STRAIGHT TEETH WITHOUT BRACES

A simple device, said to painlessly reposition the jaws, may do away with burdensome braces.

Almost every Wednesday, orthodontist Leon Kussick goes to the American Museum of Natural History in New York City to examine ancient skulls. Why? "It's my business to understand everything about the human jaw," he says. From his studies of fossil jaws and childrens' teeth, Kussick has concluded that braces, the cumbersome, costly stock-in-trade of modern orthodonture, are often unnecessary and can be ineffective as well.

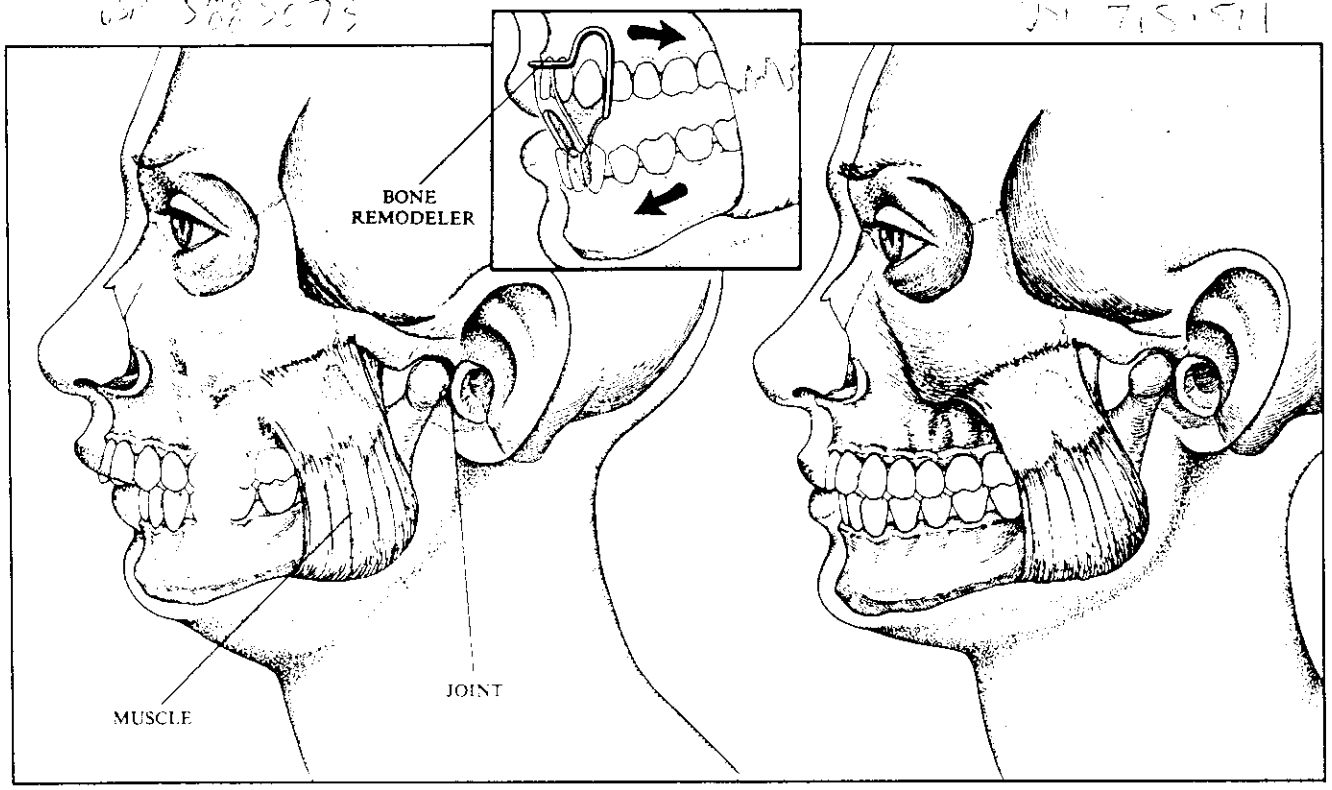
Thousands of children each year have teeth extracted and braces fitted to treat malocclusion, a defect in jaw formation that prevents the jaws from fitting together properly. According to Kussick, this approach to the problem is all wrong: "Braces move teeth, not jaws," he says, "and pulling teeth often worsens an already bad profile. Traditional orthodontists are still holding on to the tip of the iceberg—the teeth—when the heart of the trouble is in the bones and muscles."

So for 20 years, Kussick, who practices in Livingston, New Jersey, has been correcting malocclusions his own way—following a procedure that most orthodontists would consider unorthodox. His method, called bone remodeling, is based on a novel analysis of the way jaws grow. Most dental schools teach that jaw growth occurs at the front of the head, near the teeth. But Kussick and several bone physiologists disagree. They believe, instead, that new bone is added on closer to where the jaw meets the skull.

To correct the most common malocclusion—in which the upper jaw protrudes far beyond the lower—Kussick designed a simple acrylic appliance that affects the jaw's natural growth mechanisms. The patient must wear the device in his mouth three hours each day, as well as all night. When it is in place, the mouth is held open and the lower jaw is pushed forward. According to Kussick, this puts tension on the chewing muscles. The upper jaw shifts back, and the lower jaw moves farther forward, slightly displacing it from the joint where it fits into the skull. The jawbone eventually elongates and grows back into the joint. The net effect? Lengthening of the lower jaw. Once proper alignment of the jaws is achieved, the treatment is discontinued.

"The beauty of bone remodeling," says Kussick, "is that it is permanent." And the treatment, which takes one to three years, can begin as soon as the malocclusion starts to show—around age five to seven. It works best on youngsters, he adds, because they still have the potential to grow.

Kussick readily admits that his approach is controversial. But after treating more than 2,000 patients, he is convinced that it works. ■



To correct an overbite (left), a bone remodeler (inset) is used to move the lower jaw forward, slightly out of its joint in the skull. Tension on muscles causes the upper jaw to drift back and the lower to lengthen until the jaws are aligned (right). Although as many as 2,000 jaws have been treated with the device, the procedure is still not accepted by most orthodontists.

Illustration by Michael Reingold

<87 WORDS> Got cold hands, numb feet or headaches? You either operate a snow plow or you should have your head examined... well, at least a part of your head -- your jaws. Stephen Smith of the ("Tem-por-row-man-dib-u-lar") Temporomandibular Orthopedics Clinic of Philadelphia reports that reposturing jaws and bites out of joint can improve blood circulation to other parts of the body. Smith reports that patients who underwent such adjustments experienced pronounced positive effects on their circulation. Objective measurements showed an actual increase in blood flow in the fingers and toes. <SCIENCE NEWS, Dec 6, 80 pg 365, OSTEOPATHIC MEDICINE, Aug and Oct issues> Mobius Group, L.A.

S.F. EXAMINER SEPT '81

Examiner/Bob Roth

Smiling through the resin

A fast, inexpensive way for dentists to restore some very bad teeth

NEW YORK (UPI) — Dr. James Eisdorfer's specialty is making people smile.

He smiles as he recalls some of his patients — a teen-age girl from New Jersey who never smiled outside her house, a Staten Island housewife who always talked with her hand in front of her face, a young boy with a football injury, a television announcer and plenty of models.

"I give them immediate smiles," Eisdorfer said.

Eisdorfer is one of about 10 percent of the nation's dentists who now are restoring chipped, lined, stained, pitted or crooked teeth with a method that is faster and less expensive than capping.

The method, composite resin restoration, entails using a mixture of silica and quartz — compounds previously used only to fill cavities in front teeth — to paint over various flaws. After the thick mixture sets, which takes about 10 minutes, the dentist uses disks to "sculpt" the tooth into the desired shape.

Eisdorfer said his work costs about half as much as capping a tooth, a long, often painful process that involves grinding a tooth down to a stub and then crowning it with a cap of porcelain filled with gold.

While capping can run $500-$600 a tooth and take a minimum of three or fours hours per tooth with multiple visits required, painting costs $200-$250 and often can take less than an hour to restore a tooth, Eisdorfer said.

Eisdorfer also is confident that his work lasts "in excess of five years," which is about how long he has been using the process. None of his patients thus far has needed new work, he said.

"But nothing lasts forever," Eisdorfer said. "Crowns have to be redone when the gum grows up" exposing the line between the cap and the tooth stub, he said.

Eisdorfer, who received his degree in dentistry from New York University in 1973 and then specialized in capping during an internship at Mount Sinai Hospital here, does not believe resin restoration will replace capping entirely, but that it is a practical alternative.

The process is particularly practical for persons who want their teeth changed solely for cosmetic purposes — models, performers or television personalities whose smiles are their livings.

"There's no destroying a perfectly sound tooth by filing it to a stub," Eisdorfer said. "You clean the tooth and then you put the mixture over it."

Eisdorfer said he has never had a case where decay developed under the mixture.

Besides the professional smilers, patients who appear in Eisdorfer's Manhattan office include truck drivers, Little League baseball players, housewives and shy teen-agers with gaping spaces between their front teeth.

One singer from Venezuela was very pleased with his work.

"She sent me two album covers, a before and an after — with a big smile," Eisdorfer said.

Tooth straightener will set it right !

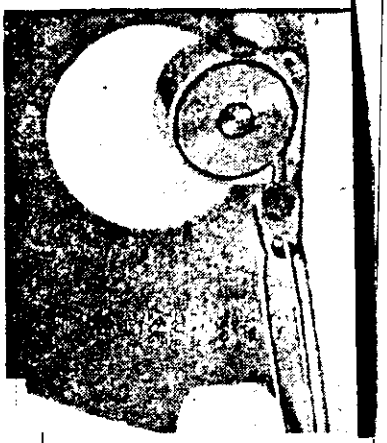
Got a crooked tooth? Don't despair! A tiny device developed by an American firm will set it right.

The miniature intra-oral tensioning device that can straighten teeth by exerting a constant linear pull is no bigger than an aspirin tablet. Its main advantge over the conventional braces-and-archwire technique is that, it does not require repeated retightening adjustments in a dentist's clinic.

The device is anchored to a firm tooth in the back of the patient's mouth and its spring mechanism attached to the crooked tooth by a fine loop of miniature cable wire. Pulling with a steady 8-ounce force, it can move a tooth by as much as 1/4 inch during a predetermined period.

Apart from eliminating repeated trips to the dentist's, this tiny tensioner will be useful in other minute adjusting applications requiring constant, but very small linear forces. The smallness of its size will enable more than one unit to be used in a patient's mouth.

INVENTION INTELL. Aug. '76



Look, ma, no fluoride

Two water-treatment fluoride chemicals that are used by more than 4,600 U.S. cities and towns to help fight tooth decay are in short supply, U.S. Centers for Disease Control officials recently reported. The two chemicals — sodium silica fluoride and hydrofluosilicic acid — are byproducts of phosphate fertilizer production. Supplies of the two chemicals are quickly disappearing as a result of a severe cutback in phosphate fertilizer production, which in turn is due to decreased demand. The shortage is expected to last 3 to 6 months, according to Jack Jackson and Thomas Reeves of CDC in Atlanta, Ga.

