add

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from Research News (U of the Univ. of Michigan) 29(7):13-15 July, 1978

Bone Growth And Tooth Implantation

[aided by applied electromagnetic fields]

transmitter cannot be made small enough to make the patient comfortable. (The Stomatognathic Laboratory's expertise in telemetry of biological information was the original reason why Ash and Geister were approached on the project.)

What remains to be decided is how the switch will be coded by the patient to transmit information. One method is to transmit signals in pulse fashion. With each bite a pulse would enter a logic device, which would count the pulses, then put out its own signal. After three pulses, for example, the logic unit would send to a remote point (another room with an attending person in it) a coded message about exactly what the patient's need was. An alternative is to use a logic unit that times the length of the bite. Then, by holding the bite for a given period, the patient would activate a certain message.

The successful use of an intra-oral signalling device may help to expand in some measure the horizons of a patient who is incapable of meeting his own physical needs. Geister and the others involved with the patient look forward to making it possible for the young man to return home.

People have long hoped for a method of implanting artificial teeth to take the place of lost teeth. No one feels that the denture satisfactorily meets the needs of chewing and comfort like an original set of enamels. The impediment to a practical tooth implant has been the challenge of finding a material that is compatible with the bone that must support the implant and of fastening the implant in place.

The Stomatognathic Laboratory and Dental Research Institute director James K. Avery's Oral Histology group are helping to make a contribution to basic research that could have a payoff in prospects for tooth implants. Electronic expertise and experience is making possible certain studies of bone growth that could help in the effort to discover a way to fasten implanted teeth firmly in the jaw. The research is sponsored by the Sybron Corporation, a company whose several divisions deal in dental materials and products.

It has for some time been understood that electromagnetic fields, when applied to the site of a bone wound or break, seem to promote the healing of the bone. The electromagnetic field does not have to be large, and the intensity of the field is at a harmless level. So the question has arisen, does an electromagnetic field promote or otherwise influence the regrowth of bone in the jaw where a tooth has been removed? Tooth removal results in an empty socket that gradually fills up with new bone. This bone growth is directly relevant to attempts to induce bone to grow around any sort of tooth implant.

