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

RADIUS	**Precision SD_{RMS} [mm]**	**Impact on Bone Parameter Measurements (CV_{RMS} [%])**				
		BMD	Ct.BMD	Tb.BMD	Ct.Th	Tb.N
Short-term intra-op						
Experienced	0.24	1.39	0.93	0.40	3.17	0.47
New	0.28	1.50	1.26	0.72	3.46	0.69
Inter-op						
Experienced	0.68	3.69	2.56	1.46	8.40	2.12
New	0.34	2.09	1.50	0.87	4.90	1.32
Scan/rescan	-	0.89	0.76	0.72	2.10	4.23

TIBIA	**Precision SD_{RMS} [mm]**	**Impact on Bone Parameter Measurements CV_{RMS} [%]**				
		BMD	Ct.BMD	Tb.BMD	Ct.Th	Tb.N
Short-term intra-op						
Experienced	0.13	0.26	0.19	0.26	0.94	0.31
New	0.11	0.31	0.30	0.28	0.52	0.31
Inter-op						
Experienced	0.30	0.61	0.42	0.65	1.97	0.85
New	0.16	0.30	0.21	0.32	1.02	0.41
Scan/rescan	-	0.43	1.38	0.70	1.25	5.64

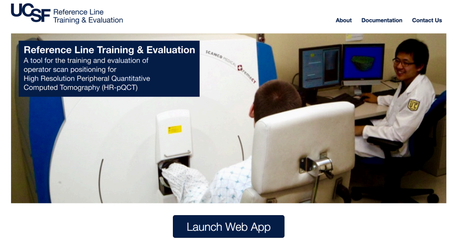
DISCUSSION

- Inter-operator variability can be significantly reduced with standardized training
- To make our training platform available to the community, we developed a webapp

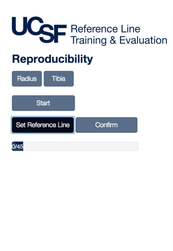
WEBAPP

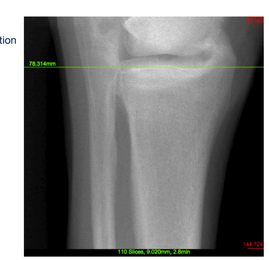
http://webapps.radiology.ucsf.edu/msk/

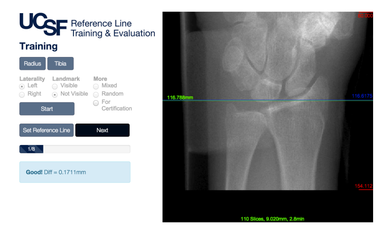
- Landing page with information and documentation

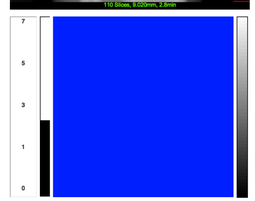


- Modules simulate scanner acquisition software
- For radius and tibia scans
- Training Module for practice on a selectable variety of typical cases
  - Images grouped by anatomical features
  - Feedback window presented at the completion of each set
- Evaluation Module for certification
  - For certification, 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.









Top: Immediate feedback after confirming line placement in Training module

Left: Reproducibility Module in the Set Reference Line stage

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