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# Prefrontal Sonic Treatment: MR Findings

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**Summary: The authors describe the use of MR in a patient who underwent prefrontal sonic treatment for relief of intractable headaches. MR demonstrated well-demarcated regions of encephalomalacia within the white matter of the frontal lobe (with relative sparing of cortex) in a characteristic conical volume that corresponded to the insonified regions.**

**Index terms: Encephalomalacia; Ultrasound, experimental studies; Brain, magnetic resonance**

It has been demonstrated that cerebral white matter is less resistant to the damaging effects of ultrasound than cortex (1). As a result of this finding, P. A. Lindstrom introduced prefrontal sonic treatment (PST) in 1954 as a substitute for lobotomy (2). PST was used for the control of pain, anxiety, and depression, initially in patients suffering from malignant disease. Following apparent safety and success with this treatment, its application was broadened to include patients with psychosis, addiction, and hypochondriasis. Also included were patients with pain syndromes felt to be of both organic and psychogenic origin (3). We describe the magnetic resonance (MR) imaging scan of a patient who 24 years earlier underwent PST for intractable headaches.

## Case Report

A 65-year-old woman with a history of nearly continuous headaches for the past 26 years was admitted for treatment with dihydroergotamine. In 1963, she had the onset of frequent headaches following a presumed viral illness. She was treated with various narcotics and tranquilizers without significant improvement. In 1965, the patient underwent PST, and was discharged with apparent improvement in her headaches.

On admission in 1989 for continued headaches, the neurologic examination demonstrated a cooperative but somewhat apathetic female. As part of her evaluation, a nonenhanced MR scan of the brain was obtained. The scan demonstrated conical regions of encephalomalacia within the frontal lobes bilaterally, with relative sparing of the overlying gray matter. Long TR short TE images demonstrated increased signal intensity in the white matter adjacent to the lesion, compatible with gliosis (Fig. 1).

Prefrontal sonic treatment was introduced as a presumably less invasive alternative to prefrontal lobotomy. Typically, sonic frequencies in the range of 1 MHz and intensities of 8 $W/cm^2$ for 1–2 min were used, with the beam applied through small craniotomies overlying the frontal lobes, as diagrammed in Figure 2. A third craniotomy was performed to allow transverse insonation of the inferior frontal lobes, although no corresponding changes are seen in the present case.

Animal and autopsy studies demonstrated tissue necrosis, predominately affecting the white matter along the beam path, with relative sparing of the cortex (2). The histologic changes in the white matter consist of an increase in both glial cells and scars, along with disruption of myelin sheaths. The microscopic anatomy secondary to PST was felt to be similar to the changes seen in patients experiencing mechanical trauma. The location of the changes in PST differed from those demonstrated in standard lobotomies in that patients receiving PST only experienced anatomical changes within the beam path (4). No pathologic changes were noted outside the insonified volume (2).

The current patient was studied by MR 24 years after undergoing PST. The central cavitations seen in each frontal lobe on MR in a characteristic conical volume correspond to the vertically oriented insonified regions illustrated in Figure 2.

Although PST is no longer employed, characteristic imaging changes may be seen in patients who have previously undergone this therapy. Since sonic therapy is currently used as an experimental adjuvant therapy in the treatment of malignant gliomas, changes similar to the ones described above might be expected in follow-up MR examinations (5).

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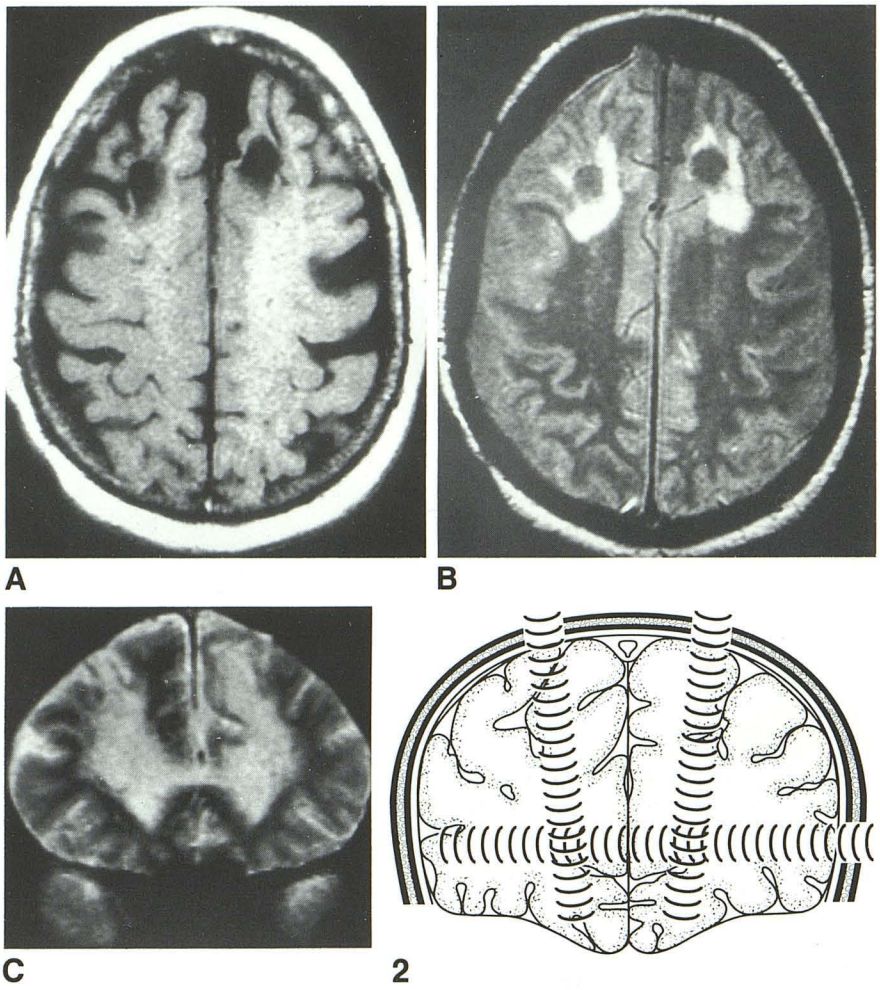


Fig. 1. *A* and *B*, T1-weighted (800/20, TR/TE) and intermediate echo (2800/30) axial images of the brain demonstrating well-demarcated regions of encephalomalacia within the frontal lobe white matter bilaterally. Increased signal intensity adjacent to the regions of encephalomalacia on intermediate echo image suggests gliosis.

*C*, Coronal multiplanar gradient recalled echo (MPGR) image (800/15, flip angle = 20°) demonstrates conical regions of encephalomalacia within the frontal lobe white matter with relative sparing of cortex.

Fig. 2. Schematic diagram of the pattern of insonation employed for PST. (Adapted from Ref. 3).

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