The CDC officials say there are other known ways to synthesize the two fluoride chemicals, but these means are too expensive to use during what is presumed to be a temporary decline in phosphate fertilizer production. A third fluoride substance — sodium fluoride — already is used in toothpastes and in some small-town water systems. But because it costs at least $1 per pound (compared with 10 to 25 cents per pound for the two fertilizer-related fluorides), sodium fluoride is too expensive to be more widely used in water.

The CDC officials estimate that use of fluoridated water can reduce the incidence of dental caries by 50 to 65 percent. A marked increase in the incidence of cavities may be apparent, Jackson and Reeves say, if the fluorine shortage should continue for at least nine months.

JULY 10, 1982 Sci News

Dentistry

Jockstraps for Jaws

Dental splints prove no boon to strength

First, put your little fingers in your ears. Now open and close your mouth. Feel a click? Hear a sound like footsteps on gravel? Those, says sports orthodontist Richard Kaufman, D.D.S., of Oceanside, New York, are signs of a sick temporomandibular joint (TMJ).

A much-touted cure for TMJ stress is driving a lot of athletes—be they weekend joggers or professional football players—to dentists. There, for $200 to $400, they are fitted with a small curve of acrylic that makes the click and the gravel sounds go away—and supposedly increases muscle strength up to 50%.

The piece of acrylic is called a bite plate or dental splint. It clips over the lower molars and bicuspids to realign the bite pattern. Using dental splints, weightlifters swear they can heft more iron and runners that they go like rabbits.

If the jaw is not properly aligned, says Dr. Kaufman,

Howard Cruse

the rest of the skeletal frame has to compensate, and eventually the stress makes you hurt all over.

Others hold that stress to any part of the body weakens the entire organism. Since many nerve pathways to the brain pass through the TMJ region, stress there could show up anywhere, they contend.

Stephen Smith, D.M.D., clinical director of the Temporomandibular Orthopedics Center at the Philadelphia College of Osteopathic Medicine, claims that TMJ dysfunction also impairs circulation. Correcting the bite, he avers, increases body blood flow, which should boost athletic performance.

Despite such substantial investment in theory, the splint failed to raise performance in its most rigorous test. True, even skeptics agree that bite splints can help reduce the headaches and neck tension of *severe*

Amer. Health Apr. '82 *A.H. Mar/Apr '82*

Television, The Modern Anesthetic

Orthodontists are well trained to get kids' teeth straight; what they often have problems with is getting them to sit straight.

Now, *Video* magazine reports, a New York orthodontist has found a way to keep his young patients quiet. He's installed a system of television sets around his patients' chairs; each child watches a video tape while the dentist is working.

"Kids are so enthralled watching television that they're totally oblivious to discomfort," says Marc Lemchen. "We've extracted baby teeth without the kids even realizing what was happening."

Each set is equipped with headphones. Patients may watch a choice of shows, including "Gilligan's Island," "General Hospital" and several specially produced tapes on tooth care. The whole set-up cost Lemchen $10,000. □□

LIFE

By Dr. Bernard Dixon

OMNI

Thanks to smallpox vaccine, a feared and vile malady was purged from the planet about a year ago. Today microbiologists are vying with one another to predict the *next* vaccine that will have such a spectacular effect on human well-being. Immunization against measles, perhaps? Theoretically that disease could also be eradicated. A really potent influenza shot? One for malaria? Or one for the common cold?

My guess is that a quite different vaccine will make the headlines during the 1980s. This decade will see the introduction of a vaccine to combat what's probably man's most common disease: tooth decay. The Western world is now being ravaged by a massive epidemic of dental caries, even among young children. Fluoridation and avoiding sticky candies can help; however, inducing immunity would be a tremendous advance.

What is the basis of this prediction? Two batches of caries vaccine already exist. They were prepared in London, at Guy's Hospital and at the Royal College of Surgeons, and they have been stunningly effective in preventing tooth decay in monkeys. But unsolved technical and ethical problems will have to be confronted before the gap is bridged between the lower animals and man. Despite much pain, discomfort, and anxiety, caries is not a dangerous disease; we must make sure that the vaccine is safe before we use it in humans.

Like smallpox or influenza, caries develops because of infection. It is caused by bacteria that colonize the surface of teeth, thriving within white plaque, which adheres to the enamel. From experiments with both germ-free and infected animals, we know that only two conditions are necessary for decay to begin. First, the food must contain sucrose or some other carbohydrate. Second, a bacterium known as *Streptococcus mutans* must be present. By fermenting carbohydrate, the bacterium produces an acid strong enough to erode enamel and begin the process of decay.

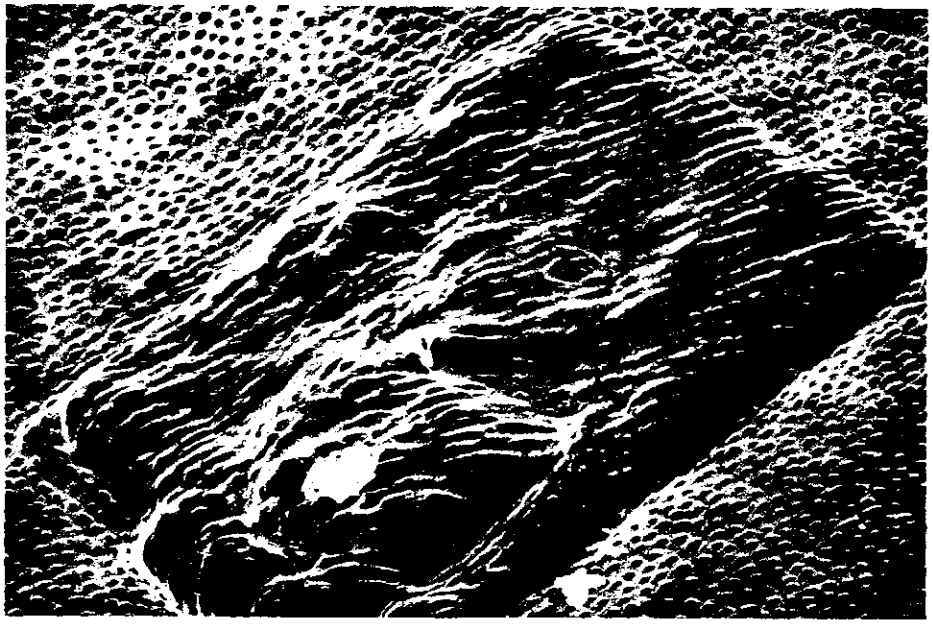
Armed with this information, we should be within reach of a vaccine against caries. As with other microbes, it should be possible to change *S. mutans* so that it triggers antibody production when injected but no longer causes disease. The only snag is that teeth seem to be "outside" the body, shielded from antibodies present in the bloodstream. Over the past decade, however, we have found that a fluid rich in antibodies seeps through the crevices between teeth and gums. This discovery has greatly boosted hopes that immunization can prevent decay. Indeed, early findings suggest this strategy is highly feasible.

Professor Bertram Cohen and his colleagues at the Royal College of Surgeons have raised Irus monkeys on a diet rich in fermentable carbohydrate and injected them with a vaccine based on *S. mutans*. The monkeys remain free of decay as much as nine years after being treated. At Guy's Hospital, Professor Thomas Lehner and his team have reported equally promising results with rhesus monkeys. Because the structure and development of these animals' teeth, and their vulnerability to decay, are very like those of human teeth, the prospects for success in man look excellent.

Until recently, one major hypothetical difficulty remained. As far as our immune system is concerned, some components of streptococci closely resemble some parts of the human heart. That is why rheumatic fever arises. Following a sore throat caused by these bacteria, antibodies generated to repel the invaders occasionally attack heart muscle instead. The possibility that this might happen with *S. mutans* vaccine worries scientists.

Professor Cohen's group has now discovered that the component of *S. mutans* that reacts against heart muscle is not needed for the vaccine to work. Efforts are being made to purify vaccine containing only those parts of the bacterium that confer protection and none that could do harm.

The cost of caries in treatment, pain, loss of teeth, and lost time in industry and education is incalculable. The prospect of its prevention is one of the most welcome and unexpected dividends of science from the Seventies. ∞



Warning to dentists: A vaccine may soon eliminate cavities like the one above, magnified 100 times.

SCI. NEWS 121:330 (MAY 15 '80)

Shifting teeth faster electrically

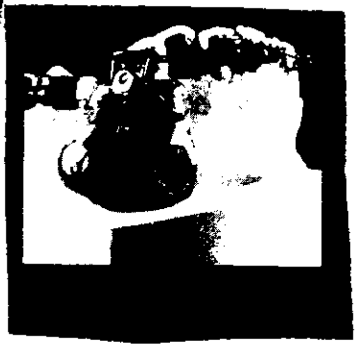
Wearing braces to move and straighten teeth can be a lengthy, painful experience. Now, two University of Pennsylvania researchers believe electrical stimulation of the gums may cut in half the time braces must be worn. The researchers are just beginning a three-year clinical study with 60 female patients to test the method.

Orthodontist Zeev Davidovitch, who began the work in 1975 with materials scientist Edward Korostoff, says orthodontists have conventionally used mechanical force to shift teeth. Mechanical devices that push or pull a tooth apply force to a tooth's crown. The force is transmitted downward to the root and into the tissues, including bone, that surround the root. There the bone tends to dissolve or resorb ahead of the moving tooth's root where the pressure is high and to build up behind the root where the pressure is low. The problem, says Davidovitch, is that tissue remodeling doesn't happen overnight. "What we're doing with electricity is simply enhancing the rate of tissue remodeling," he says. Although braces are still necessary, they are needed for a shorter time.

The electricity source is approximately the size and shape of two nickels stuck together. It consists of a transistor and several resistors and batteries, encased in epoxy and dental acrylic plastic. The device provides a constant current of between 15 and 20 microamperes at about 1.5 volts. Korostoff says the easily removable circular unit attaches to the bracket already installed for orthodontic wires and lies against the gum, between the gum and the cheek. One major effort during the first year of the clinical trials will be to reduce the size of the device, Korostoff says. A graduate student researcher, who has worn the device for a short time, says its presence is noticeable, but it is not uncomfortable compared with the normal discomfort people suffer when they wear orthodontic braces. He says he did not feel the electric current at all.

Although the method was tested successfully on cats, Davidovitch admits that testing it on humans is a new field. "We don't know what will happen," he says. "There are many questions we haven't answered yet." Initially, patients will wear the device for about 8 to 10 hours at night. "We may find that it's not sufficient," says Davidovitch, "but this is why we plan to conduct these experiments, to get the bugs out of the system."

Both Korostoff and Davidovitch are optimistic that their method will work on humans as well as it did on cats, and they are very excited about their work. Through the University of Pennsylvania, they hold a patent on the method and device now being tested at the university's School of Dental Medicine.



Computers tackle gum disease

During the past several years conventional X-ray diagnosis has undergone a technical improvement called digital subtraction radiography. Digital computers are coupled to X-ray sensors to enhance the quality of X-ray imaging, thus bringing out information in the images that would otherwise not be available. Digital radiography's most extensive use so far has been in the diagnosis of heart disease (SN: 6/12/82, p. 395).

