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3D REGIONAL DIFFERENTIATED BONE REMODELING MONITORING AT THE PROXIMAL FEMUR BEFORE, DURING 60 DAYS BED REST AND ONE YEAR FOLLOW-UP AFTER USING REACTIVE JUMP EXERCISES AS COUNTERMEASURE FOR AVOIDING LOSS OF BONE MASS

Abstract

Bed rest (BR) studies are used as analog of zero-g environments to study effects of unloading conditions on humans. Thus, countermeasures for avoiding body detriment due to absence of mechanical stimuli (g-forces) required for healthy are relevant. In a long duration BR study (60 days) reactive jump exercises was tested as countermeasure (CM) to avoid amongst others bone mass loss. 24 healthy male subjects (20-45 YO, BMI 20-26kg/m2) were maintained in BR (HDT 6 degrees) after random group assignment: training (JUMP) or control (CTRL). Training consisted of 4x10 reactive jumps and 2x10 hops realized in 5-6 sessions per week in a custom manufactured sledge jump system. For the first-time in a BR study high resolution CTs (HR-QCT) of proximal femur were performed for monitoring bone remodeling 8 days before BR (base data collection), 6 days after BR (recovery, R+6) and at R+360. A designed protocol including anatomical landmarks for measurements and image analysis allowing bone remodeling comparisons of proximal femur was used. Using fixed density thresholds for bone segmentation, the femora (JUMP=11 (1 not study related drop out), CTRL=12) were digitally cut at the trochanter minor (landmark) for analysis and comparison of proximal femoral volumetric bone density (VBD) variations. Subsequently, the femora were rotated forming a right angle between an axial head axis and the horizontal trochanter minor plane permitting 3d regional differentiated femoral neck image analysis for VBD quantifications. VBD of the total neck (including bone marrow) as well as those from segmented cortical and trabecular neck bone were determined. In proximal femur (up to trochanter minor) VBD was reduced after BR (R+6) as expected in the CTRL group (1%). No VBD changes were found for the JUMP group. The VBD of the neck region containing all tissues (cortical and trabecular bone and bone marrow) was reduced in 2.8% for the CTRL and 1.8% for the JUMP group. After segmentation of the cortical and trabecular neck bone, a reduction of 2.2% for CTRL and no density changes at the cortical region in the JUMP group were measured. In the trabecular region of the femoral neck, a reduction of up to 4.1% for the CTRL and 2.5% for the JUMP group were measured. No significant differences within or between groups up to R+360 after using this CM were found statistically. After 3D regional differentiated bone remodeling analysis of the neck, highest bone densities reductions occurred in trabecular bone.