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Scalpel-Free Surgery Using Everyday Acoustics

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Toronto's *Globe and Mail* newspaper published an article regarding an experimental technique developed in Canada (https://www.theglobeandmail.com/canada/article-focused-ultrasounds-allow-scalpel-free-brain-surgery). It allows doctors to do brain surgery using precision imaging and ultrasound instead of scalpels and surgical saws. Although the technique has been used for treating a variety of conditions from tremors to brain cancer some of the most promising studies have been on patients with severe, intractable cases of mental illness such as depression and obsessive-compulsive disorder.

According to Focused Ultrasound Foundation focused ultrasound has been used worldwide to treat more than 200,000 patients.

Ultrasound is by definition sound with frequencies higher than 20,000 Hz and that are above the audible limit of human hearing. Depending of the applications, the range of ultrasound is quite large. As an example, acoustic microscopy uses frequencies as high as several GigaHertz (GHz). Very high frequencies have very short wavelengths which are on the order of ½ the size of the tissue or molecule to manipulate. This allows for heating, moving, or even levitating these small structures.

Ultrasound technology has a very wide range of applications. It is used for non-destructive testing of oil pipes, SONAR (under water detection), and fetal or organ examination. Ultrasound is a relatively old technology, where sound ways are directed to a target. In the case of SONAR they get reflected and these waves are detected and processed, resulting in an image. In the case of the human body, those sound waves travel harmlessly through the tissues. If the waves are focused on a particular point of a tissue, they generate heat, since their energy is concentrated. This heat can be

used for different purposes such as burning a tumor that would be otherwise inaccessible, to facilitating drugs to be delivered directly to a tissue. Another application is to modify faulty brain wiring; something that is currently impossible to do by other means.

To perform this kind of surgery, the patient is equipped with a helmet-like device that have many miniature ultrasound transducers that emit the sound wave. The patient is then introduced into a magnetic resonance imaging (MRI) machine. The MRI allows surgeons to precisely pinpoint the spot on the brain that is the object of the ultrasound and to perform the operation.