Now digital radiography also looks promising in the early detection of gum disease, according to a report in the August NIDR RESEARCH NEWS. R.L. Webber and his team at the National Institute of Dental Research in Bethesda, Md., had 10 dentists look for signs of gum disease in conventional radiographs and in digital radiographs that had been taken of newly diseased gums. In every instance the dentists were better able to detect disease in the digital images.

SCI. NEWS OCT. 2 '82

Trenchmouth and stress

SCI NEWS NOV 13 '82

A strong relationship between stress and trenchmouth — a bacterial infection of the gums characterized by gum bleeding, gum pain and foul breath — has been demonstrated for the first time in a study, reports Ronald B. Cogen of the University of Alabama School of Dentistry in Birmingham and colleagues. Stress appears to cause trenchmouth by increasing levels of the adrenal hormone cortisol in the body. This increase impairs the ability of a type of immune system cell to dispose of harmful bacteria, Cogen and his team found.

Cogen studied 100 trenchmouth patients. Compared with controls matched by race, age, sex, socioeconomic status and plaque accumulation on the teeth, trenchmouth sufferers showed significantly more anxiety, reported more negative recent life events that affected them to a greater perceived degree, were significantly more depressed and suffered from a significantly greater number of emotional disorders. The trenchmouth patients were also examined for levels of various hormones. Only the adrenal hormone cortisol was increased. Adrenal hormones increase in the body in reaction to stress and depress the body's immune system. White cells in the patients were also studied because white cells make up a substantial part of the body's immune system. The levels of various kinds of white cells were within normal levels in the patients. But the patients were found to possess impaired polymorphonuclear leukocytes—white cells known to engulf and eliminate bacteria.

The study also produced an unexpected finding: blacks appear to be virtually unaffected by trenchmouth. Only one of the 100 study patients was black, yet all came from a university dental clinic population that was 40 percent black.

EFFECT OF ELECTRIC BRACES SHOCKING

PHILADELPHIA—Electric braces, which could take a big bite out of the amount of time usually needed to straighten teeth, have been developed by researchers at the University of Pennsylvania School of Dental Medicine.

Dr. Zeev Davidovitch, orthodontics professor and head of the research team, says miniature batteries, transistors and resistors produce and regulate the low-level electric current in the device.

The electrical-mechanical device, used with conventional orthodontic braces, has been successfully tested on animals. Davidovitch says it could straighten teeth twice as fast as regular braces and be no more inconvenient. He hopes to begin a three-year study on humans soon. "The bulkiness of this power pack resembles the bulkiness of an extension screw, [often] used to expand palates," he says.

"It can be easily taken in and out and should pose no discomfort to the patient. He can wear it only at night, and he can't throw it out of adjustment unless he steps on it or breaks it with a hammer."

In initial tests, standard braces were placed on one side of a cat's mouth, the device on the other. An electrode was placed on either side of a tooth and a small amount of electricity was generated.

Weeks later, the researchers found that where there was electrical stimulation tooth movement was twice as fast. The scientists also found that because cell stimulation occurs a few minutes after electricity is introduced, the device does not have to be worn 24 hours a day.

"When you try to move teeth, you apply forces—the wires, springs and elastic bands—to the teeth. The force is transmitted to the surrounding tissue," Davidovich explains.

"We thought if we could get more cells involved in the surrounding tissue, we would get move rapid tooth movement."

It has been estimated that only five to 10 percent of those who need orthodontia receive it, Davidovich says. If treatment time, which often runs into years, can be halved, more patients will be willing to undergo treatment, he predicts.

SEALING THE GOODNESS IN YOUR TEETH

Tooth decay, mankind's most prevalent disease, may soon be a thing of the past. Fluoridated water, available to over half the American population, has already reduced the incidence of caries by 60 percent since 1945. Now a preventive technique that coats the decay-prone rear teeth with a glaze-like plastic sealant is being perfected, and it promises to wipe out cavities entirely.

"The sealant could definitely mean the elimination of cavities," says Dr. John A. Hargreaves, professor of pediatric dentistry at the Harvard School of

son won't say what the substance is because a patent on it is pending.) Thus, drawing on the fake cigarette doesn't coat the lungs with dangerous tar or fill them with carbon monoxide, though it does give them about half the nicotine vapor provided by a puff on a real cigarette. So far, reports Dr. Jacobson, all who have tried the nondombustible cigarette have either cut down or stopped smoking for up to two years.

—Larry Frederick

SF CHRON. Jan 15 '82

SYLVIA PORTER

Changes in The Dental Field

ITEM: Almost one of every four Americans over age 50 is already toothless. By age 65, the number doubles. Altogether, more than 40 million people wear dentures.

ITEM: In the face of these startling figures, there are encouraging signs that dental care will become more available to the 50 percent of the U.S. population that never receives this type of service. The dental profession is moving toward a non-medical environment with retail store dental facilities. At the same time, the number of women entering dentistry is climbing dramatically.

ITEM: Among the 135,000 dentists in practice today, 50,000 have opted to avoid the expense of establishing private practices. Instead, these men and women have entered group practice or hospital-based practices as they graduate from dental school. Today, 63 retail dental operations in 15 states are housed in 21 different chain, drug and discount stores — with unforeseeable effects on dentist-patient relationships.

Behind many of dentistry's new trends is the growing cost of dental education. Today's dental student may incur costs of up to $200,000 for education and establishment of a dental practice, Dr. Stuart Ginsberg told a Greater New York Dental Me[illegible] recently. That tab poses an insurmountable pro[illegible]n for the middle class, the traditional wellspring of new dentists.

"Who can afford to become a dentist?" Ginsberg asks. "The very rich can, but they normally do not; the very poor, subsidized student can, but few enter the dental profession. That leaves the middle class as the major pool of new dental talent. Apparently neither these students nor their parents can afford the astronomical cost."

This helps explain why dental school applications plunged to 9000 in 1980, compared with 15,000 in 1975 for the same 6000 places in the nation's 60 dental schools. In 1981, some major dental schools couldn't fill available places for the first time in the 20th century.

Meanwhile, though, enrollment in dental schools by women has risen from less than 1 percent until 1970 to 19.8 percent in 1980. Projected figure for the number of women in the dental work force in 1990 has been estimated at 7.9 percent of total dentists as against the current proportion of 3.2 percent.

To Ginsberg, a possible side effect will be the downgrading of dentistry from a profession to a job with concentration on mechanics instead of science. The high cost of practicing dentistry is making the profession less attractive to bright young people. The average net income in dentistry stands at $4[illegible]00 annually compared with about $60,000 in the [illegible]y 1970s, despite enormous inflationary pressures.

"This is not a great deal of money in terms of attracting highly trained people to the profession," commented Dr. Bernard Tillis, editor of the New York State Dental Journal.

16

VACCINE TO WIPE OUT TOOTH DECAY TESTED

SAN FRANCISCO—A dental professor says a vaccine that blocks the buildup of bacteria on teeth and prevents decay is being developed—and users wouldn't have to worry about eating candy.

But before the vaccine—being tested on people in several countries—can be used, it must be examined for long-range side-effects, Dr. Harold Slavkin said recently.

It is not sugar but bacteria that causes tooth decay, said Slavkin, professor of craniofacial biology and biochemistry at the University of Southern California.

"The idea is not to remove sugar from the diet but to prevent bacteria from sticking to teeth," he explained.

The vaccine blocks such attachment, thereby preventing decay, he said.

Animals are also being used as subjects to test vaccines to prevent gum diseases, which result in inflammation, swelling, bleeding and, eventually, tooth loss.

"The toothbrush has not turned out to be a very effective way to check this disease on a worldwide basis, simply because most people aren't perfectionist enough to maintain absolute hygiene. So, the vaccine looks promising," Slavkin said.

Such research indicates "we are on the edge of a new frontier in dental and medical care, which could include such seemingly outlandish practices as 'cloning' healthy tissues to replace diseased tooth enamel and gum tissue," he said.

Dentist Shows Off His 'Invisible' Braces

By John Wilkes

A Beverly Hills dentist described in San Francisco yesterday his vastly improved version of invisible dental braces — attached not to the front but to the back of the teeth.

Dr. Craven Kurz told colleagues at the American Dental Association convention that he has already successfully straightened the teeth of 50 people with the new braces and that 2000 other patients are now wearing them.

He said his technique represents a "novel application of standard techniques used by most orthodontists." In effect it's turning braces inside out — placing them behind the teeth instead of in front where they are so visible.

Kurz, a 39-year-old former professor of orthodontics at the University of California at Los Angeles, said the new braces are more comfortable than conventional braces and, unlike conventional braces, they leave no telltale dullness in the enamel on the front of the teeth when they are removed.

He said he developed the braces to straighten the teeth of Playboy Bunnies and other glamorous patients who could not allow their appearance to be marred by "tinfoil on their teeth."

The invisible braces cost a third more than conventional braces, however, because they take longer to put on and adjust.

Kurz showed scores of before-and-after slides of patients during his 2½-hour talk at the Moscone Center, and one patient described her experience with the braces.

"For the first two weeks my tongue kept finding the braces, and I had a hard time saying 's,' " said Denise Mauchmar, 28, Kurz's orthodontic technician, who wears a full set of the invisible braces. "But now, after seven months, I hardly notice them."

A similar version of invisible braces was introduced by a Japanese orthodontist, Dr. Kinya Fujita, at the 1961 meeting of the American Association of Orthodontists. Kurz insists his braces are more successful.

As with conventional front braces, the wires of his invisible braces are anchored to metal bands around the four rear molars on the top and bottom of the jaw.

The metal anchors are bonded to the back of each tooth in a three-step process. First, the enamel is etched with acid to prepare a surface roughened by microscopic fissures. Then resin is applied to the prepared surface so it penetrates the fissures in the enamel, giving the bonding material a strong base. Finally, the anchor is cemented to the resin. When the anchors are in place, the wires are laced through them and tightened, as with conventional, front-of-the-teeth braces.

Kurz has trained 2000 of the more than 6700 American orthodontists in the new technique in seminars sponsored by Ormco, the dental appliance manufacturing company to which he sold the patent to the process.

"Within a year's time," said Kurz, "just about every orthodontial supply company will be making the appliance."

Susan Huggins

Say Cheese

That Cheddar Smile

A new whey to fight tooth decay

Photographers have always acted as if "cheese" were the mantra for a big healthy grin. Now, research at the University of Minnesota indicates that it could be. Certain kinds of cheese appear to prevent cavities.

Just saying the word won't do any good, and it's not yet clear that four out of five dentists are about to recommend a lotta ricotta. But microbiologist Charles Schachtele, Ph.D., believes he's closing in on a cheese chemical that can disarm dental bacteria.

Using tiny sensors, Schachtele checks the chemical breakdown of countless foodstuffs in the mouth. These tests have measured the way dental plaque immediately turns the carbohydrate-sugars of almost all foods into corrosive, enamel-eating acids.

Recently, however, the Minnesota researcher discovered a remarkable exception: 7 of 13 cheese types he and colleagues looked at—there are more than 2,000—don't turn into plaque acid at all. Three of them—aged Cheddar, Monterey Jack and Swiss—actually prevent acid from forming all around them, even on molars doused with sugar water.

