A step towards screening patients for osteoporosis

Osteoporosis affects the structural integrity of bone, causing bones to break more easily. It is an affliction that is often diagnosed too late, once a fracture has already occurred. This is because most patients don't show any symptoms prior to a fracture. Since osteoporosis mainly affects the elderly, fractures can have crippling and even life-threatening consequences. Osteoporosis-related fractures can be prevented with proper care, including fall prevention aids and improving bone integrity using drugs.

Methods that currently exist to diagnose patients with osteoporosis require an X-ray or a computed tomography (CT) scan. An image of (part of) the body is created to measure the bone mineral density (BMD), which is considered a measure for bone integrity. But because most patients don't show any symptoms before they suffer a fracture, osteoporosis is highly underdiagnosed. People with fragile bones are at risk, but don't receive the treatment that can prevent fractures. This problem can potentially be reduced by opportunistic screening: measure the BMD in patients using CT scans that were obtained for a different reason. Patients without symptoms are thus screened for osteoporosis, without additional exposure to ionizing radiation.

A current gold standard BMD assessment method called quantitative CT (QCT), requires the inclusion of a bone density calibration (BDC) phantom in the scan. The BDC phantom is a tool that is used to convert image values to BMD values. However, this phantom is typically not placed inside the scanner when there is no indication for osteoporosis and even if there is an indication, the phantom can be easily forgotten. On top of that, QCT measurements have shown to be affected by the amount of fat in the bone marrow. QCT might therefore not be the optimal method for opportunistic screening.

We developed six different approaches to a three-material decomposition to assess BMD in patients without the need for a phantom. A three-material decomposition allows the quantification of specific materials inside an image. One of the few requirement is that the image should be obtained with a dual-energy CT scanner. Images obtained with such a system contain more information than images that were generated using a single-energy CT scanner. The three-material decomposition method not only works without a phantom, it also enables us to quantify the amount of fat in the bone marrow, possibly improving the accuracy of BMD measurements.

The results of our six three-material decomposition methods were compared to BMD values that were obtained with QCT. We found that the BMD measurements were highly correlated, but the BMD values obtained with our methods were generally higher. The reason for this overestimation remains unclear. Therefore, more research is required to improve the accuracy of the three-material decomposition methods. Suggestions for future research are mentioned in our research report.