Standardized Training For HR-pQCT Scan Positioning Reduces Inter-Operator Precision Errors


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BACKGROUND
- HR-pQCT is an in-vivo imaging technique used to assess bone quality, evaluate bone diseases and monitor drug therapies
- The operator acquires a projection of the limb, 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, and affects data comparability in multicenter studies

AIM
- To compare intra- and inter-operator precision for experienced operators without training vs. new operators with training
- To develop a training and certification platform (webapp) for HR-pQCT operators

PRECISION EXPERIMENT
- We reproduced the acquisition interface of the HR-pQCT system (XtremeCT, Scanco Medical AG)
- 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
- New operators underwent training with theoretical and practical demonstration, and simulated scan positioning exercises

OPERATOR PRECISION
- A total of 8 experienced and 6 new operators position reference lines at anatomical landmarks
- We measured positioning precision and impact on bone parameters for short-term intra-operator and inter-operator reproducibility

<table>
<thead>
<tr>
<th>Operator</th>
<th>RADIUS</th>
<th>Precision SD RMS [mm]</th>
<th>Impact on Bone Parameter Measurements (CV RMS [%])</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-term intra-op</td>
<td>Experienced</td>
<td>0.24</td>
<td>1.39</td>
</tr>
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<td>New</td>
<td>0.28</td>
<td>1.50</td>
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<td>Inter-op</td>
<td>Experienced</td>
<td>0.68</td>
<td>3.69</td>
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<td>New</td>
<td>0.34</td>
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<table>
<thead>
<tr>
<th>Operator</th>
<th>TIBIA</th>
<th>Precision SD RMS [mm]</th>
<th>Impact on Bone Parameter Measurements (CV RMS [%])</th>
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</thead>
<tbody>
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<td>Short-term intra-op</td>
<td>Experienced</td>
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<td>0.26</td>
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<tr>
<td></td>
<td>New</td>
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<td>0.31</td>
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<td>Inter-op</td>
<td>Experienced</td>
<td>0.30</td>
<td>0.61</td>
</tr>
<tr>
<td></td>
<td>New</td>
<td>0.16</td>
<td>0.30</td>
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DISCUSSION
- Inter-operator variability can be significantly reduced with standardized training
- To make our training platform available to the community, we developed a webapp

WEBAPP
http://webapps.radiology.ucsf.edu/msk/
- Landing page with information and documentation
- Modules simulate scanner acquisition software
- For radius and tibia scans
- Training Module for practice on a selectable variety of typical cases
  - Images grouped by anatomical features
  - Feedback window presented at the completion of each set
- Evaluation Module for certification
  - For certification, must pass three randomly presented sets
- Reproducibility Module for operator precision test
  - Visual feedback of position variability and with a summary precision metric (RMSE) reported.

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Training module
- Confirming line placement in the Set Reference Line stage
- Immediate feedback after confirming line placement in Training module
- Reproducibility Module in the Set Reference Line stage