Gouda, Brie, blue and mozzarella—along with ham, "undoctored" peanuts and certain kinds of fish—caused almost no acid buildup by themselves. Cheddar, Monterey Jack and Swiss actually blocked what in mathematical terms should have been a 1,000-fold increase in tooth acid from sugar exposure.

Schachtele told *American Health* that he doesn't yet know which components of cheese do the trick. But he is optimistic that the dental-acid blocker can be isolated—and lead to an important new food additive.

Is there a way to incorporate the cheese protector in a new kind of toothpaste? "It's a possibility," Schachtele acknowledges. But he stops short of endorsing jingles like "You'll wonder where the yellow went when you brush your teeth with Roquefort."

—David Monagan

SWISH AFTER EVERY MEAL?

A vaccine to prevent cavities has had good results in rats and monkeys put on a diet of sweetened foods; some dental researchers are optimistic that it will be equally effective in people. Limited human trials are under way.

"It's been established beyond doubt that the vaccine has protected animals to an exceedingly high degree," says Dr. William H. Bowen, chief of the caries (i.e., tooth decay) prevention branch at the National Institute of Dental Research in Bethesda, Maryland. "If all goes well, I'd say we'll have an anticaries vaccine for humans in as little as four or five years."

The vaccine consists of killed *Streptococci* bacteria—the variety that normally inhabits the mouth, not the kind that causes strep throat. Alive and in their natural habitat, these bacteria gleefully pounce on carbohydrates stuck to the teeth, and the interaction produces acids that eat through enamel. What the vaccine does is stimulate the salivary glands to secrete more of the antibodies that attack and destroy *Streptococci*. Vaccinated animals have developed 60 percent fewer cavities than untreated controls.

Test animals get the vaccine either mixed in their food or by injection, but researchers aren't sure yet how it would be given to people. In the human trials so far, volunteers are swallowing it. Early results from these experiments, however, show that some people fail to release the *Streptococci* antibodies, probably because the vaccine is destroyed in the inhospitable digestive tract. So investigators are considering a liquid, to be swished around the mouth, mouthwash style, in order to directly stimulate the salivary glands.

Howard Cruse

90 Million Americans Suffering From Gum Disease

Gum disease in America has reached epidemic proportions, reports Dr. Robert Genco, of State University of New York at Buffalo.

"Eight out of ten adults over the age of 35 — an estimated 90 million Americans — have some form of periodontal disease," he says. "If not controlled, it can ultimately lead to tooth loss through weakened tooth support.

"The treatment of this condition is costing the American public about $1.5 billion a year, and not all those who have it are being treated."

Dr. Genco, who is chairman of the Department of Oral Biology, is heading a new Periodontal Disease Clinical Research Center at the university.

Page 6 — MIDNIGHT/GLOBE — Ja

Jan 3 '78

TRAY 5

Washing Away Tooth Decay

By Charles Petit
Science Correspondent

A 5-year-old Oakland child sprawled lazily on his back in the dentist's chair.

He opened his mouth wide, exposing a pale tan spot of typical childhood tooth decay in an upper molar.

Steel implement in hand, Dr. David L. Rothman told him what a good boy he was, then stepped on a foot control switch and moved in.

No drill whirred in the dental clinic treatment room at Children's Hospital Medical Center of Northern California in Oakland. No shots of pain-killing drugs. There was only the clicking noise of a small electric pump that delivered a steady stream of clear and nearly tasteless solution to the tooth.

Rothman probed gently with the applicator as the decay gradually softened and washed away, leaving a roughly circular cavity surrounded by healthy white enamel and underlying dentin.

The little boy did not squirm or show any discomfort. He just watched, relaxed and fascinated, holding the hand mirror Rothman had given him.

It all took less than 20 minutes, with no pain. Except for a 30-second touch-up with a low-speed drill just

Back Page Col. 1

Photos by Roger Ilyon

After a mask isolated the young patient's tooth, the solution was discharged through the hook-like end of the tool so it could soften and wash away the decayed area

A WASH FOR TOOTH DECAY

From Page 1

before the silver filling went in, there was no drilling.

Rothman was demonstrating a new method of washing away cavities, with little or no drilling and no pain-killing drugs or gas. Approved for marketing by the Food and Drug Administration late last year, it comes to California in November.

This process is not for everybody every time. Many fillings still will mean drills and needles, particularly for hard-to-get-at cavities between teeth, Rothman said. Only a lot more experience will reveal just where this new method fits into dentistry.

The use of this non-toxic, painless solution comes more than a decade after two dental researchers at Tufts University in Boston, Drs. Melvyn Goldman and Joseph Kronman, came across an enzyme-like chemical called GK-101E that softens only portions of teeth already breaking down because of bacterial decay.

The company that has the rights to it, National Patent Dental Products of New Brunswick, N.J., is finding a ready market among dentists for the enzyme and the applicator equipment at $700 a set.

The firm claims that the substance is non-toxic and does not irritate gums or the pulp of the tooth, and that it breaks down rapidly in water and urea, substances that the body contains naturally.

The president of the company, Keith Stoneback, said, "The dentists are very excited, but we're very nervous about the public hearing about this product before the dentists have it." He refused to guess what percentage of fillings can be done with the system, marketed under the name Caridex (caries is the medical term for tooth decay).

"A lot will be up to the individual practitioner," he said. "You can use it in almost any situation, but it is not always practical."

Cavities that are between teeth or that are otherwise hard to get to, he said, may require so much drilling just to gain access that the Caridex method offers little benefit.

The system comes as tooth decay already is on the wane in America. Reasons include increased fluoridation of water, sales of mouthwashes and toothpastes that contain fluoride, a tendency by many people to brush and floss more and avoid sweet or starchy foods that promote decay, and better dentistry.

Sometimes fillings are not even needed for small areas of decay that can be rehardened with chemicals that restore the mineral structure of enamel.

Nonetheless, so much advance interest has been generated by the Caridex system that the CDA Journal, the magazine of the California Dental Association, commissioned three respected California dentists to review scientific literature concerning it. The magazine also had Rothman try it out at Children's Hospital.

"It's very unusual for us to order a test of a product, but we did it this time because this is such an unusual idea," said Rich Martin, the magazine's managing editor. "If it performs as the manufacturer claims, it would be a major innovation. (When) anybody tells you they have an idea for drill-less dentistry, we're interested."

Dr. Ernest Newbrun, a professor of dentistry at the University of California at San Francisco, was among those who went through the scientific reports but did not try the device itself. He is cautious.

"You have to be careful with these things," he said. "I remember back in the '50s when somebody came out with a sort of sand-blaster for cavities. There was a lot of hype and hope, but it never caught on."

DR. DAVID ROTHMAN
He 'didn't think it would work'

More positive was Rothman, who has tested it on about 45 children, ages 18 months to 17 years. "I really didn't think it would work," he said. "But it does."

In some cases it made a dramatic difference. One 4-year-old girl sat calmly through the procedure. She had been sent to Children's Hospital by a neighborhood dentist because she flew into a panic over drills and needles.

If her cavities had not washed out successfully, the next step would have been to put her under general anesthesia for her fillings.

Instead, Rothman gave her the pedal switch for the pump, and she happily operated it with her hands while he worked on her tooth.

Textron Strike

Hartford, Conn.

About 1200 workers walked off their jobs yesterday at two Textron Inc. plants that make ball bearings for the aerospace, farm equipment and machine tools markets.

United Press

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SAVE GUMS AND CASH

Expert's simple technique spares victims pain, too!

A DENTAL scientist has discovered a cheaper and easier way of eliminating gum disease.

Dr. Paul Keyes of the National Institute of Dental Health uses a sophisticated microscope and a television monitor to detect the early signs of periodontal (gum) disease.

Once found, the illness is overcome with the use of anti-bacterial agents.

The ailment is often blamed on poor diet, and causes its victims to lose their teeth due to destruction of bone and gum tissue in the mouth.

And it's a problem that can literally make you put your money where your mouth is. Surgery, the traditional cure, can cost from $1,000 to $10,000. Even then, there's no guarantee the patient will keep his teeth.

(Keyes' non-surgical method costs anywhere from $125 to $750.)

Keyes says a certain type of bacteria is always seen in the gums of people with periodontal ailments. Once that bacteria is destroyed, the disease is gone.

Diseased

The bacteria are called actino omyces viscosis, and show up readily during a microscopic examination of a diseased person's teeth.

The infection, which appears as squiggly lines on a television monitor, ferrets its way into crevices between the tooth and gum, remain there until transmitted to another person or until flushed out.

Kissing is the most common way of passing on the infection.

Keyes says he has treated more than 150 periodontal disease sufferers in the past seven years with his new method, and claims great success.

"Those patients who followed my treatment guidelines have done well," he says.

His treatment starts with an examination of the infected gums. Afflicted tissue will contain the offending bacteria as well as white blood cells, the body's disease fighters.

Keyes then removes all the bacteria deposits in the teeth, often flushing out bacteria from near the tooth root. These areas are treated with anti-bacterial medications.

In extreme instances, Keyes will prescribe antibiotics like ampicillin or tetracycline for a few weeks to kill off untouched bacteria.

When that's done, the patient follows a home-care course that involves daily brushing with an antibacterial paste made from salt, baking soda and hydrogen peroxide.

Keyes says the simplicity of his treatment has caused some dentists to be skeptical of his therapy.

"Any competently trained general practitioner can teach a willing patient to control his own problem," he says.

Most patients will notice a healthier color in their gums soon after beginning treatment. The teeth will become less loose, and gum bleeding will diminish.

Dr. Thomas Roberts, a Palm Beach, Fla. dentist, agrees with Keyes' findings. "If the patient follows his prescription to the letter, there is no doubt the condition can be arrested," he says.

Arrested

Dr. George Diaz, another Palm Beach dentist who uses the Keyes method, says, "You must keep in mind that it's a team effort. The patient must be willing to do his part if he wants to keep his teeth."

Other experts, like former University of North Carolina periodontics professor Dr. Paul Cummings, hail Keyes' treatment.

Cummings says the method is far better than anything he has seen.

"The plus is successful treatment at low cost without surgery," he says. "The only minus is the periodontist makes less money using this technique."

"As far as I am concerned, the plus outweighs the minus. I believe a dentist should be in practice to help people, not put them into bankruptcy," Cummings adds.

Keyes adds that his treatment saves the patient from extreme pain.

This is not the first time Keyes' has upset the dental applecart. It was he who, 20 years ago, first noted that tooth decay was caused by a bacterium called "strep mutans."

SWEET SUBSTITUTE FOR SUGAR FOUND

—Continued from page 1

in quite a few ways and suddenly we woke up and saw what they were up to with this one."

Kinghorn says the prospects of growing the plant, Stevia rebaudiana, in the United States seem bright. The plants "grow like weeds, so cultivation is a very attractive commercial proposition," he says. They are already being grown in limited quantities in California.

Part of the study's urgency is the lingering fear that saccharin, which has been linked to cancer in rats, might still be removed from the market.

The FDA has tried to ban saccharin as a food additive since 1977, but Congress has blocked the action. Other synthetic sweeteners, called cyclamates, were banned in 1979 as potential health hazards. So far, no other sugar substitutes have received FDA approval.

