THE EXPERIMENTAL APPLICATION OF ULTRASONICS TO THE LOCALIZATION OF BRAIN TUMORS

PRELIMINARY REPORT*

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This report concerns an experimental attempt to apply ultrasonic pulses to the localization of brain tumors. The purpose of these experiments was to examine the possibility of locating, at the time of surgery, subcortical neoplasms without the use of brain needles. The principle upon which the experiments were based is that high frequency sound waves, when driven through tissues, are believed to travel at a rate proportional to the tissue density and to the tissue elasticity. These sound waves are reflected by surfaces of density or elasticity change, known as interfaces, and echoes are produced. Depending upon the texture and thickness of the tissue through which the waves traverse, the time interval before reception of the echo varies. With these known data it was postulated that by measuring this time interval, when ultrasonic pulses were sent through normal brain tissue, the presence of an underlying subcortical neoplasm might be ascertained.

The problem first centered itself around whether or not the texture of cerebral neoplasms varied sufficiently from normal tissue to be differentiated by this ultrasonic vibration method. The second problem was whether or not one could by this method establish with reasonable accuracy the presence of a subcortical neoplasm. The third problem was to ascertain whether or not pulsed ultrasonic vibrations of the proposed frequencies produced damage to cerebral tissues.

For these experiments a crystal from an ultrasonic Trainer device, 15-Z-1 developed by the Special Devices Center of the U. S. Navy, was mounted in a cylindrical chamber (ultrasoundoscope) as shown in Fig. 1. The crystal or transducer was caused to resonate electronically at a frequency of 15 megacycles per second, i.e., 15 million times per second. The sound waves generated by the transducer pass through the water contained in the chamber, through

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the rubber membrane stretched across the top, and on through any biological tissue placed in contact with the rubber membrane. The transducer vibrates for a duration of \( \frac{1}{2} \) of a millionth of a second and is then stopped, so that pulses of ultrasonic energy are produced. The echoes resulting from reflection of the vibrations are received by the transducer during the quiescent periods. The echoes are continuously recorded on a synchroscope, and they can be photographed for the purpose of obtaining permanent records.

![Diagram](image)

**Fig. 2.** Shows a composite explanatory arrangement referred to in the text of the experiments conducted with a piece of normal cerebrum.

In an attempt to answer the first problem, i.e., of comparative tissue textures, normal and neoplastic cerebral tissues were removed surgically and immediately examined. Neoplasms diagnosed histologically as being ependymoma, ependymoblastoma, glioblastoma, astrocytoma and metastatic were examined. In Fig. 2 are shown two photographs of the synchroscope tracings obtained when ultrasonic waves were sent through a piece of normal cerebrum measuring 1.43 cm. in thickness. The actual synchroscope tracings can be seen together with enlarged drawings. The distance designated “A” represents approximately the time interval for the pulse to reach the rubber membrane and to return. The distance “B” represents the time interval required for the pulse to pass through the tissue laid upon the rubber membrane and for the echo from the tissue-air interface to return to the rubber membrane. In order to check the position of the tissue-air interface, a piece of 26 gauge aluminum was placed on top in contact with the tissue. The strong return echo from this piece of metal can be observed in the tracings to the right.