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LETTER TO THE EDITOR

Letter to the Editor

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(The Editors do not hold themselves responsible for opinions expressed by correspondents)

Regarding Pickhardt PJ, Lee SJ, Liu J, Yao J, Lay N, Graffy PM, et al. Population-based opportunistic osteoporosis screening: Validation of a fully automated CT tool for assessing longitudinal BMD changes. *Br J Radiol* 2018; 91: 20180726.

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In the recent study entitled “Population-based opportunistic osteoporosis screening: Validation of a fully automated CT [computed tomography] tool for assessing longitudinal BMD [bone mineral density] changes”, the authors addressed the important care gap of low screening rates for osteoporosis diagnosis and concluded that their “robust, fully automated CT BMD tool allows for both individualized and population-based assessment”. However, the reported results raise questions as regards to validation and generalization for clinical care.

The reported fully automated approach has two technical limitations. Most importantly, it applies a single BMD calibration, i.e. the conversion from measured attenuation (in Hounsfield Units, HU) to BMD is the same for all patients, scanners and time points and probably for different table heights. First of all, this assumes that all scanners involved were stable over a period of years. Unfortunately a regular water calibration does not guarantee the stability of BMD values, nor identical BMD values across scanners. CT values were introduced to calibrate water (and water equivalent materials) across scanners. However, the mass absorption coefficient of bone significantly differs from that of water and therefore absorption of bone may vary from scanner to scanner even with perfect water calibration. Moreover, the HU value of bone depends on X-ray field inhomogeneity, which varies with table height and may also not be stable longitudinally despite perfect water calibration. Indeed

dedicated regular phantom scans to determine stability of BMD measurements often demonstrate instabilities. Thus the calibration approach applied in the study can introduce appreciable measurement errors,¹ and it is questionable whether data can be compared longitudinally, across different scanners or obtained with different acquisition settings on a given scanner.² In addition, if a patient loses weight over time, or if a CT machine is changed, the HU values typically change without a change in true BMD. The authors defended their approach in part by implying, incorrectly, that their linear conversion approach was comparable to patient-specific phantomless calibration.³

The second limitation is the missing control of the automated process. The 95% limits of agreement between automated and manual measurements ranged from –32.8 HU to 22.4 HU and for some patients differed by almost ± 60 HU, obviously unacceptable for the diagnosis of an individual patient. While this approach may be used in population-based studies with a corresponding decrease of precision, for the diagnosis of individual patients these outliers must be identified and manually corrected if necessary

Both these technical limitations question the ability of this approach to detect real changes in BMD over time for the individual patient. Consistent with the cited literature,⁴ this new study reported a higher annual rate of bone loss in females right after menopause. However, beyond that period, the rate of bone loss in females was reported to reduce further over time and approach zero around age 65, although cross-sectionally there was no decrease in BMD loss with age (Figure 4 in Pickhardt's paper). Results in Figure 4 are consistent with published reference data but the data in Figure 5 of Pickhardt's paper may be affected by the limitations outlined above. These inconsistencies are also reflected in Table 2 of Pickhardt's paper, which lists 9.6% (female) and 6% (male) BMD decreases between age 65 and 70 but an annual change of less than

0.5%, confirming the difficulty of interpreting the longitudinal data.

Many aspects of medical image processing, such as quantifying data in a CT scan, can be automated. The question then is, at what cost in terms of quality? Accuracy and precision of a properly calibrated BMD measurement for the individual

patient are central tenets of clinical bone densitometry.⁵ It is not clear that the automated method presented in this study has been sufficiently validated for clinically assessing BMD for individual patients either at a single time point or longitudinally. The use of Hounsfield Units for the diagnosis of osteoporosis is scanner and imaging protocol specific, and may be appropriate in narrow settings if properly validated.

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