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Hip joint loading differences between *Paranthropus robustus* and *Australopitecus africanus* revealed by the cortical bone distribution at the femoral neck

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Given the ability of the cortical and trabecular tissues to respond to the loading environment, the reconstruction of the locomotor repertoire of australopiths (*Australopithecus* and *Paranthropus*) has increasingly integrated information from the inner structure of the appendicular skeleton [1-4]. There has been a particular focus on the internal structure of the hip joint because of its critical role in locomotion. The asymmetrical distribution of cortical bone in the femoral neck, with thinner superior (S) and thicker inferior (I) cortex, has been shown to characterize bipedal humans, reflecting the stereotypical loading of the hip joint. In australopiths, the combination of a human-like S/I asymmetry at the base of neck and a less asymmetric distribution at mid-neck has been interpreted as a commitment to terrestrial bipedalism associated to a slightly altered gait kinematics compared to *Homo* [1,3]. A recent X-ray microtomographic (μCT) analysis of cortical bone thickness distribution across the femoral neck of four *P. robustus* specimens has identified three additional features: (i) a human-like trend of lateral-to-medial decrease in S/I asymmetry; (ii) an accentuated contrast between the relatively thicker anterior and the thinner posterior walls, and (iii) a marked lateral-to-medial thinning of both cortices. However, it is still unknown whether, and to what extent, these features also characterize *Australopithecus*. Given previous evidence for some trabecular variation between *Au. africanus* and *P. robustus* in different skeletal elements [4,5], we predict that a refined assessment of the *Au. africanus* femoral neck cortical distribution has the potential to reveal gait-related differences with respect to *P. robustus*.

Using μCT data (resolution 30 μm), we assessed the cortical bone distribution in two proximal femora from Sterkfontein Caves, South Africa: StW 479 from Member 4 attributed to *Au. africanus* and StW 311 from Member 5, originally attributed to *Au. africanus*, but recently suggested to represent either early *Homo* or *P. robustus* [4]. Both fossils are housed at the Evolutionary Studies Institute and were scanned at the Paleosciences Centre of the Univ. Witwatersrand (South Africa). Due to differences in preservation, we extracted a set of slices at regular intervals from the base (lateral) of the neck to 70% of the total neck length in StW 479 and one at mid-neck of StW 311. We compared their functional signals to the published evidence from the *P. robustus* specimen SK 82 from Swartkrans (South Africa) and 25 extant humans and 8 extant chimpanzees [3].

Our refined S/I measurements of StW 479 support previous CT-based estimates [1]. StW 479 shares with SK 82 a S/I asymmetry in cortical thickness at the base of neck that decreases latero-medially. These features, also observed in extant humans, are thought to reflect habitual bipedal locomotion and the action of the gluteal abductor muscles [1,3]. However, while SK 82 has a less asymmetric S/I ratio than in humans, especially at mid-neck, StW 479 shows a human-like distribution along the neck. In addition, relatively thicker posterior and thinner anterior walls are identified in StW 479, while an opposite pattern is observed in SK 82 [3]. Such differences suggest that the locomotor related-biomechanical environment of the hip joint differs between *Au. africanus* and *P. robustus*, supporting locomotor diversity within the early hominin record. StW 311 shows similarities with StW 479 in cortical bone distribution at mid-neck and differs from the condition in SK 82. Since its trabecular bone distribution pattern at the head is similar to the nonhuman ape condition and differs from the *Au. africanus* pattern [4], further investigation of the trabecular network across the StW 311 neck are needed to help clarify its loading conditions and taxonomic attribution.

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