However, saccharin will be kept on the market by the Reagan administration even if Congress doesn't renew the law that allows its sale, according to Health Secretary Richard Schweiker. Schweiker maintains that it is foolish to ban it.

"Until we find a new kind of sweetener to substitute," Schweiker says, "I would think that in saccharin's case the benefits clearly outweigh the risks."

MAGNET MOUTH

SCIENCE DIGEST

Crisscrossed by wires and laced with elastics, the smile of the orthodontic patient fairly bristles with hardware. But soon, common dental braces may be dramatically simplified by means of an unlikely component: magnets.

Braces straighten unruly teeth by gently—but insistently—pulling them into line. Usually, the teeth are wrapped in metallic bands, which are then connected to one another by wires. By periodically adjusting the wires, the orthodontist coaxes and tugs the teeth into new alignments. Additional force is often provided by small rubber bands that link and pull the upper and lower molars toward each other.

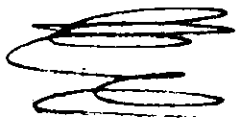
This traditional bracing system has proved effective, but it is by no means perfect. "I've never been happy with the rubber bands," says orthodontist Abraham Blechman, of Columbia University's School of Dental and Oral Surgery. "You depend on the patients to change them from time to time, and very often they simply forget."

What Blechman proposes is to replace the elastic loops with four small, powerful magnets. Wired to the metal bands that girdle teeth at the back of the jaw, the magnets—positioned so that they attract each other but never touch and thereby lock the jaws—would steadily pull and align the teeth.

In addition to simplifying maintenance, magnets would work faster and more efficiently than conventional procedures. Unlike rubber bands, which flex and shift the direction of their pull each time the mouth moves, and soon lose their elasticity as well, magnets exert a relatively unchanging force regardless of whether the jaw is tightly shut or slightly slack. Magnetic fields also readily pass through food and saliva, which allows treatment to continue unimpeded while the wearer is eating.

Although magnetic orthodontia is promising, Blechman cautions that at least another year of research is needed before the procedure will be widely available. Nonetheless, he is optimistic. "In the past two and a half years," he notes, "I have used magnets on four patients. Treatment time has been decreased by as much as fifty percent, and we have witnessed no adverse side effects.

"For the first time," Blechman adds, "we have a procedure that leaves everything to the doctor, and the patient is finally relieved of the responsibility of maintaining the braces himself." ■



BAKING SODA CURBS GUM DISEASE

An old home remedy that keeps the fridge smelling clean may also help people avoid expensive surgery.

Though largely forgotten in recent years, baking soda has long been known to be a good tooth powder; and now there's laboratory evidence for its effectiveness in preventing gum disease.

Back in 1978, researchers at the National Institutes of Health startled the dental community by observing that a home-care regimen that, among other measures, included the use of salt and baking soda retarded periodontal (gum) disease.

More recently, scientists at the University of California, San Francisco, conducted tests that focused on the power of baking soda (sodium bicarbonate), Epsom salts (magnesium sulfate) and table salt (sodium chloride) to kill oral bacteria. The research is funded by the makers of Arm & Hammer baking soda.

"We took organisms found to be associated with periodontal disease and exposed them to the various salts, then checked to see if they grew," says oral biologist Ernest Newbrun, who made the tests with associate Charles Hoover.

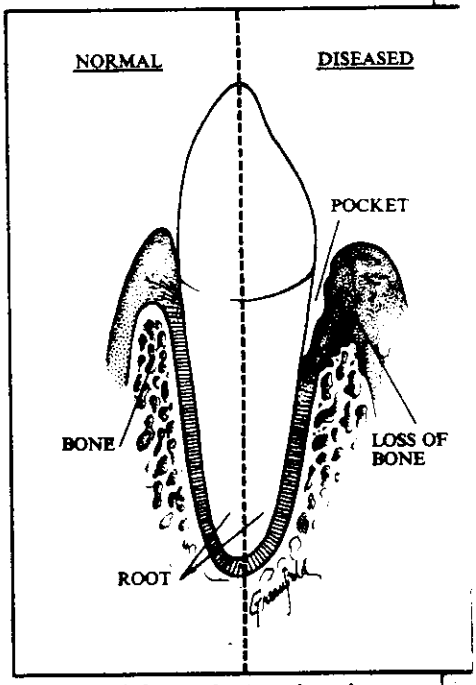
The next test was to determine the lowest amounts at which the salts were effective. The bacteria were inhibited by baking soda at lower concentrations than were necessary with Epsom salts or table salt. And the baking soda seemed to take special aim at gum-disease-causing bacteria, affecting them more than they did other bacteria. Newbrun adds, "Now we're doing rate studies, to see how fast they're killed."

Periodontal disease is an advanced stage of inflammation of the gums. It begins when harmful bacteria gather between gums and teeth, combining with food to form plaque, which hardens into tartar. As the inflammation worsens, surrounding tissue is broken down and pockets form—where the process continues.

Treatment involves scaling the teeth and root surfaces to remove the tartar. If the inflammation is extensive, surgery is also undertaken: the gums are repositioned to shorten the pockets. "It's difficult to maintain a clean pocket deeper than four or five millimeters," Newbrun observes, "so surgery may be required. But it's always a last resort."

An estimated 75 percent of children over 14 have some form of gum disease, and two out of three Americans have serious gum trouble by middle age.

The research team is now planning clinical trials. Experimental and control groups will receive a full periodontal cleaning and instructions in home care: use of floss and toothpicks as well as proper brushing. Also, the experimental group will apply baking soda to the gums, in powder or paste form. The groups will be evaluated in about a year.



Periodontal disease begins when the gum, which normally rests snugly against the tooth (left), moves away. This creates a pocket (right) in which bacteria gather.

"The scaling and root planing alone will shrink the pockets," Newbrun says. "The question is, will the baking-soda users show even less inflammation than the normal home-care group?" □

SCI. DIGEST, '82/'83

RINSING AWAY DECAY

While new inroads in chemical dentistry aren't likely to make the dentist's drill obsolete, they may reduce the need for drilling and even more serious dental work

By JANET RALOFF

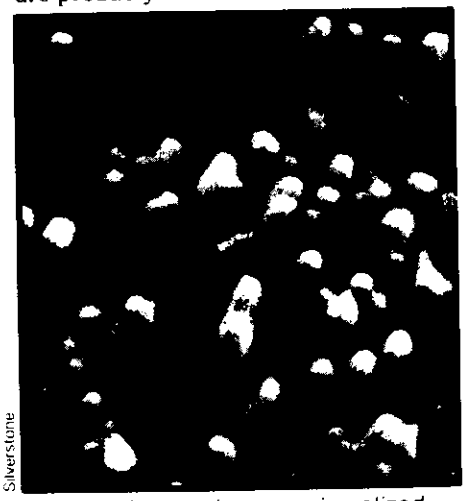
It's the ultimate in painless dentistry – some might even say "natural" dentistry. By harnessing chemical reactions that involve fluoride, calcium and phosphate, researchers are developing new weapons for the war on cavities. A major focus is the development of mouth rinses that work as synthetic "supersalivas." Generally envisioned as a home-based addition to a regular brushing and flossing regimen, they're being aimed not only at fighting decay but also at strengthening teeth and even repairing developing cavities.

One of the pioneering treatments, based on such a mouth rinse, has been used for more than 10 years in the experimental management of people with otherwise rampant, uncontrollable tooth decay. Other treatments will undergo clinical trials in the next few years. None is expected to put the dentist out of work. In fact, as an adjunct to the mechanical dentistry best symbolized by the pick and drill, these treatments promise to help preserve much of the dentist's handiwork – from fillings to caps and crowns – that might otherwise be lost as subsequent decay eroded the teeth onto which these were anchored.

In the mouth, a process of demineralizing and remineralizing – a dissolving and reforming of tooth mineral – occurs continually at the surface of teeth. Plaque-forming bacteria, which thrive on the fermentable carbohydrates in food, create weak acids (SN: 3/29/86, p. 203). It's these acids that demineralize teeth. Saliva contains the constituents needed to remineralize them again. Carious lesions, or caries, form when demineralization exceeds remineralization.

In its first stages, a carious lesion does not contain an actual "cavity"; the tooth mineral just becomes more porous and "spongy" as swiss-cheese-like holes begin to form within it. When perforations become too numerous and too large, a hole or cavity forms, or the weakened tooth breaks.

"We have shown over 20 years that wherever one side of a tooth touches another, there's a [carious] lesion," says Leon Silverstone, director of the University of Colorado's Oral Sciences Research Center in Denver. Crowded teeth, therefore, always harbor decay. "In fact," he says, "by the time a lesion is clinically detectable, it may have existed just below the tooth surface for about three years." Using microscopy, he explains, "we have shown that in the typical person there are probably at least 20 lesions that are small but cannot be seen by our best available diagnostic techniques" – like visual inspection or dental X-rays.



Silverstone

When tooth crystals are remineralized, they often become larger – and therefore stronger – than the originals. Enamel crystals shown in this scanning electron micrograph have been remineralized from 10-30 microns in diameter to about 100 microns.

Such findings have convinced Silverstone that dental researchers should give up focusing on the impossible: preventing lesions. He says, "We must instead concentrate on stopping them from growing" into true cavities.

An approach being taken by his lab and several others is to create a mouth rinse that outperforms saliva, the body's natural remineralizer. The "calcifying fluids" Silverstone and his colleagues are developing contain a solution of calcium and phosphate, together with a small quantity of fluoride. Calcium and phosphate are the remineralizing constituents of saliva. Fluoride serves as a catalyst to speed the precipitation of calcium phosphate – in the form of a hydroxy apatite – onto or into teeth.

But that's not fluoride's only role. It is able to inhibit the activity of some bacterial enzymes and their acid-producing processes, and at extremely high concentrations it can also kill some plaque bacteria. Even more important, it tends to become incorporated into the apatite (as a fluoridated hydroxy apatite, or "fluorapatite"), creating a mineral that is actually less dissolvable by acids (SN: 3/8/86, p. 150). And, Silverstone says, because the remineralized fluoridated-apatite crystal will be larger than the crystal it replaces, it will have a smaller surface-to-volume ratio. With a smaller exposed surface, acid erosion – or dissolution – becomes a more lengthy process.

In designing a superior remineralizing solution, Silverstone says, the real trick is to tailor its chemistry so that it depos-

Silverstone

Left: Artificially created carious lesion in human enamel, concealed by a 20-micron-thick cover, viewed with polarizing microscope. Right: Ten 6-minute surface exposures to remineralizing fluids have reduced porosity, reduced the lesion area by 86 percent and increased the depth of surface cover by 30 microns.

its new apatite crystals where you need them. And that may not be on the tooth surface.

The acid attack that initiates a carious lesion begins the process of decay by dissolving apatite crystals from a tooth surface. Silverstone's research has shown that within a few hours a new layer of hydroxy apatite crystals will form over the initial surface attack. This cover repairs only some of the decay; the rest is buried. Over time, the buried decay will grow as more and more mineral is lost from this "white spot lesion." But its growth is invisible to the dentist, Silverstone says, because the actual tooth surface is hard and apparently healthy. "This is also why it's so difficult to stop a very early cavity," Silverstone points out. "It's covered by a solid, intact surface."

