landmark visibility, and receive feedbacks on their performances

EXPERIMENTS

• A total of 8 operators from multiple imaging centers positioned reference lines at anatomical landmarks on 56 scout view images
• We measured positioning precision (SD RMS) and impact on bone parameters (CV RMS) for:
  • Short-term intra-operator reproducibility
  • Long-term (6-24 months) intra-operator reproducibility
  • Inter-operator reproducibility

Figure 1. Scout view of double-stack volume images (a). Reference line and corresponding single-stack volume (cyan) (b).

Figure 2. Training and evaluation software for reference line position (a). Feedback to operators after training (b).

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