Focal Brain Suppression by Means of a Silicone Rubber Chemode*

Technical Note

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Over the last decade, our group has been placing electrodes in the thalamus, midbrain, and temporal lobes for the diagnosis and treatment of temporal lobe seizures and associated episodic violence, movement disorders, and chronic severe pain. These techniques relied upon the destruction of focal areas of the brain for a therapeutic result. More recently, we have been trying to achieve the relief of chronic severe pain by precise focal electrical stimulation rather than brain destruction. However, we felt that a significant improvement could be made, even over this approach, by the use of chemical agents instead of electricity to stimulate or suppress discrete areas in the central nervous system.

Chemodes, slender tubes able to deliver chemical agents through their tips directly into deep focal areas of the brain, have been developed by a number of investigators for use in experimental animals and man. These chemodes, some of them delivering minute quantities of chemicals through micro-miniaturized pipettes, are not capable, however, of delivering these agents over a prolonged period of time and do not use a membrane to pass agents into the brain selectively.

The use of the silastic membrane developed by Folkman for the transport of chemical agents into biological tissues has the following advantages:

1. Silastic is relatively non-irritative to tissues.
2. Chemical agents are sterilized as they pass through its substance.

Received for publication June 12, 1968.

* Delivered at the annual meeting of the American Association of Neurological Surgeons (Harvey Cushing Society), April 7–11, 1968, Chicago, Illinois. This investigation was partially supported by PHS Research Grant CA 07368-05 from the National Cancer Institute and aided by a contract from the National Cancer Institute, PH-43-67-1325.

3. Its selective permeability is similar to that of biological lipid membranes; it will pass substances soluble in lipid solvent or substances that go into the gaseous phase.
4. Depending upon surface area, membrane thickness, and the chemical agents under scrutiny, the rate of passage is constant over a period of hours, days, weeks, or even months.
5. The use of a silastic membrane at the tip of a chemode prevents mechanical injury that might occur with direct liquid or gas injection in the brain.

Our first use of silastic chemodes involved aseptic stereotaxic implantation into the midbrain reticular formation in cats. A diagram of the chemode used is seen in Fig. 1. We tested Tefurane, Cyclopropane, Nitrous Oxide, and Methoxyflurane in the chemode and have reported the results of these exper-

FIG. 1. Schematic diagram of chemode used in cats.
In brief, we were able to produce behavioral and electrical sleep with as little as 0.2 cc of Tefurane or Cyclopropane. The cats would awaken after 60 to 90 minutes, be groggy for another 15 to 30 minutes, and then resume normal behavior. Electroencephalographic changes paralleled behavioral changes, and the continuous depth recordings from the region of the chemode in the midbrain were quite similar to recordings from metal screws in the surface of the skull.

Because of the reproducible nature of our experiments with anesthetic gases and silicone rubber chemodes in the reticular formation of cats, we felt it would be safe and clinically advantageous to produce a temporary suppression of thalamic activity in a patient with terminal cancer and severe chronic pain. We planned to do this by passing Tefurane into the medial thalamus through a silastic chemode. The chemode chamber (Fig. 2) was incorporated into one of our standard inlying thalamic electrodes. Two 32-gauge cannulas entered the silastic chamber to conduct and exhaust the Tefurane from this unit. The chamber, 1.6 mm in diameter and 4 mm in length, was situated between a stimulating-recording tip and a lesion-making bullet with a thermistor for recording temperature. Four electrodes were placed in the patient's brain, one in each centromedian-parafascicular thalamic nucleus and one in each amygdala. The two electrodes implanted on the right contained a chemode chamber lined with silicone rubber. Only the chemode chamber in the nuclei centromedian-parafascicularis was used for the passage of Tefurane. The details of the case history follow.

**Case Report**

A 44-year-old man was admitted with a 3-year history of intractable pain in the left cranial vault, face, and neck. Six years before admission, a malignant tumor was diagnosed in the left parotid gland. A number of surgical procedures were carried out to excise this tumor, including a radical neck dissection and parotid removal with subsequent full thickness skin grafting. He also had several extensive courses of deep x-ray therapy. X-ray examination indicated that the tumor had invaded the skull and nearly replaced one petrous pyramid. Trigeminal block of the third division of the trigeminal nerve with 95% alcohol did not relieve the pain.

His complaints consisted of two types of pain; one was "like an ice pick" applied deep in his left ear behind the left eye. This was a constant pain which kept him awake and was not relieved by 24 Numorphan (10 mg) tablets daily. He had a second and separate pain in his left upper lip; this pain came down like "fine lines," usually at the end of the day. Several months before he was admitted to the hospital, he began to have generalized seizures.

**Examination.** The patient had a large sur-

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**Fig. 2.** Human stereotaxic electrode incorporating silicone rubber chemode.