But by varying the relative proportions of calcium to phosphate in the remineralizing fluid, he is learning how to target where new apatite is deposited. "When you have high calcium, you remineralize the outer surface of a tooth," he says. "As you start dropping the calcium, you begin remineralizing inside the tooth." Based on these findings, he's already developed a series of calcifying fluids that he says "are very effective at remineralizing lesions."

By using them to fill in a lesion's swiss-cheese-like holes, people should be able to repair caries naturally, he says, before the decay develops into a full-fledged cavity. Silverstone suspects that these fluids ultimately will be marketed as mouth rinses in a range of formulations, each designed to tackle decay from a different cause or in a different type of tissue – for example, in tooth enamel, or in root tissue. Similar work is under way at the University of Iowa's Dows Institute in Iowa City.

The remineralizing rinse being developed at the University of Rochester (N.Y.) contains, in addition to the standard calcium, phosphate and fluoride, several additives to enhance the transport of the remineralizing chemicals through the enamel, which acts as a molecular sieve. One of the additives, strontium, reduces the solubility of apatite and tooth enamel, particularly when delivered in conjunction with fluoride, says John Featherstone, who chairs the oral biology department at the university's Eastman Dental Center. And tartrate, his studies indicate, enhances the transport of calcium through the enamel to buried carious lesions.

In 14-day tests, he reports, a rinse with these additives rehardened the deep-seated carious lesions Featherstone and his colleagues had initiated in human tooth enamel. In one preliminary test of its ability to work under real-world conditions, the researchers embedded tiny test slabs of enamel into temporary dental bridges worn by subjects for two weeks. A one-minute-per-day swish of the rinse through the teeth reduced the depth of the buried caries 25 percent more than did saliva exposure alone in similar, artificially developed lesions.

The most widely used of the synthetic-saliva remineralizing solutions was developed about 15 years ago at the University of Rochester by dental pathologist Erling Johansen and chemist Thor O. Olsen. Previously, they had found that certain mineral crystals appeared to survive – even grow – in the acid environment of active caries. Chemical analysis of these crystals showed their fluoride content to be 20- to 30-fold higher than that of normal tooth materials.

"I realized that if I could change the normal crystals to the same chemistry as those observed in the carious lesions, they should have the same cariostatic [properties]," recalls Johansen, now dean of the Tufts School of Dental Medicine in Boston. And the fluoride-and-mouth-rinse treatment that he and colleagues have now used on more than 1,500 persons is designed to do just that.

Twice daily for two weeks, then once daily for another two weeks, patients wear custom fitted "teeth trays" – similar to the tooth protectors worn by athletes – that have been coated with a 2 percent sodium-fluoride-solution gel. (The trays keep the gel close to the tooth surface and keep saliva from washing the gel off the teeth during each five-minute treatment.) To enhance the repair of teeth, several times a day patients swish through their teeth a mouth rinse that is supersaturated with six times the amount of calcium and phosphate present in normal saliva.

Saliva: The first line of defense

"Every time you eat something sweet you produce at least 20 minutes of acid," says Athena Papas, director of the Rubenstein Oral Health Clinic at Tufts University in Boston. Saliva not only washes off the acid but also contributes calcium and phosphate to replace the tooth mineral dissolved by acid attack.

That's why people with impaired salivary glands or reduced saliva flow are particularly susceptible to cavity formation. These individuals, suffering from what is generally termed "dry mouth," aren't able to bathe their teeth in enough of the body's natural remineralizer to offset the demineralization that occurs each time they eat a sweet or drink something acidic, like orange juice.

The severe dry mouth common among patients who have received radiation therapy for head or neck cancer, for example, often leads to such rapid cavity development that individuals can begin losing their teeth to severe decay within a year. For many millions more, dry mouth is a side effect of medication. Boston dentist Michael Stone notes that "in hay fever season we see people get decay who ordinarily would not." The reason? "They're taking antihistamines."

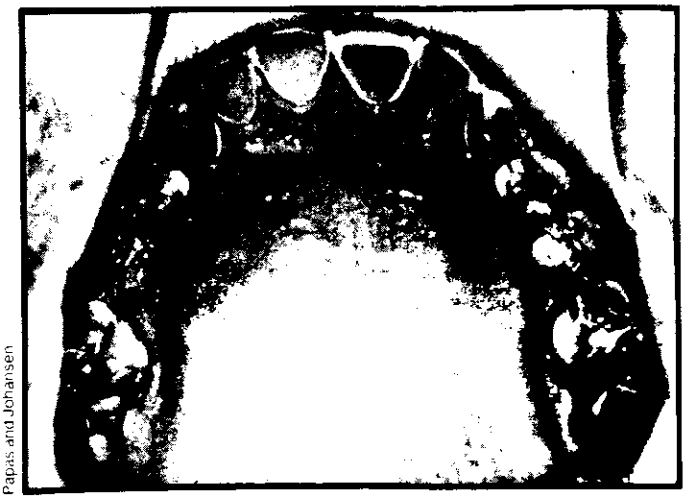
One way to stimulate saliva flow is to chew gum. However, if the salivary gland is impaired or the saliva itself is deficient, gum chewing may not suffice. It was initially to help these people that Erling Johansen and his colleagues at the University of Rochester (N.Y.) developed their fluoride-and-mouth-rinse therapy.

But remineralization is not saliva's only decay-fighting attribute. John Featherstone and his co-workers at the University of Rochester's Eastman Dental Center have found that several classes of organic constituents of saliva – namely phospholipids and phosphoproteins – "adsorb strongly to the crystals of the tooth." Not only are they bactericidal, he says, but they also help neutralize the acidity of the tooth environment. These organic materials may even form a barrier film that partially protects teeth from acid attack, Featherstone says. Similar organic components in cheddar cheese may account for that food's established ability to fight tooth decay, according to a report by the Rochester researchers at the March meeting of the American Association of Dental Research in Washington, D.C.

To date, the month-long and usually one-time therapy has been used to treat people whose decay was unmanageable by their regular dentist – mainly those suffering from "dry mouth" caused by disease, aging, radiation therapy or use of any of some 250 medications, including most antihistamines, antidepressants and heart medicines.

At a scientific meeting last year, Johansen and Athena Papas, director of the Rubenstein Oral Health Center at Tufts, reported on the results of two groups of such patients. One group of 94 treated at Tufts' Rubenstein clinic included patients aged 6 months to 60 years old. Among them, they had 725 carious lesions in tooth roots. After a month's treatment with the intensive fluoride applications, all observable decay had been arrested, the researchers reported. Moreover, the mouth rinses spurred remineralization in an average of 77 percent of the lesions.

The second group involved 34 of the "worst" cases from the private practice of a dentist in Perry, N.Y., a town with unfluoridated water. Prior to treatment, 93 percent had active carious lesions. Not only did treatment arrest their decay, says study director Johansen, but over the remaining four years of the study "no new caries developed."



Papas and Johansen

Bulimia: Stomach acids have entirely eroded the enamel from the backs of upper front teeth in this patient, shown here five years after Tufts fluoride-and-remineralizing program. A single series of the treatments saved the teeth by halting tooth-mineral erosion, rampant decay and painful sensitivity to temperature extremes.

At the March meeting of the American Association of Dental Research in Washington, D.C., Papas and Johansen offered their first report on its use on a small but special class of patients: nine bulimics, individuals who routinely regurgitate food immediately after eating to keep from gaining weight. According to Papas, the Tufts fluoride remineralizing treatment is the only one so far shown capable of halting a bulimic's tooth destruction.

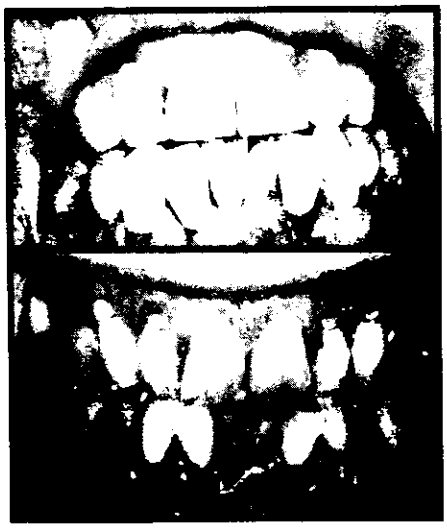
The hydrochloric acid [illegible]mit can, within a year, completely erode the hard, protective enamel from a bulimic's teeth, leaving them painfully sensitive to extremes in temperature and vulnerable to rampant decay. Ordinarily, if the bulimia isn't halted, stomach acid will eventually erode away tooth material to the point where a full set of crowns will be necessary, Papas says. Such restorative dental work will not necessarily end a bulimic's dental woes, Papas says, because the strong stomach acid that daily washes through the mouth will eventually erode the tooth base onto which any crowns and fillings are anchored.

Before coming for treatment at Tufts, one bulimic patient Papas saw had gone to her dentist weekly to replace fillings that kept falling out. But once treated with the intensive fluoride-and-mouthrinse regimen, Papas says, decay stopped and the porous, carious tissue remineralized. Unfortunately, Papas laments, "although we halted the [acid] erosion, she's still bulimic."

Today this treatment is available only at Tufts or from one of a few Tufts-trained dentists. The real limitation to its wider use, Johansen says, is the availability of the remineralizing chemicals, which are presently being formulated at Tufts. However, Johansen says, negotiations are under way with potential developers to get them onto the commercial market "soon." And once they are available, Johansen says he'll begin classes to train dentists to use the therapy in their own practices.

With advances like these, research is closing in on cavities. Whether marketed as an over-the-counter mouth rinse or a semicustomized prescription treatment, the new remineralizers may someday offer a painless and largely automatic repair of incipient decay.

Johansen and Papas/Tufts Sch. of Dental Med



Top photos: Two patients, just [illegible] "dry mouth." Patient not receiving [illegible] decay and tooth loss in 11 months; patient's teeth are [illegible] and healthy. Radiation for head and neck cancer, suffering [illegible] ufts therapy (lower left) developed tremendous [illegible] ower right: Ten years after Tufts treatment, this

NATIVE AMERICAN DENTISTRY

have struck out infected teeth. Undoubtedly other tribes did the same.

In many parts of eastern North America, the roots or crushed inner bark of prickly ash (*Xanthoxylum* spp.) was placed on aching teeth. Several eastern tribes made a decoction of the roots of goldthread (*Coptis groenlandica*) as a mouthwash for toothache as well as for sore gums and canker sores. The Meskwaki made an infusion of the root bark of panicled dogwood (*Cornus paniculata*) and held it in the mouth to ease toothache. The Meskwaki also used a decoction of geranium roots (*Geranium maculatum*) as a mouthwash for toothache and sore gums, or they put the root hairs of eastern skunk cabbage (*Spathyema foetida*) on an aching tooth. In Pennsylvania, the root bark of tulip tree (*Liriodendrum tulipifera*) was heated and placed on an aching tooth. The Alabama put a piece of goldenrod root (*Solidago* sp.) in a tooth cavity. The Miwok of California also used goldenrod; they held a decoction of it in the mouth for a few minutes, then spat it out.

The Plains tribes chewed the rootstock of calamus (*Acorus calamus*).

