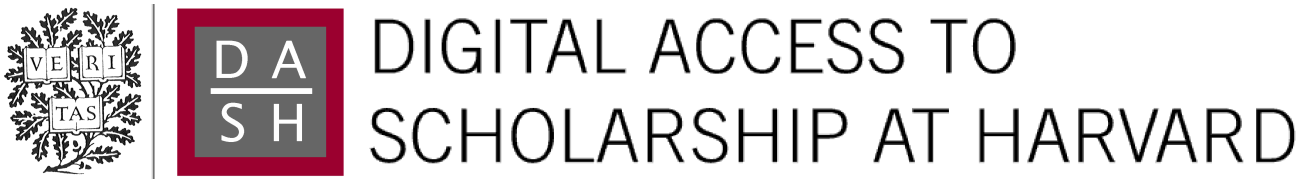

Trabecular Bone Orientation in Flexed Versus Extended Postures in Guinea Fowl: A Test of Wolff's Law

Trabecular bone orientation in flexed versus extended postures in guinea fowl: A test of Wolff's Law

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Abstract:
Although bipedal locomotion is a hominin synapomorphy, disagreements persist about whether early hominin bipeds were capable of fully extended limb posture, or used a bent-knee, bent-hip gait. Several recent studies have used the orientation of trabecular bone in limb joints to infer posteral differences during bipedal locomotion between early bipeds and later Homo. There analyses depend on the assumption that the orientation of the trabeculae in joint corresponds to the orientation of compressive forces that are transmitted through the joints. However, the hypothesis that trabecular struts will differ in orientation because of differences in the orientation of loads they experience during growth have not been tested.
This study experimentally tests the hypothesis that there is a quantifiable relationship between the orientations of trabeculae and joint posture. The experiment included 16 guinea fowl (Numida melegris): 6 extended-posture runners, 6 flexed-posture runners, and 4 sedentary controls. The exercised animals ran 6 days per week at 1.9 mph for 15 minutes, on either a flat treadmill or a treadmill inclined to 20°. Kinematic and ground reaction force data collected as the birds moved on horizontal and inclined substrates confirm that the degree of flexion at the knee at toe-off is 10° greater when moving up inclines relative to level running. Micro-CT scans were analyzed using image analysis software to relate this difference to trabecular and subchondral bone morphology within the distal femoral epiphysis, including subchondral bone thickness, and trabecular orientation, number, thickness, volume, and connectivity.