Sound as weapon against glaucoma

Ultrasound, which has been used by ophthalmologists primarily to look into the eye, is finding new application as a treatment for glaucoma.

Over 100 people with glaucoma have been treated with ultrasound in the past two years, Cornell University researcher Michael E. Yablonski announced this week at a press seminar sponsored by Research To Prevent Blindness, Inc. "The results have been very promising, with a success rate approaching 80 percent," he says.

While Yablonski is optimistic about the new procedure's potential for halting progression of the disease, ultrasound's long-term value in glaucoma first needs to be proven. "This is still in the experimental stage," he notes.

The vision of about 1.6 million people in the United States is impaired by glaucoma, a condition marked by high pressure in the fluid within the eye. It results from various causes, and strikes both children and adults. The disease causes degeneration of the optic nerve. Its victims suffer anything from blurriness at the edge of the visual field to total blindness — the latter affecting 62,000 patients in the United States alone.

In the new procedure, developed in New York by Jackson Coleman of Cornell and Frederic Lizzi of Riverside Research Institute, patients receive a shot of anesthetic behind the eye. Five-second shots of ultrasound, trained through a funnel into a one-half-millimeter beam, are aimed at five to eight spots on the sclera, the white part of the eye. The entire procedure takes 15 minutes.

The sound waves weaken the sclera, lowering eye pressure in three ways, Yablonski says. The fluid within the eye can percolate out through the weakened areas; damage to some of the cells that release fluids into the inner eye reduces fluid secretion; and fluid absorption by the blood vessels of the eye picks up.

Because fluid pressure shot back up in some patients who had been on drug therapy prior to ultrasound treatment, all of the patients in the study are now being kept on anti-glaucoma medication.

One-quarter of the successful attempts involved a repeat procedure. Yablonski doesn't know how many times the procedure could be repeated on the same patient. Among the failures, a drop in pressure occurred but only for a short time.

There have been some side effects, Yablonski reports. The eyeballs of some patients softened, and in others, blood got into the interior of the eye. But these conditions cleared quickly, he says.

The Cornell researchers began using therapeutic ultrasound two years ago, following safety trials on animals and blind humans. Most of their patients had failed to respond to the conventional drug and surgical treatments for glaucoma.

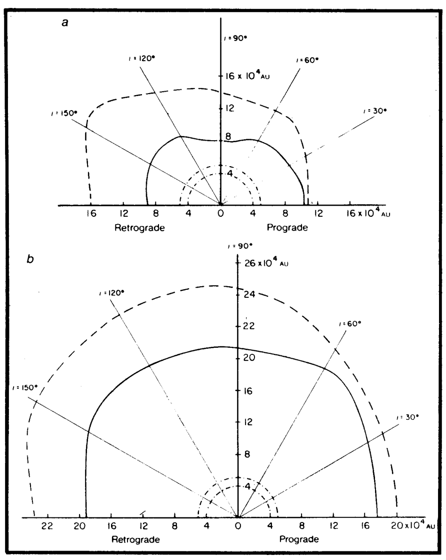
While at present Cornell is the only hospital doing the operation, they have sent specialized ultrasound machines to the Wilmer Eye Institute in Baltimore and the Massachusetts Eye and Ear Infirmary in Boston so that researchers there can evaluate the procedure. —*J. Silberner*

The size of the solar system—but for an occasional star

In a very real sense, the solar system is far larger than the space occupied by the orbits of the known planets. Pluto, usually the outermost, gets as distant as 7.3 billion kilometers from the sun, but billions of comets, for example, are believed to orbit the sun in paths that may carry them 1,000 times that far away. Those outer limits, dubbed the "Oort cloud" after the Dutch astronomer who conceived it, are thought to form a vast, spherical shell perhaps as much as 15 *trillion* kilometers in diameter.

But were it not for the gravitational perturbations caused by occasional passing stars or large molecular clouds, two researchers have determined, the ultimate extent of the solar system — the region in which the motion of orbiting objects would be controlled by the sun's gravity alone — would be far larger still, a "stability zone" more than 50 trillion kilometers across.

Ignoring those passing perturbations, only two gravitational influences besides the sun itself would make any difference, according to Roman Smoluchowski of the University of Texas at Austin and Michael Torbett of Murray State University in Murray, Ky. (formerly with the Carnegie Institution in Washington, D.C.). Both of them are essentially fixed: the concentrated mass at the center of our Milky Way galaxy (the sun is off toward the edge) and the much more widespread mass throughout the central plane of the galactic disk. They are the reason that the stability boundary would not be a regular sphere, and the resulting shape would be made more complex (see illustration) by the fact those non-sun-centered influences would act differently on objects whose orbits were inclined to the galactic plane at different angles.



The calculated "boundary of stability" of the solar system (as seen from the direction of the galactic center, with each graph's horizontal axis in the galactic plane) is defined here as the region within which objects orbiting the sun would remain in stable paths unless affected by perturbations such as passing stars. The solid curve in Fig. A shows what would be the limit of mean distances from the sun of objects orbiting it at different inclinations, while their maximum distances are shown in Fig. B, expressed in astronomical units or AU (1 AU equals about 150 million kilometers). The dashed curve in each figure shows the larger boundary that would exist if the gravity of only the galactic center, rather than its whole central plane, were influential. Dash-dot semicircles show the cometary "Oort cloud."

Smoluchowski and Torbett/NATURE

The result would be that the distance over which an orbiting object would stay in the grip of the sun's gravity would vary depending on the plane of the object's orbit. To work out the size and shape of the stability zone, Torbett ran a selection of orbits with differing angles and sizes through a computer, noting how large an orbit would be possible for each given orientation. Any object orbiting the sun in a given plane would have to stay closer than that maximum distance to avoid being pulled out of its stable path by the rest of the galaxy's mass. (The resulting stability zone, as shown in two dimensions, can be envisioned in three-dimensional form by rotating each figure around its vertical axis.)

But this overall stability zone is not, of course, that stable in reality. When the solar system first formed, its comets may have been distributed throughout the whole region, but the passing stars and molecular clouds (independent of those that are a part of the galaxy) have theoretically been picking away at the more distant comets for nearly 5 billion years. Such transient perturbations, the scientists note in the Sept. 6 Nature, may have been occurring at a rate of several per billion years (the clouds) and several per million years (the stars). The remaining Oort cloud, only about a third the size of the hypothetical stability zone, would be all that remains of the original comet population. Some researchers doubt that the Oort cloud even exists, but if it does, its borders mark the present limits of the solar system's safe, stable haven.

—*J. Eberhart*