a surgical treatment to permanently deaden pain transmission in the trigeminal-nerve system involved in cluster headaches. It involves inserting a needle through a small hole at the base of the skull, advancing it into the nerve, then delivering sufficient radio-frequency radiation through the needle to thermally coagulate the nerve's small, pain-carrying fibers. The rest of the nerve remains intact, he says.

Mathew says he has performed the surgery on 70 patients, chosen because their headaches had resisted all other forms of therapy. The heat treatment helped most of these patients, halting all cluster headaches in about 75 percent of them — including several who had endured daily headaches for more than a year, he reports. Moreover, he says, the procedure can be repeated if the deadened nerve ever regenerates and the headaches return. In Mathew's view, the technique's primary drawback is a numbing around the eye on one side of the face.

Lee Kudrow, director of the California Medical Clinic for Headache in Encino, tried an even more novel approach: light therapy. Various researchers have found evidence that cluster headaches may involve a derangement of the brain's circadian "clock." Twelve years ago, Kudrow noted that some patients could get rid of their headaches by routinely sleeping a few hours later in the morning. Kudrow's new data, based on a preliminary study involving only four patients, hint that clinicians might reset faulty biological clocks in cluster-headache sufferers by prescribing two-hour stints under bright lights — beginning at dusk — for four consecutive days.

"It was very dramatic," he told SCIENCE NEWS. "We were able to break the cluster period within two weeks of the time we did the bright-light therapy." And patients didn't have to alter their sleep cycle.

If follow-up studies confirm the effectiveness of this therapy, patients might treat themselves inexpensively at the start of each cluster by sitting under a bank of 12 to 14 blue-white fluorescent lights at home, Kudrow says.

"We still haven't figured out why there is a disruption of the biological clock [in cluster-headache victims]," Mathew notes; nor do researchers know how the faulty clock might trigger the production of pain.

However, several of last week's reports helped piece together another puzzle: What generates the pain in cluster and other headaches?

For years, headache specialists assumed that the dilation of blood vessels triggered cluster-headache pain. Many headaches do occur near dilated blood vessels, and many effective headache medicines constrict dilated vessels. But lately, "we have come to realize that the [dilation/constriction theory] of headache pain is much too simple — and inaccurate," says Michael A. Moskowitz of Massachusetts General Hospital in Boston.

Pain fibers not only transmit pain but also promote inflammation in the blood vessels and other tissues they innervate. Moskowitz and others recently found that the nerve fibers have receptors for some medications effective against migraine and cluster headaches. He now reports that such drugs appear to work not by altering the diameter of throbbing vessels, but by blocking both the nerve's transmission of pain and the inflammation it fosters in nearby tissue.

His new data show how receptors for some headache drugs — and for other chemicals not yet used for headaches — appear to be "modulating the release of inflammation-provoking chemicals in the wall of [painful] vessels," he says. For example, his team prevented vessel inflammation in rats by pretreating the tissue with these drugs.

Kudrow also expresses excitement over other presentations at the meeting that appear to confirm an observation he first reported last year: that cluster-headache patients seem to suffer a temporary malfunctioning in the system that regulates the oxygen levels in their blood.

Kudrow says his work indicated that nitroglycerine, which triggers headaches in patients during an active cluster cycle, accomplishes this feat by depressing blood oxygen levels. In healthy people and in cluster-headache patients during remission, the nitroglycerine-fostered drop in oxygen lasted only 20 minutes. In patients undergoing a cluster cycle, oxygen levels stayed low three times longer — and spawned a new headache.

Two studies reported last week also indicate that active-cycle cluster headache victims have difficulty compensating for low blood oxygen levels. Together, Kudrow says, these studies may finally explain why inhaling pure oxygen — a now-standard treatment for cluster headaches, pioneered by Kudrow in 1979 — has proved so effective. *— J. Raloff*

STM scientists strong-arm silicon atoms

In the quest to build new materials one atom at a time and to create new machines with nanometer-scale components, scientists use a high-precision tool called the scanning tunneling microscope (STM). Demonstrations of the STM tip's manipulative potential have included words spelled out with xenon atoms and microscopic piles of gold deposited in the shape of the Americas (SN: 11/17/90, p.310).

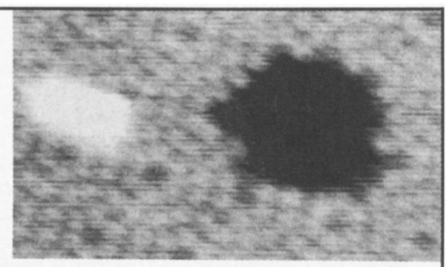
Now, two physicists have discovered that by adding a bit of electrical and chemical brawn, they can use the STM tip to pick up and reposition silicon atoms, overcoming the atoms' resistance to such maneuvering. Their results boost hopes for developing "nanoelectronic" devices, orders of magnitude smaller than today's electronic components, suggest In-Whan Lyo and Phaedon Avouris of the IBM Thomas J. Watson Research Center in Yorktown Heights, N.Y. They describe their work in the July 12 SCIENCE.

"Being able to manipulate silicon is an important first step," says physicist Daniel Rugar, who has used the STM tip to build up mounds of gold at the IBM Almaden Research Center in San Jose, Calif. "Silicon is the basis of most semiconductor technology."

In addition, the ability to pick up and move small numbers of atoms will make it easier for chemists to study the properties of atom clusters, says Avouris.

To pull atoms out of a silicon surface where they are covalently bonded, Avouris and Lyo tap chemical forces that come into play when the STM tip nears the surface. By themselves, these forces are not quite strong enough, Avouris explains, but pulsing a voltage through the tip creates a potent electrical field that can yank silicon atoms out of their places and up to the tip.

"Within one-hundredth of a second, the atoms swarm the tip," Avouris says. "The details of the motions are not known, but my feeling is that cooperative effects [between the atoms] are likely to be important."



IBM/SCIENCE

STM tip removes atoms from silicon surface, leaving a black void, and then dumps them in a pile (white spot) just to the left of the void.

The atoms gathered at the tip do not seem to diffuse into it, he adds. They hang on while he repositions the tip, then let go when he changes the direction of the electrical field. Thus, he can deposit a mound of silicon atoms wherever he wants.

By changing the tip-to-surface distance ever so slightly, Avouris can also control the amount of silicon affected by the electrical field. "As we come closer and closer," he says, "we can tune it so that eventually a single atom can be removed." *— E. Pennisi*