Automatic bone density evaluation from CT images

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Introduction

The evaluation of the bone density from medical images is an important task both in clinical and research fields.
Clinically it is one of the parameters used for osteoporosis prediction and therefore bone fracture risk assessment. It is commonly measured using the Dual Energy Xray Absorptiometry (DEXA).
In biomedical research it can be used to compute the mechanical properties of the bone for subject-specific finite elements models.
We propose a *method* to evaluate automatically the bone density from CT images. Differences between males and females and the variations between the left and the right sides of the body for the lower extremities are evaluated.

Material

CT images of Caucasian patients.

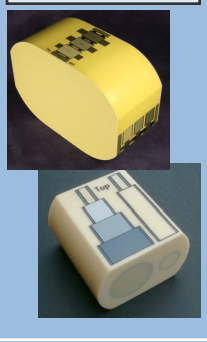
TIBIA	left male	right male	left female	right female
# patients	65	61	80	78
Age [yy]	65.9±15.4	66.4±14.7	64.1±16.6	64.7±16.4

FEMUR	left male	right male	left female	right female
# patients	69	66	86	81
Age [yy]	65.9±14.3	65.8±14.4	64.7±16.4	63.8±16.5

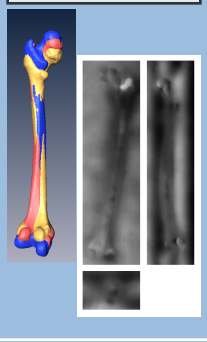
Method

CT images segmentation

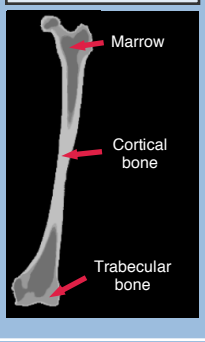
CT image calibration



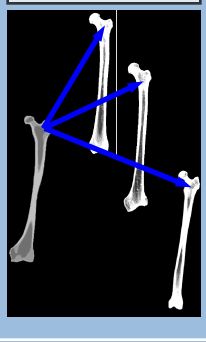
Rigid and non-rigid registration



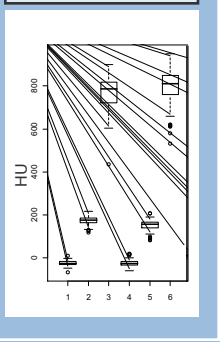
Reference bone labeling



Correspondence calculation

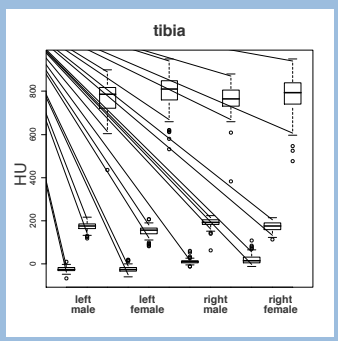


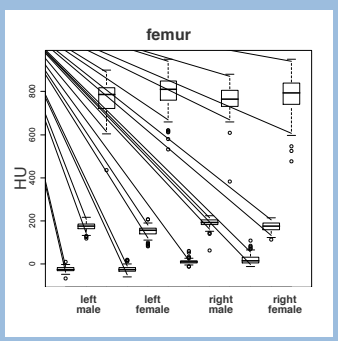
Statistical analysis



Preliminary Results

Lower values correspond to marrow, intermediate ones to trabecular bone, while the higher to cortical bone.
Intensities are higher for males than for females ($p<0.05$) for cortical bone and marrow.
Female densities are more spread than for males.
No significant differences comparing left and right sides, for both males and females, were found.





Discussion and Conclusion

Hounsfield unit values are lower than expected for the cortical bone, while they are in the expected range for the trabecular bone and marrow. This could be linked to errors in the correspondence detection, due to the small thickness of the cortical bone.
The comparison between males and females underlines both higher densities for men and larger differences among women. Both results can be linked to the variation of bone density that affects women after 40 years old.

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