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Forced Marching with Load Decreases Tibiofemoral Joint Space Compared to Running

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Knee osteoarthritis (OA) is prevalent among military servicemembers and has been linked to occupational load carriage. Lower extremity injury risk is two times higher in female recruits. Effects of load and ambulation strategy (walk vs. run) on knee kinematics are known, however effects on arthrokinematics during high-velocity walking (force march) is unknown. Analyzing knee biomechanics during a loaded march is essential to understand potentially injurious motion and OA progression. **PUPPOSE:** To identify effects of load carriage magnitude and ambulation strategy on knee arthrokinematics in recruit-aged women. **METHODS:** 12 recruit-aged women (age: 24.5 ± 2.4 years) ran and force marched on a treadmill while carrying no load (bodyweight [BW]) and while loaded with +25%BW and +45%BW (average: 14.3 ± 2.0 kg, 25.6 ± 3.5 kg). Synchronized biplane radiographs of the right knee were collected (150 images/s, 1s). Computed tomography scans were segmented to construct subject-specific femur and tibia models. Joint coordinate systems were created and a validated model-based tracking system determined in vivo bone motion (accuracy: 0.9° , 0.7mm). Six degree-of-freedom knee arthrokinematics were calculated. Two-way repeated measures analysis of variance examined effects of load (BW, +25%BW, +45%BW) during each movement (run [RN], force march [FM]) on kinematics, joint space, and contact center location (CCL) at four time points (foot strike (0%), 10%, 20%, 30% stance, $\alpha=0.05$). **RESULTS:** Treadmill velocity was 2.0 ± 0.2 m/s. Knees were 7.5° more extended and 0.6° more abducted during FM vs. RN at 10-30% (all $p \leq 0.004$) and 2.4° more internally rotated (IR) with +45%BW at 20-30% (all $p < 0.033$). IR decreased 1.8° during FM vs. RN at 20-30% (all $p < 0.048$). Anterior translation increased 0.6mm with +25%BW ($p=0.045$) at 0%. Medial translation increased 0.2mm at 20% ($p=0.039$). Joint space decreased 1mm at 0% during FM vs. RN (Med/Lat: $p=0.001$). Medial CCL was more medial during FM vs. RN at 10-30% (all $p < 0.030$). CCL was more anterior during FM vs. RN at 10-30% (Med: all $p < 0.001$; Lat: all $p \leq 0.002$). **CONCLUSION:** Loaded forced marching affects knee arthrokinematics in recruit-aged women. Prolonged load carriage could increase risk of degenerative injury in this population.

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