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Effects of wearing high-heels on the forefoot: an MRI evaluation

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Rheumatoid arthritis frequently involves inflammation of the forefoot. At present Magnetic Resonance Imaging (MRI) is increasingly used, mostly for research purposes, to detect inflammation. Given the sensitivity of MRI, a relevant issue is to discern pathology from normal variations as abnormalities have been observed in healthy persons.[1–4] In particular it is unknown whether regular physical exercise or wearing a particular shoe type affects MRI results. Bone marrow edema has been described in (sometimes asymptomatic) athletes.[5] Since wearing high-heels shifts pressure from the heel to the heads of the metatarsal bones,[6–8] we hypothesized that this might result in acute abnormalities of the forefoot similar to changes secondary to trauma or repetitive stress. We performed a single-blind crossover study to determine this.

Three healthy females (17-18 years) underwent 1.5T MRI examinations of the dominant foot before (8am) and after (5pm) a school-day, with provoked walking distance and visual-analogue-scale pain score. Activities, pain and symptoms were recorded twice every hour. Flat shoes were worn on day 1 and high heels (mean height 9.48cm) on day 2. Subjects wore flat shoes for one week before both examinations. MRI of the forefoot included T_1 weighted and T_2 weighted fat-suppressed scans, both in three orthogonal directions. Evaluation was performed by two readers independently who were blinded to the study day. In case of disagreement a third reader, a musculoskeletal radiologist, took the judgment. The study was approved by the institutional review board and all participants gave their written informed consent.

The subjects walked 6.7, 6.1 and 6.5 km on day 1 and 8.1, 7.0 and 7.1 km on day 2, including 15-minutes of stair climbing. VAS-pain scores remained low (range 0-2) on day 1 but increased to 5-8 at the end of day 2. Pain was predominantly located at the forefoot area. One subject (a fanatic gymnast) had extensive bone marrow edema of the medial sesamoid bone adjacent to the first MTP joint, which was unchanged over all four MRI's. No other abnormalities were seen on all 8am MRIs, and neither on the forefoot MRI at 5pm at day 1. All 5pm MRIs taken on day 2 revealed plantar subcutaneous edema, consistently located at the medial forefoot, extending over 25-34mm proximal to the metatarsophalangeal (MTP) joints (figure 1). Since during high-heel wearing the pressure point is at or distal to the MTP joints, this edema may have been caused by soft tissue strain due to tensile loading.[6] Two subjects also developed subcutaneous edema dorsal to the metatarsal heads, probably as a direct result of entrapment of the forefoot. Importantly, no other changes, such as synovitis, joint effusion, bone marrow edema, enthesitis, (intermetatarsal) bursitis, tenosynovitis or plantar fasciitis, were observed.

Thus, in the present case series we observed that physical exercise of moderate intensity and high heeled exercise does not cause bone marrow edema or deep soft tissue abnormalities. The pain that was experienced when performing physical exercise and wearing high heels was probably related to the presence of subcutaneous edema, plantar typically proximal to the MTP joints. The major limitation of these data is that the number of sub-

jects studied is small. Nonetheless all individuals evaluated showed remarkably consistent results. Altogether, these data therefore imply that wearing high-heels is not associated with short-term structural abnormalities. The long-term effects of high heel-wearing remain unknown. These results are relevant when interpreting forefoot MRI-examinations of rheumatoid or orthopedic patients

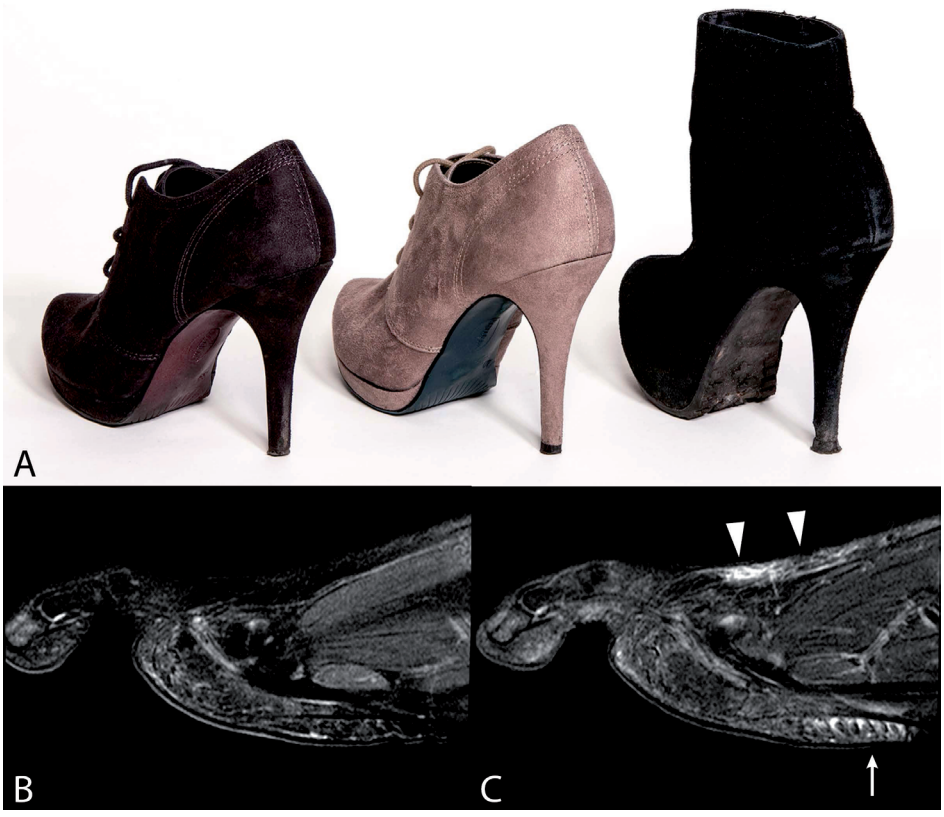

Figure 1: (A) High heels worn by the three subjects. (B,C) Sagittal T2-weighted fat-suppressed image at the level of the second metatarsal bone before (B) and after (C) a day of high heel wearing shows subcutaneous edema at the plantar and dorsal side. Note the proximal location to the MTP joints on the plantar side (arrow).

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