Wireless signals could transform brain trauma diagnostics

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Technology developed at UC Berkeley harnesses wireless signals for instant brain diagnostics. Credit: César A. González

New technology developed at the University of California, Berkeley, is using wireless signals to provide real-time, non-invasive diagnoses of brain swelling or bleeding.

The device analyzes data from low energy, electromagnetic waves, similar to the kind used to transmit radio and mobile signals. The

technology, described in the May 14 issue of the journal *PLOS ONE*, could potentially become a cost-effective tool for medical diagnostics and to triage injuries in areas where access to medical care, especially medical imaging, is limited.

The researchers tested a prototype in a small-scale pilot study of healthy adults and brain trauma patients admitted to a military hospital for the Mexican Army. The results from the healthy patients were clearly distinguishable from those with brain damage, and data for bleeding was distinct from those for swelling.

Boris Rubinsky, Professor of the Graduate School at UC Berkeley's Department of Mechanical Engineering, led the research team along with César A. González, a professor at the Instituto Politécnico Nacional, Escuela Superior de Medicina (National Polytechnic Institute's Superior School of Medicine) in Mexico.

"There are large populations in Mexico and the world that do not have adequate access to advanced medical imaging, either because it is too costly or the facilities are far away," said González, "This technology is inexpensive, it can be used in economically disadvantaged parts of the world and in rural areas that lack industrial infrastructure, and it may substantially reduce the cost and change the paradigm of medical diagnostics. We have also shown that the technology could be combined with cell phones for remote diagnostics."

Rubinsky noted that symptoms of serious head injuries and brain damage are not always immediately obvious, and for treatment, time is of the essence. For example, the administration of clot-busting medication for certain types of strokes must be given within three hours of the onset of symptoms.

"Some people might delay traveling to a hospital to get examined

because it is an hour or more away or because it is exceedingly expensive," said Rubinsky. "If people had access to an affordable device that could indicate whether there is brain damage or not, they could then make an informed decision about making that trip to a facility to get prompt treatment, which is especially important for head injuries."

The researchers took advantage of the characteristic changes in tissue composition and structure in brain injuries. For brain edemas, swelling results from an increase in fluid in the tissue. For brain hematomas, internal bleeding causes the buildup of blood in certain regions of the brain. Because fluid conducts electricity differently than brain tissue, it is possible to measure changes in electromagnetic properties. Computer algorithms interpret the changes to determine the likelihood of injury.

The study involved 46 healthy adults, ages 18 to 48, and eight patients with brain damage, ages 27 to 70.

The engineers fashioned two coils into a helmet-like device, fitted over the heads of the study participants. One coil acts as a radio emitter and the other serves as the receiver. Electromagnetic signals are broadcast through the brain from the emitter to the receiver.

"We have adjusted the coils so that if the brain works perfectly, we have a clean signal," said Rubinsky. "Whenever there are interferences in the functioning of the brain, we detect them as changes in the received signal. We can tell from the changes, or 'noises,' what the brain injury is."

Rubinsky noted that the waves are extremely weak, and are comparable to standing in a room with the radio or television turned on.

The device's diagnoses for the brain trauma patients in the study matched the results obtained from conventional computerized

tomography (CT) scans.

Interestingly, the tests also revealed some insight into the aging brain.

"With an increase in age, the average electromagnetic transmission signature of a normal human brain changes and approaches that of younger patients with a severe medical condition of hematoma in the brain," said González. "This suggests the potential for the device to be used as an indication for the health of the brain in older patients in a similar way in which measurements of blood pressure, ECG, cholesterol or other health markers are used for diagnostic of human health conditions."

Provided by University of California - Berkeley