The Miwok of California also chewed the stems of goldback fern (*Pityrogramma triangularis*) to soothe aching teeth.

In the Southwest, the Pima heated a fresh twig of creosote bush (*Larrea mexicana*) and placed it in the cavity of an aching tooth.

Caries Res. 16: 235–242 (1982)

Remineralization of Artificial Caries-Like Lesions in vivo by a Self-Administered Mouthrinse or Paste

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Key Words. Remineralization · Mouthrinse · Caries, artificial

Abstract. A mouthrinse formulated to fulfill physicochemical requirements for rapid remineralization of early carious lesions was investigated in vivo using intraoral appliances in adults. Human enamel slabs with artificially induced early lesions were embedded in the appliances. Complete rehardening of the inner 40–50 μm and twofold rehardening of the remaining body of the lesion occurred in 160-μm deep lesions with a 1-min mouthrinse on each of 14 consecutive days. Saliva alone rehardened the inner 20 μm only. At least the inner half of lesions 65 μm deep rehardened completely and the remaining body of the lesion rehardened fourfold over 14 days. Monofluorophosphate toothpastes, tested similarly remineralized to the same extent as saliva alone and increased the surface layer hardness. The remineralizing solution shows potential value as a daily mouthrinse for the prevention or reversal of early carious lesions.

Remineralization of early carious lesions of dental enamel occurs naturally in vivo [*Head*, 1912; *Anderson*, 1938; *Backer-Dirks*, 1966]. Enhancement or stimulation of this natural remineralization process by application of a mouthrinse, paste or gel would be valuable therapy in the control of caries. In order for any topical remineralizing therapy to be clinically useful its rate of action must be much faster than the calcifying systems studied to date [*Levine*, 1972, 1975; *Silverstone*, 1977]. Physicochemical requirements for rapid remineralization of early carious lesions in vitro were recently reported [*Featherstone*, 1979, 1981]. We suggested (i) that an anion like tartrate was necessary to partially complex metal ions and promote their transport into carious lesions, (ii) that fluoride was necessary in low but diffusible concentrations to promote rapid remineralization, (iii) strontium and zinc were desirable at low concentrations, (iv) calcium and phosphate were necessary at concentrations below saturation, and (v) that a pH around 6.0 was optimal. In the present study a mouthrinse and toothpaste

formulated to fulfill these, and other in vivo requirements, were investigated using intraoral appliances in humans.

Materials and Methods

Acrylic resin intraoral appliances similar to those described by *Koulourides* et al. [1974] were made for the lower dental arch of each of 6 adults (3 male, 3 female) aged between 25 and 60 years. The appliances had two buccal flanges, each holding a small enamel slab (4 × 2 × 2 mm) with two artificial carious lesions (fig. 1).

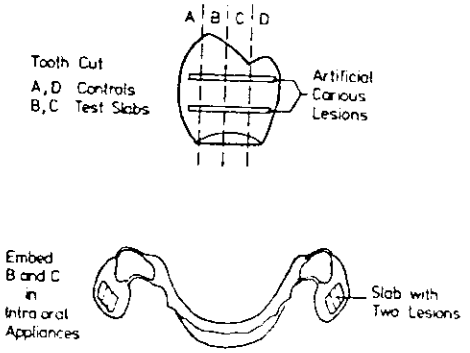

Fig. 1. Schematic procedure for preparation of intraoral appliances and enamel slabs with lesions.

Preparation of Enamel Slab/Lesions

The crowns of caries-free human premolars (erupted) were brushed with hot detergent solution, rinsed in distilled water, and air-dried. The crowns were cut to produce mesial and distal halves, completely coated with nail varnish except for two horizontal bands approximately 200 μm wide and 8 mm long. For tests I–IV (see below) each crown half was immersed for 7 days at 37 °C in 40 ml of 0.1 mol/l lactate, pH 4.5, with 0.1 mmol/l MHDP present (methane-hydroxy-diphosphonate) to produce subsurface artificial lesions [*Featherstone* et al., 1978]. Shallow lesions for test V (see below) were produced in a similar way by immersion of each crown half for 7 days at 37 °C in 40 ml of a solution containing 0.075 mol/l lactic acid, 0.025 mol/l acetic acid, 0.5 mmol/l MHDP, adjusted to pH 5.5 with sodium hydroxide. Four slabs, approximately 4 × 2 × 2 mm, each containing part of two artificial lesions (fig. 1) were cut by diamond saw from each half crown. Two slabs were retained as untreated controls and the other two were cleared of varnish. The slabs were embedded (Araldite GY250: Hy837, Ciba-Geigy) in opposite flanges of the one intraoral appliance with only the outer tooth surface (with the lesions) exposed. For tests I and II (below) opposite half crowns of the same tooth were used for each subject.

Test Procedures

The tests (except for IV) were carried out in five stages on all six subjects as follows. In all cases the subjects continued with their usual dietary habits during the test periods of 14 days. All subjects were living in a fluoridated water area (1 mg/l) during all tests.

Test I. In vitro Dip, in vivo Exposure. The appliance was worn continuously for 14 days except for once daily when it was removed, one flange only was immersed in 10 ml of test solution RS (see below) for 1 min, and then the appliance was replaced in the mouth. There was insufficient time for the control lesion to dry out. The volunteers did not eat or drink for at least half an hour after treatment. While the appliance was out of the mouth the natural teeth were cleaned by electric toothbrush and the mouth thoroughly rinsed with water. Thus, one side of the appliance was treated by in vitro immersion in RS plus oral exposure and the other side by oral exposure alone.

Test II: in vivo Rinse. The appliance was worn continuously for 14 days except for once daily when it was removed. After each removal the natural teeth were cleaned as above, the mouth thoroughly rinsed out with water and the appliance replaced. Subsequently 5 ml of test solution (RS) was swished around the mouth by the subjects for 1 min and expectorated. The subjects did not eat or drink for at least half an hour after treatment.

Test III: in vivo Toothpaste. The appliance was worn continuously for 14 days except for once daily when it was removed, the natural teeth cleaned, the mouth rinsed with water as above, and the appliance replaced. The enamel slabs in the appliance, and the natural teeth were then brushed under supervision with one of the three

test pastes (see below) using an electric toothbrush. The subjects expectorated but did not rinse out, nor have anything to eat or drink for at least half an hour.

Test IV: in vitro Dip. Enamel slabs, each with two lesions, from two teeth were dipped individually in 5 ml of solution RS for 1 min on each of 14 days. The slabs were dabbed dry and stored in air overnight between dips. Untreated lesions, in slabs from the same teeth were retained as controls.

Test V: in vivo Rinse, Shallow Lesions. Enamel slabs with lesions less than half as deep a those used in tests I–IV were worn in the appliances and rinsed in the mouth for 1 min daily on 14 days as in test II above.

Assessment

At the end of the test period the enamel slabs were removed from the appliances, cut perpendicular to the outer enamel surface, embedded, and examined for hardness and lesion depth. Approximately one quarter was cut off each slab on the diamond saw through the test lesions perpendicular to the surface. Slabs were embedded in Araldite (D Hy951 Ciba-Geigy) with the final cut face exposed, and sequentially polished with 12.5 μm alumina (Buehler), 6, 3 and 1 μm diamond (Hyprezspray, Engis Ltd.).

Hardness profiles were determined across treated and untreated lesions and normal enamel on the Leitz minihardness tester according to the method of *Purdell-Lewis* et al. [1976]. In this method diamond impressions are made in a line at about 25-μm intervals across the cut and polished face from the outer enamel surface, over the lesion area, and into the underlying intact enamel. The diamond indenter falls approximately perpendicular to the rod and cystallite directions, hence largely avoiding the danger of cutting between rods or crystals. In the present study a 15 g weight was used near the enamel surface and 50 g for inner measurements. This minimizes crystal shatter and distortion which is observed with larger weights (e.g. 500 g). The hardness of the embedding resin (Araldite) was measured at approximately 9 Knoop Hardness Number (KHN) which is severalfold lower than that of carious enamel (50–100 KHN) and hence would not be expected to contribute significantly to measured hardness values of the experimental tissue. This technique therefore enables ready comparison of demineralized enamel with normal enamel and is sensitive to remineralization in a comparable way. It has been well characterized by *Purdell-Lewis* et al. [1976].

Lesion depths were measured as follows: rhodamine 6G, 1% solution in ethanol, was used to stain the lesions and the distance from the outer enamel edge to the junction of the demineralized lesion and the underlying sound enamel was readily measured (under the hardness tester microscope) as the lesion depth.

Test Solutions and Pastes

Remineralizing Solution (RS) for Tests I–V. This test solution RS was formulated according to the physicochemical principals proposed by *Featherstone* [1979, 1981]. Hydroxybenzoate was added as a preservative and xylitol as a noncariogenic sweetener to mask the mineral taste and produce a palatable rinse. Test solution RS was made using lab reagent grade chemicals in distilled water at the concentrations (mol/l): calcium (as nitrate) 2×10^{-3}; zinc (as chloride) 10^{-4}; strontium (as chloride) 10^{-4}; tartaric acid 10^{-2}; potassium phosphate 3×10^{-4}; sodium fluoride 6×10^{-4}; xylitol (Roche) 2.5% w/v; methyl *p*-hydroxybenzoate 0.02% w/v; pH adjusted to 6.0 with sodium hydroxide.

Toothpastes. The toothpastes used in test III were prepared by Colgate-Palmolive Pty. Ltd., Sydney, Australia. (i) Control paste nominally contained 0.76% sodium monofluorophosphate (MFP) in a standard toothpaste mix with dicalcium phosphate (48%) as the abrasive. (ii) Test paste R was the same as control paste except that 20 μg/g zinc and 25 μg/g strontium were added as chlorides during manufacture of this batch of toothpaste. This formulation was chosen to simulate, on dilution, the oral concentrations of zinc and strontium obtained when using RS. (iii) Test paste CSP, was commercially obtained 'Floran' CSP paste (Batch B62127; Creighton Pharmaceuticals, Sydney) with nominally 10% calcium sucrose phosphates–calcium orthophosphate complex. The toothpastes were analyzed for free fluoride (Orion electrode) after dissolving aliquots in water. They contained 29, 8 and less than 1 μg/g for control paste, paste R, and paste CSP respectively.

$CaNO_3$ 2×10^{-3} — K Phosphate 3×10^{-4} — pH 6 (NaOH)
$ZnCl$ 10^{-4} — NaF 6×10^{-4}
$SrCl$ 10^{-4} — Xylitol 2.5% w/v
Tartaric Acid 10^{-2} — Methyl p-Hydroxybenzoate 0.02% w/v

35

Results

For simplicity oral exposure is referred to as saliva treatment.

Tests I and II: in vitro Dip, in vivo Rinse

The lesions were partially remineralized from the inside outwards by saliva alone, dip + saliva (test I, side dipped in RS), and rinse (test II, oral rinse in RS) + saliva. The lesion depths were reduced by approximately 30% in the case of rinse + saliva in test II (table I). The mean of the control depths was significantly different from all the others at the 0.1% level. Reduction in lesion depth by saliva alone was different from dip + saliva ($p < 0.002$). The dip + saliva did not differ significantly from rinse + saliva ($p = 0.1$).

