Scientists and NASA astronauts developing near real-time osteoporosis and bone cancer test

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A new test for offers the possibility of near real time monitoring of bone diseases, such as osteoporosis and multiple myeloma. The functionality of the test, which measures changes in calcium isotope ratios, has been validated on blood samples from NASA space shuttle astronauts.

Our bones are largely built of calcium, and the turnover of calcium can indicate the development of bone diseases such as osteoporosis and the cancer multiple myeloma. Geochemists have developed extremely accurate ways of measuring calcium isotope ratios, for example for the study of sea shell deposits in sedimentary rocks. Now a group of US geochemists, biologists and clinicians, from Arizona State University and the Mayo Clinic, have worked with NASA to put these techniques together to develop a new, rapid test of bone health.

These methods, using mass spectrometry, can discern the relative ratios of the calcium isotopes 42Ca and 44Ca in bone. The researchers found that lighter calcium isotopes, such as 42Ca, are absorbed from the blood into the bone during bone formation. Conversely, these light isotopes tend to be released into the bloodstream when bones break down. By measuring the ratios of the two isotopes in blood or urine scientists can calculate the rate of change of bone mass

According to lead researcher, Ariel Anbar(Arizona State University):"The big advantage of these measurements is that they show

what is happening in the bone, whereas traditional bone health measurements, such as DXA scans, show what has happened. This means that we can have a real near-time view of what is happening in the bone, rather than comparing before and after, when damage may have already been done".

"Our goal is that these measurements will allow us to see bone breakdown in osteoporosis, but also can show us the progress of certain bone cancers, such as multiple myeloma".

The research was piloted in bed-bound subjects (who lose bone mass), but the best way for the researchers to test whether the system worked was in an ambient and less controlled population who are known to experience rapid bone loss. In space, because of zero gravity conditions, astronauts experience very rapid bone loss. Working with NASA, the researchers measured calcium isotope ratios in urine from 30 shuttle astronauts, before, during, and after the flights. This allowed them to confirm that the test worked at high sensitivity (NASA partly funded the research).

Ariel Anbar said:"We were able to confirm that Ca isotopes of the shuttle shifted as expected, meaning that they we could see in more or less real time the ongoing bone loss. We did this using a simple urine sample, taken at various points during their flights".

The researchers have also looked at a group of 71 patients who either had multiple myeloma (bone cancer), or were at risk of multiple myeloma.

"What we saw with cancer patients was interesting. Those patients who tended to lose the lighter 42Ca isotope seemed to be the ones where the cancer was the most active. This means that the tests could theoretically feed into decisions on whether or not to treat a patient, for example if a

cancer was dormant or growing very slowly, and to assess the effectiveness of treatments".

He continued"At the moment, this is still a test which is in development, but we have shown it can work. There is work to be done to further validate the tests, and costs to consider, however the advantage for this methodology is that the patient doesn't have to come to the machine; the measurements can be done with a blood or urine test. And from a scientific point of view, we are delighted that we have the chance to combine geochemistry, biology, and space science to benefit patients".

Commenting, Scott Parazynski, MD, former NASA astronaut, currently University Explorer and Professor at Arizona State University said:

"It's tremendous to see a sophisticated geochemical assay being translated into what could become a really significant medical diagnostic tool. Physicians treating osteoporosis and other calcium disorders of bone, including multiple myeloma, have very few tools at their disposal to quickly determine whether the treatments they're providing are actually making a difference. By using calcium isotope ratios, healthcare providers may be able to optimize therapies for these debilitating illnesses in the future."

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