High-resolution Peripheral Quantitative Computed Tomography Imaging Protocol for Metacarpophalangeal Joints in Inflammatory Arthritis: The SPECTRA Collaboration

To the Editor:

High-resolution peripheral quantitative computed tomography (HR-pQCT; Scanco Medical AG, Brüttisellen, Switzerland) is a novel peripheral CT instrument capable of accurately and reproducibly imaging bone microstructure at great resolution (isotropic voxel dimension of 82 μm). It provides precise measures of 3-D microstructural morphometric details and volumetric density of the cortical and trabecular components of bone (Figure 1), with minimal radiation exposure (< 3 μSv per scan)[1]. Therefore, HR-pQCT has the potential to identify and quantify early microstructural bone quality changes before permanent bone damage has occurred. To date, HR-pQCT has been used to assess bone quality in a variety of metabolic bone conditions. Image acquisition and analysis protocols are well defined for the assessment of systemic bone density and microarchitecture of the distal radius and tibia. This has largely been semiautomated to promote reproducibility and observer independence across investigational sites.

A new proposed application of HR-pQCT is in the study of inflammatory arthritis, to determine alterations to systemic bone density and periarticular bone such as erosions, joint space narrowing, and localized osteoporosis. The initial publication on using HR-pQCT to study rheumatoid arthritis (RA) metacarpophalangeal (MCP) joint changes was by Stach, *et al*[2]. This was followed by further studies to characterize erosions in RA and psoriatic arthritis[3], erosion identification comparing high-resolution ultrasound and HR-pQCT[4], and erosion healing with RA treatment[5]. Others have assessed erosion identification and periarticular bone density in RA[6]. One study has assessed systemic bone density in Chinese women using corticosteroids for lupus[7]. Researchers from sites in Calgary and Vancouver, Canada; Zurich, Switzerland; and San Francisco, California, USA, have also initiated studies and presented abstracts at international meetings, with publications in peer review and in press. An international collaboration meeting was held in Calgary on November 10-11, 2011, to share work completed to date, discuss image acquisition and analysis protocols, and develop new collaborative projects. Participants agreed on a standard image acquisition protocol for MCP joint analysis in inflammatory arthritis (Table 1).

From this meeting, the SPECTRA, or Study GrouP for XTrEme-CT in RA, was established. Working groups were established to focus on priority areas for research and agreement, such as consensus on defining erosions, measuring joint space width, comparing HR-pQCT imaging with standard imaging techniques (e.g., plain radiographs, magnetic resonance imaging, and ultrasound), analysis methodology, and cortical bone evaluation analysis protocols.

The SPECTRA group will initially focus on HR-pQCT imaging in early and established RA, but future avenues of research should include HR-pQCT evaluation of early microstructural periarticular MCP joint bone changes in other systemic inflammatory arthritis conditions. The SPECTRA group plans to convene regularly around the European League Against Rheumatism and American College of Rheumatology annual meetings. Any interested investigators are welcome to join the collaboration.

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Figure 1. 3-D reconstruction of the second, third, and fourth metacarpophalangeal joints using high-resolution peripheral quantitative computed tomography.

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Table 1. Image acquisition protocol for metacarpophalangeal joint analysis in inflammatory arthritis using high-resolution peripheral quantitative computed tomography.

Acquisition parameters	Manufacturer recommends standard clinical acquisition measures (82 μm, 60 kVp, 900 μA, 100 ms) with daily quality-control calibrations.
Patient positioning	Optimal immobilization necessary to acquire high-quality images suitable for analysis.
Image quality for analysis	Use the manufacturer's grading scale and include images graded 1–3.
Scout view	The minimal length of the scout view should include imaging of the 2nd and 3rd MCP joint spaces, with at least 3 mm on either side of the joint space to ensure adequate assessment of joint positioning and land marking.
Joints	At a minimum both the 2nd and 3rd MCP should be imaged.
Hand	If only unilateral images are acquired, then the dominant hand should be scanned unless the person has had a fracture in that arm in the last year and/or they have had any surgery in the area to be scanned.
Position	The MCP are to be positioned between 0° and 15° of flexion, consistent with current clinical radiographic imaging positioning of the MCP joints.
Reference line	The initial reference line for the scout view should be the midpoint of the concave articular surface of the base of the 2nd or 3rd proximal phalanx, whichever is the most distal. The scan should start at a minimum 2 mm distal to this line and should include a minimun of 2 stacks (~220 slices) to ensure that both the 2nd and 3rd MCP joint spaces are contained fully within the first 110 slices, in an effort to avoid any potential effect of stack artifact or discontinuity in the joint space. If a 3rd stack (~330 slices) can also be done, the scan start location can be located more distally if needed, but it should still be ensured that the 2nd and 3rd MCP joint spaces are fully contained within 1 stack.
Reproducibility/precision	Investigators should report a measure of reliability (e.g., RMSCV, LSC) for their evaluations.

MCP: metacarpophalangeal; RMSCV: root square mean coefficient of variance; LSC: least significant change.

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