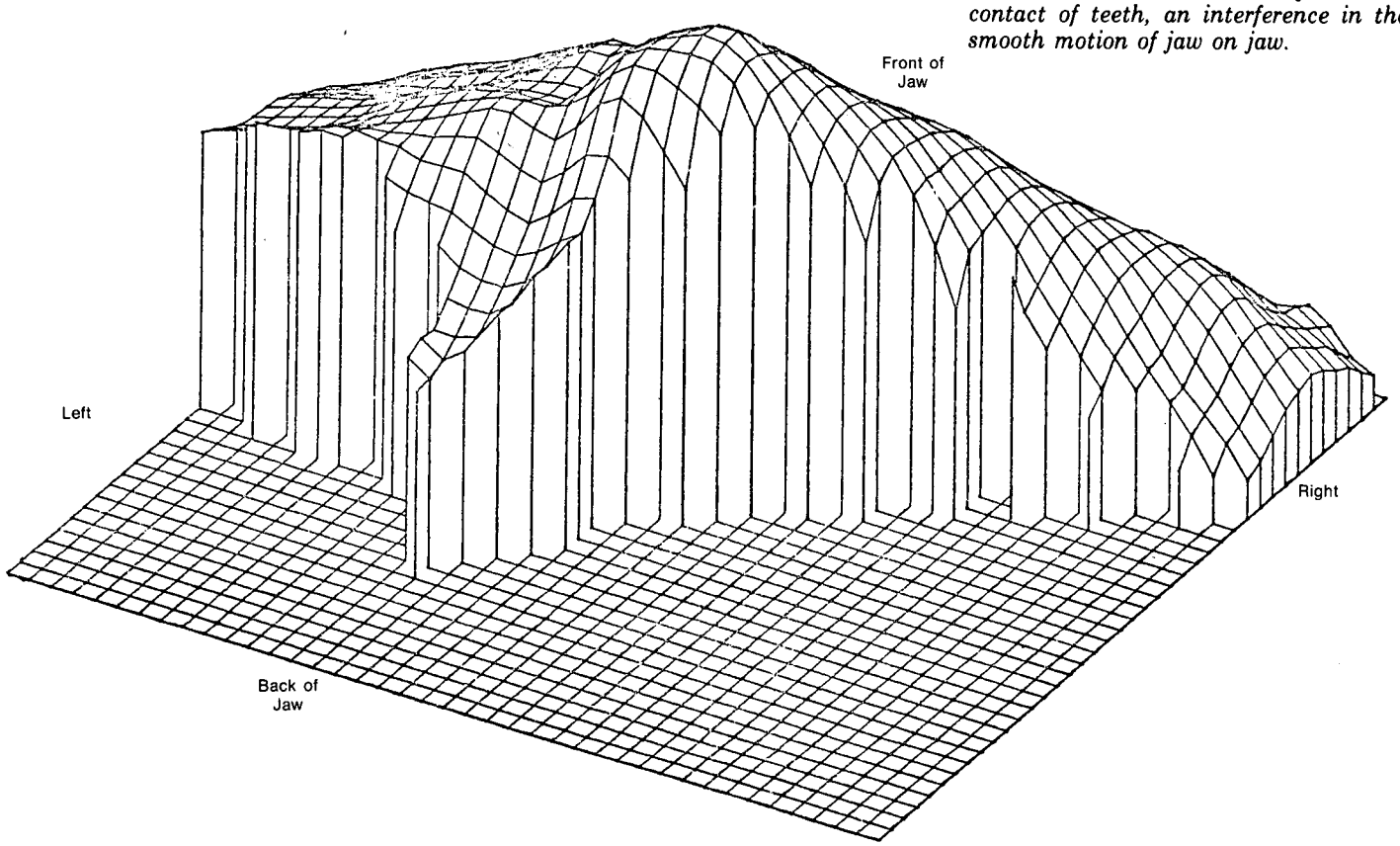
Dental Dogs

The project has involved a study with dogs to determine the rates of regrowth of bone in tooth sockets after removal of a tooth. Growth with an electromagnetic field in place was compared to growth without external influence. The dogs had been especially bred for dental research. Measurements were to be made from x-rays of the dogs' jaws that were to be taken according to a method devised by Albert G. Richards, professor of dentistry and specialist in cephalometrics (skull measurements).

First the dogs had to submit to having dental impressions taken. From the impressions it was possible to fashion an acrylic applicance that fit over the dogs' lower teeth. These, it was thought, would carry field coils and hold them in place at just the point where bone regrowth would be taking place. Unfortunately this approach did not work. The dogs so objected to having an object in their mouths that they succeeded in dislodging the acrylic appliances no matter what efforts were made to fix them in place. (Even so, Geister has reported, the experience of implanting electronic gear inside plastic appliances was to prove helpful in designing the bite splint for the quadriplegic patient whose case is discussed above.)

Finally it was necessary to fabricate metal applicances that would attach firmly on the dogs' teeth—something more like braces than a bite splint. The metal devices were accepted by the dogs and the experiments proceeded. Investigators pulled a tooth on each side of the dogs' lower jaws, then took an initial x-ray of the vacant sockets. The metal device that held the field coils was at-

If you slide your lower jaw backward, forward, and to both sides while maintaining light contact with the upper teeth, you will observe that the jaw moves up and down as it encounters obstruction by various teeth and by the occlusion in general. This diagram shows the envelope of motion of one person's lower jaw and indicates at least one point of interference in the smooth motion of the jaw. The point of view here is from the throat looking out of the mouth toward the left. The low point in the foreground represents what dentists call centric relation, *a position in which the lower jaw is forcibly pushed rearward as far as possible. The high point on the diagram is called* centric occlusion *and represents a position in which the subject's teeth are in normal contact. The area indicated shows a premature contact of teeth, an interference in the smooth motion of jaw on jaw.*



tached to teeth next to the site of the wound. The field coils produced a pulsed magnetic field whose intensity was not even as great as that used in the magnets that hold refrigerator doors closed.

About every other day radiographs were taken of the progress of bone growth. The field coil applicance remained in place for ten to fourteen days. In the end each dog was killed and final measurements of bone growth were taken post mortem. The data proved to a certainty that the sides of the dogs' jaws with the field coil appliances experienced more rapid bone growth than did the other sides of the dogs' jaws where healing took place naturally.

A Tailored Wave

Geister and Ash expect that further research will continue in this area and have proposed to Sybron that the company continue to fund the studies. They hope to learn whether, for example, the electromagnetic field can be tailored to optimize bone growth with respect to time and quality of growth—for example, it will have to be shown that electromagnetically induced bone growth is just as permanent as natural growth. Another question of special interest is whether bone growth can be induced effectively if a tooth implant is installed after the original tooth is pulled. Sybron believes that it has a material that is compatible with bone and other jaw tissues. Further studies may help to show whether bone growth can make for a good hold on the implanted tooth.

It also remains to be discovered whether, in addition to bone growth, the field coils can help induce reattachment of the periodontal ligaments that hold natural teeth to bone.These sturdy ligaments are sheared off when a tooth is pulled. It may be that the ligaments will not adhere to implants. Or, if they do not, it may be that implants with irregular surfaces can be installed and the bone

made to grow around the irregularities to form a good mechanical hold on the implant, even without the ligaments functioning normally. On the theoretical side, Geister wants to ascertain exactly what characteristic of the electromagnetic field is responsible for the enhanced growth.

Most of the studies covered in this *Research News,* except for the bone growth effort, are supported by a funding mechanism that can be crucial in some fields of research. Fundamentally the Dental Research Institute, in which these studies take place, is a collection of research grants whose source is the National Institutes of Health (NIH). The Dental Research Institute's program is reviewed annually in its entirety, and NIH funds the Institute with a block grant. This means that certain studies within the Institute can enjoy a period of freedom to develop—three to five years perhaps—without the pressure to show immediate results. Lacking this period of freedom, some young investigations can find themselves cut off while established avenues of inquiry continue to get the available funding.

Electromyographic studies of temporomandibular joint syndrome is a field that has benefited from such freedom. Today some of the fruits of the program are becoming evident and significant. Solid evidence is now in hand concerning the relevance of electromyographic data to the problem of jaw pain. In years to come more and more dentists and dental researchers should be able to build on this base of knowledge, which developed at its own pace within the precincts of a unique research institution.

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