Researchers develop method for detailed imaging of fragile bone structures

European Commission

The researchers from the Technische Universitaet Muenchen (TUM) in Germany, the Paul Scherrer Institute in Switzerland and the Swiss Federal Institute of Technology (ETH-Zurich) said osteoporosis is currently diagnosed almost exclusively by establishing an overall reduction in bone density. This new method will give much greater information about the associated local structure and bone density changes. Until now doctors have been hampered by their lack of ability to look in detail at changes to bone density.

TUM's Professor Franz Pfeiffer said this is all about to change. 'With our newly developed nano-CT [computed tomorgraphy] method it is now possible to visualise the bone structure and density changes at high resolutions and in 3D,' explained Professor Pfeiffer, who led the research. This will 'enable us to do research on structural changes related to osteoporosis on a nanoscale and thus develop better therapeutic approaches'.

Professor Pfeiffer's team used X-ray CT to develop its method. CT scanners are used every day in hospitals and medical practices for the diagnostic screening of the human body — the body is X-rayed while a detector records from different angles how much radiation is being absorbed.

'In principle it is nothing more than taking multiple X-ray pictures from various directions,' the authors said. 'A number of such pictures are then used to generate digital 3D images of the body's interior using image processing.'

The new method measures both the overall beam intensity absorbed by the object under examination at each angle and the parts of the X-ray beam that are deflected in different directions or 'diffracted'. A diffraction pattern is generated for every point in the sample and this supplies additional information about the exact nanostructure, as X-ray radiation is particularly sensitive to the tiniest of structural changes, according to the researchers.

'Because we have to take and process so many individual pictures with extreme precision, it was particularly important during the implementation of the method to use high-brilliance X-ray radiation and fast, low-noise pixel detectors,' said Oliver Bunk, who was responsible for the experimental setup at the PSI synchrotron facilities in Switzerland.

The diffraction patterns were then processed using an algorithm developed by the team, TUM researcher Martin Dierolf stated. 'We developed an image reconstruction algorithm that generates a high-resolution, 3D image of the sample using over 100

000 diffraction patterns,' he said. 'This algorithm takes into account not only classical X-ray absorption, but also the significantly more sensitive phase shift of the X-rays.'

Roger Wepf, Director of the Electron Microscopy Centre at ETH Zurich (EMEZ), acknowledged that while 'the new nano-CT procedure does not achieve the spatial resolution currently available in electron microscopy', 'it can — because of the high penetration of X-rays — generate 3D tomography images of bone samples'.

He said, 'The new nano-CT procedure also stands out with its high precision bone density measurement capacity, which is particularly important in bone research.' The researchers noted that the method will open the door to more precise studies on the early phase of osteoporosis and to the evaluation of the therapeutic outcomes of various treatments in clinical studies.

SOURCE [1]

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