Potential of Osteoporosis Detection with a Microwave Wrist Tester

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\section*{Introduction:}
Osteoporosis represents a major health problem, resulting in substantial increases in national health care costs. Current methods to detect osteoporosis rely upon ionizing techniques such as Dual-energy X-ray Absorptiometry (DXA) and Quantitative Computed Tomography (QCT). The objective of this study is to validate a low-cost non-ionizing method, which uses modern microwave technology, and to construct the corresponding premarket testbed.

\section*{Materials and Methods:}
The microwave wrist tester is shown in Fig. 1. It includes a movable frame with two 2X antenna arrays and pressure sensors. Antennas are connected to a Keysight FieldFox N9914A Network Analyzer. Wrist measurements are performed when pressure of 1 kg force is applied. Both reflection and transmission coefficients are measured over a frequency band. After obtaining WPI IRB approval, we enrolled 20 subjects (55-80 years of age) with a low bone density including osteopenia and osteoporosis. Additionally, we enrolled 20 healthy subjects (27-55 years of age). We measured left and right microwave wrist signature for every subject, including reflection coefficient S11 and transmission coefficient S21, over the frequency band 0.2-2.0 GHz. We also collected wrist circumference measures and BMI/age/gender data.

\section*{Results and Discussion:}
Fig. 2 indicates that there might be a significant difference in the response of normal and osteoporotic wrists. However, these data relate to the two subjects only. We will discuss application of a few imaging diagnostics machine learning algorithms for detection/classification of our frequency curves from 40 subjects. Our major challenge is the small sample size problem in training the AI system.

\section*{Translational Impact:}
We attempt to develop this promising microwave detection method since DXA is costly and time intensive. Many elderly people simply do not do the bone density test until the first fall.