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Letter/*Musculoskeletal imaging*

Regional osteopenia or regional acceleratory phenomenon: What have we missed at MRI?

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Dear Editor,

Regional osteopenia is a non-specific bone change during which bone remodeling is focally and transiently stimulated in response to immobilization or insult [1]. Patchy or linear bone resorption in the subcortical and physeal areas can be seen on computed tomography (CT) [1]. In regional osteopenia, recruitment, differentiation and activation of progenitor cells of the monocyte-macrophage and of the pluripotent mesenchymal stem cell lineages are increased with a subsequent accelerated cycle of bone remodeling, also called the regional acceleratory phenomenon [2]. Changes on fat-saturated fluid-sensitive magnetic resonance imaging (MRI) presumably associated with subacute regional osteopenia have barely been reported yet [3,4]. We report herein that presence of a subtle and subcortical or diffuse and patchy increase in signal intensity detected on fat-suppressed fluid-sensitive images with bone resorption on CT can be associated with normal marrow signal on T1-weighted spin-echo images and therefore differs from the bone marrow edema-like pattern.

Three patients who experienced sport injury involving the ankle (patient 1; 40-year-old woman), the fore foot (patient 2; 29-year-old man) and the knee (patient 3, 35-year-old woman) underwent MRI examination during their follow-up period. Initial diagnoses included minor lateral ankle sprain with normal initial radiographs (patient 1), fractures of the 2nd 3rd and 4th metatarsal necks on radiographs (patient 2) and superficial contusion with normal initial knee MRI examination (patient 3). Patients were treated with non-steroidal analgesics and immobilization by using air cast for 2 weeks (patient 1), plaster for 6 weeks (patient 2) and crutches (patient 3). Clinical follow-ups were unremarkable, without signs of type I complex regional pain syndrome. CT or radiographic examinations obtained at a delay of 6 to 12 weeks after initial trauma demonstrated the presence of subcortical linear or more diffuse patchy areas of bone resorption (Figs. 1–3). T1-weighted spin echo images revealed no abnormalities, demonstrating the absence of the bone marrow edema-like pattern. On fat-suppressed fluid-sensitive (Figs. 1–3) or enhanced T1-weighted (Fig. 1) images, patchy, linear or more diffuse areas of intermediate signal intensity were present in the areas of bone resorption on CT. No low signal intensity bands indicative of trabecular bone fractures were observed.

On fat-suppressed fluid sensitive MRI, researchers have described either disseminated patchy or subcortical linear areas of moderate increase in signal intensity in association with disuse osteoporosis [3] or with structural joint lesions [4,5]. Similarly, after anterior cruciate plasty, White et al. observed the presence of a subcortical rim of increased signal intensity in the patella that was present 12 weeks after surgery but not 6 or 24 weeks after surgery [6]. They postulated that this signal alteration was associated with vasodilatation because it involved areas of increased vascularity [5]. Very limited information is available on associated changes on T1-weighted MR images [3] and, to our knowledge, no correlation with CT has been reported. Findings in our three patients suggest that the areas of abnormal signal intensity of fat-saturated fluid-sensitive images can be associated with normal fat signal intensity on T1-weighted images and with bone resorption on CT imaging. De Abreu et al. reported the presence of fat lobules on T1- and T2-weighted spin-echo images that differed from the disseminated patchy areas of increased signal intensity on T2-weighted images in patients with disuse osteoporosis [3]. We can only postulate about the associated histological findings. The absence of changes on T1-weighted spin-echo images could indicate an unaltered or even increased fat content in areas of bone resorption. The moderate increase in signal intensity on fat-suppressed fluid-sensitive images could be associated with a mild increase in cellularity, interstitial edema or vasodilatation as expected in association with the regional acceleratory phenomenon [2]. Knowledge of this MRI pattern is important to avoid confusion with the bone marrow edema-like pattern that is visible on both T1-weighted and fat-saturated fluid sensitive images in association with chondral lesions, insufficiency fractures, transient osteoporosis or regional migratory osteoporosis [4,7]. Further MRI studies should address temporal changes associated with regional osteopenia to better discriminate between disuse and more clinically relevant post-traumatic bone changes.

Abbreviations: CT, computed tomography; MRI, magnetic resonance imaging.

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Fig. 1. Regional osteopenia in a 40-year-old woman 12 weeks after right lateral ankle sprain. (a) CT image of the right ankle in the coronal plane demonstrates subcortical bone resorption (arrows). (b) T1-weighted spin-echo image in the coronal plane (TR/TE, 520/18 msec) demonstrates normal marrow signal intensity. (c) Corresponding fat-saturated intermediate-weighted image (TR/TE; 4370/42 msec) demonstrates subcortical linear areas of high signal intensity (arrows). (d) T1-weighted Dixon water-only image (TR/TE, 862/12 msec) obtained after intravenous administration of a gadolinium-based contrast agent demonstrates increased signal intensity in the same areas as in (c) (arrows).

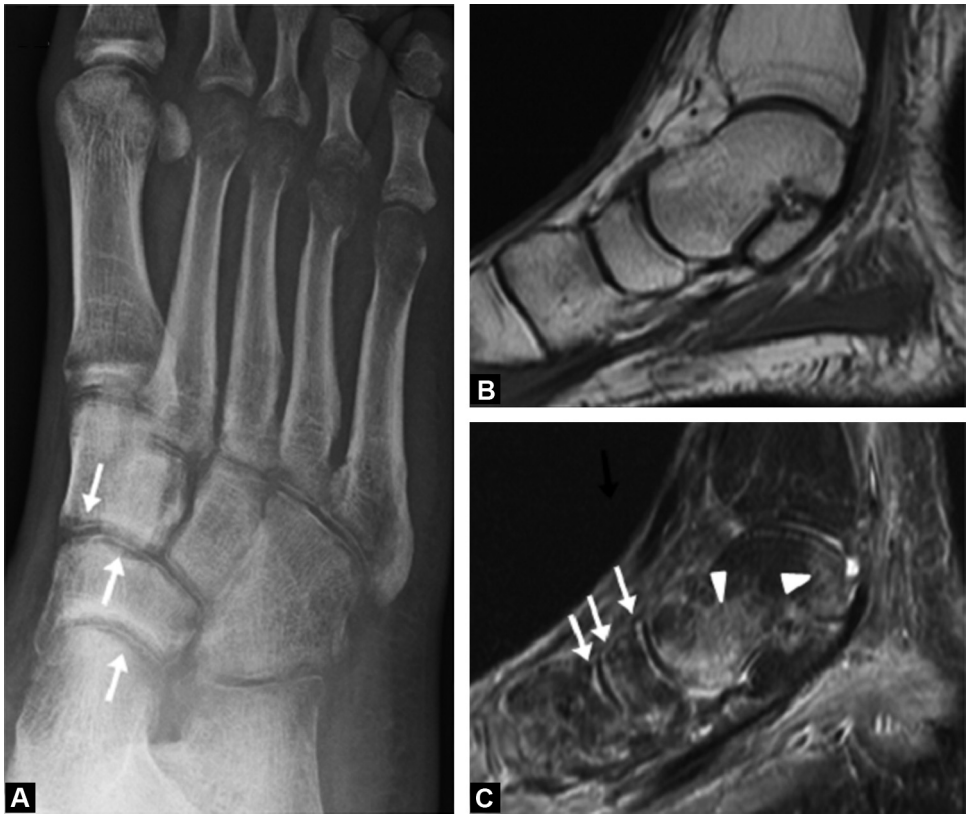

Fig. 2. Regional osteopenia in a 29-year-old man 6 weeks after 2nd – 4th metatarsal neck fractures. (a) Oblique radiograph of the foot demonstrates marked regional osteopenia with linear subcortical lucencies (arrows). (b) T1-weighted spin-echo image (TR/TE, 630/18 msec) in the sagittal plane demonstrates normal marrow signal intensity. (c) Corresponding STIR image (TR/IT/TE, 2600/150/20 msec) demonstrates subcortical linear (arrows) or more diffuse (arrowheads) areas of intermediate signal intensity.

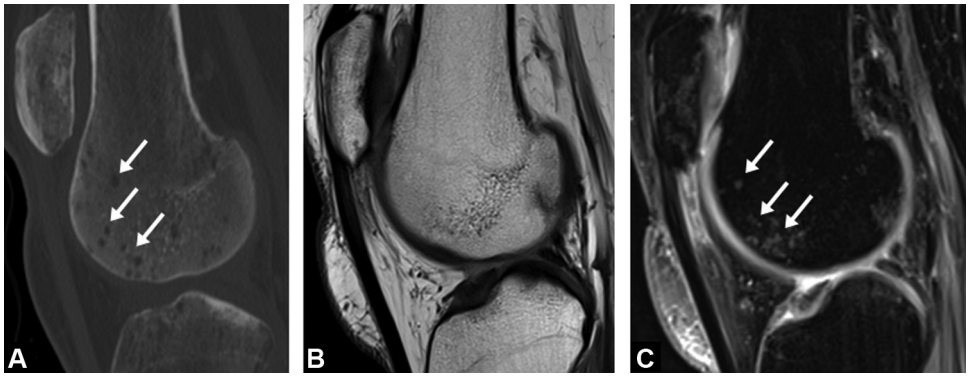

Fig. 3. Regional osteopenia in a 35-year-old woman 12 weeks after post-traumatic skin contusion and normal initial knee MRI. (a) CT image of the left knee in the sagittal plane demonstrates scattered patchy lacunae of bone resorption (arrows) in the distal femur and more diffuse osteopenia in the patella. (b) T1-weighted spin-echo image (TR/TE, 700/19 msec) in the sagittal plane demonstrates normal marrow signal intensity. (c) Intermediate-weighted fat-saturated image (TR/TE, 4000/24 msec) in the sagittal plane demonstrates patchy areas of intermediate signal intensity in the condyle (arrows) corresponding to the areas of bone resorption on CT and more diffuse marrow changes in the patella.

Human rights

The authors declare that the work described has been carried out in accordance with the Declaration of Helsinki of the World Medical Association revised in 2013 for experiments involving humans.

Informed consent and patient details

The authors declare that this report does not contain any personal information that could lead to the identification of the patients.

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Author contributions

All authors attest that they meet the current International Committee of Medical Journal Editors (ICMJE) criteria for Authorship.

Disclosure of interest

The authors declare that they have no competing interest.

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