Hardness profiles (fig. 2) obtained from indentation tests illustrate the distribution of remineralizing effects of the various treatments. The observed inner lesion edge coincided with hardness values in the range 175–225 KHN. The 14-day exposure to the oral environment (saliva) rehardened approximately 20 μm of the inner lesion. The 14 × 1 min in vitro dips in solution RS or 14 × 1 min in vivo oral rinses with RS together with saliva not only rehardened 40–50 μm of the inner lesion to at least the value of normal enamel but also rehardened the remainder of the body of the lesion to at least the value of the 'surface layer' (fig. 2, 3).

In test I a marked difference in apparent plaque growth was seen. The enamel slabs in the flanges of the appliances not dipped in solution RS grew dark yellow or brown plaque (readily observed by naked eye), in contrast to the dipped sides on which plaque growth was not readily observed by naked

Table I. Depths (μm) of lesions in human tooth slabs exposed to remineralizing tests I and II

Subject No.	Treatment			
	Control untreated	14 day saliva only	14 day dip + saliva	14 day rinse + saliva
1	157[1]	130	124	114
2	150	146	122	109
3	162	140	135	117
4	158	125	120	111
5	159	134	105	109
6	150	133	114	111
Mean[2]	158	135	120	112
SD	11	8	12	14

[1] Each value in the body of the table is the mean depth of 2 or 4 lesions.

[2] Overall mean values are contributed to by 10–20 lesions.

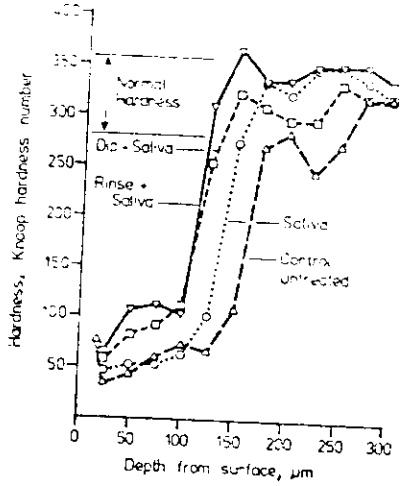

Fig. 2. Hardness profiles (50 g) across typical lesions from tests I and II. △ = Control lesion, untreated; ○ = lesion exposed to 14 days saliva and no rinse; □ = lesion exposed to 14 × 1 min in vitro dip in solution RS and 14 days saliva orally; ▽ = lesion exposed to 14 × 1 min oral rinses with RS and 14 days saliva orally.

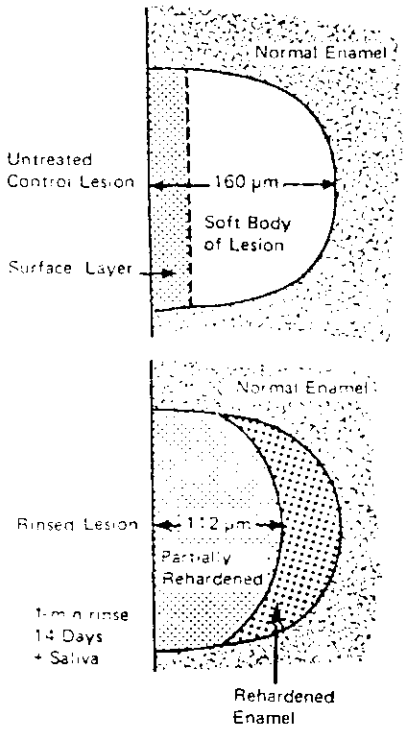

Fig. 3. Diagrammatic representation of the rehardening effect on lesions in vivo of solution RS (from tests I and II)

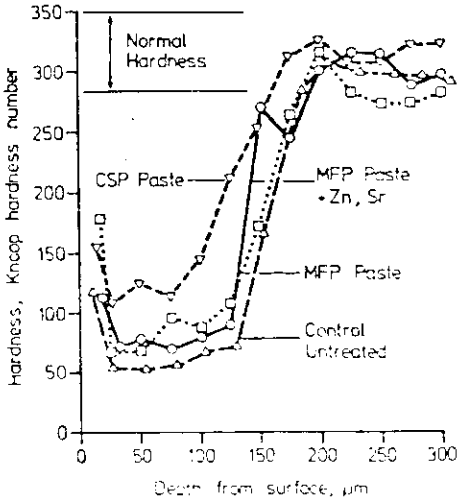

Fig. 4. Hardness profiles (50 g) across typical lesions from test III (14 days, once a day brushing). △ = Control lesion, untreated; ○ = test paste R; □ = control paste; ▽ = CSP paste.

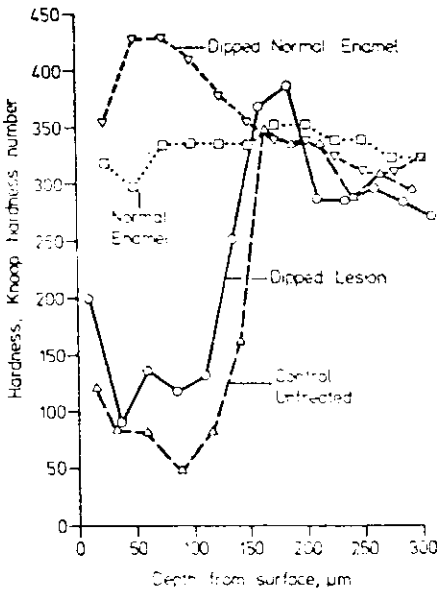

Fig. 5. Hardness profiles (50 g) across typical lesions from test IV (14 × 1-min dips, in vitro). △ = Control lesion, untreated; ○ = dipped lesion; □ = normal enamel between lesions, untreated; ▽ = normal enamel between lesions, dipped.

eye. In test II with oral rinsing of both flanges plaque was only observed on the enamel slabs as a pale yellow coating. However, no quantitative assessment of plaque was made in the present study.

Test III: in vivo Toothpaste

The measured depths, in micrometers (means and standard deviations), were as follows: control paste (2 subjects, 8 lesions), 135 (11); test paste R (3 subjects, 12 lesions), 136 (9); CSP paste (1 subject, 4 lesions), 118 (13); control lesions, untreated, 156 (9).

Control paste and paste R showed a similar effect to saliva alone on depth reduction

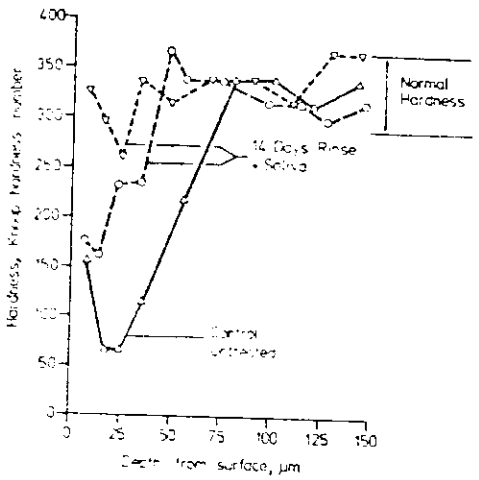

Fig. 6. Hardness profiles (15 g) across typical shallow lesions for test V (oral rinsing). △ = Control lesion, untreated; O, ▽ = lesions from two different subjects rinsed 14 days showing the range of hardness profiles found. The line of '0' represents the lowest level of rehardening.

and rehardening (table I, fig. 2, 4). However, the surface layer hardness was improved with the pastes.

The lesions treated with CSP paste were completely rehardened about 40 μm on the inner side and the remaining body of the lesion was partially rehardened to a similar level to the rinsed lesions in test I.

Test IV: in vitro Dip

The mean depths of dipped and control (undipped) lesions were 123 μm (SD 19) and 149 μm (SD 9) respectively. The dipping rehardened approximately 20 μm of the inner part of the lesion and partially rehardened the body of the lesion to the value of the original surface layer (fig. 5). Profiles across normal enamel and dipped normal enamel between lesions showed that normal enamel, up to a depth of about 100 μm, increased in hardness. This trend was also seen in oral rinse tests I, II, and V but was not as marked as the in vitro results.

Test V: in vivo Rinse, Shallow Lesions

The mean depth of control lesions (untreated) was 65 μm (SD 6). Lesion depths were difficult to measure accurately for the rinsed lesions because of a high degree of remineralization which made the inner lesion boundary indistinct. 5 of the 24 rinsed lesions were not observed even after staining with Rhodamine 6G solution. Hardness profiles (fig. 6) showed that the inner half (approx. 30–40 μm) or more of the observed lesions was rehardened to normal enamel hardness. The remaining body of the lesion was partially rehardened to varying levels, mostly higher than 200 KHN.

Discussion

This work has clearly illustrated the natural remineralizing capacity of the oral environment. Saliva, possibly in combination with fluoride in the drinking water (1 mg/l), provides chemical species suitable for rebuilding enamel apatite or depositing new apatite. Some subjects (table I) showed better remineralizing capacity than others. When the enamel slabs with lesions were dipped externally in solution RS this generally enhanced the rebuilding capacity of saliva (table I, fig. 2). The mouth rinsing with solution RS, however, produced a substantial rebuilding and rehardening in all subjects, at least as good as the sum of saliva alone and in vitro dip alone. The effects of saliva and of rinsing with solution RS are thus at least additive and possibly synergistic. Since the inner 40–50 μm of the 160-μm deep lesions was rehardened to at least

the hardness of the original enamel and the remaining body of the lesion more than doubled in hardness in just 14 days with only a 1 min rinse daily, the solution tested in this study has clinical potential as a caries reversal or preventive agent. The disappearance of some of the shallow lesions (65 μm deep), the almost complete rehardening of the inner 30–40 μm of all the shallow lesions, and three- to fourfold rehardening of the remaining body of the lesion clearly shows the effectiveness of the solution in rehardening early carious lesions.

The readily visible reduction in plaque when RS was used was an unexpected beneficial side effect. It may be related to the presence of hydroxybenzoate, zinc, strontium, or indeed a combination of components, but as yet remains unexplained. The incorporation of xylitol as a noncariogenic sweetener may have assisted remineralization by stimulating saliva flow.

It is well known that the use of toothpastes containing sodium MFP leads to reduction in caries incidence [e.g. *Naylor and Glass*, 1979] over periods of 2 or 3 years. If the caries reduction is partially due to remineralization it should be possible to enhance the effect by improving the remineralizing ability of the paste with appropriate additives. The reasons why pronounced remineralization did not occur with either the control MFP paste or the MFP paste with zinc and strontium in the present study are not clear. A higher free fluoride content in the paste may be necessary. The increased surface layer hardness produced with the MFP pastes suggests their action may be preventive rather than restorative.

The sucrose phosphate paste, however, did lead to remineralization in a similar way to rinsing with solution RS. Although this was only tested on 1 subject, all four lesions were similarly remineralized, and the subject used (No. 2, table I) was the poorest natural remineralizer. Sucrose phosphate, perhaps by acting a a calcium carrier or as a saliva stimulant, may have potential in the promotion of enamel remineralization.

In conclusion, daily mouthrinsing with a solution especially designed to rapidly penetrate early carious lesions [*Featherstone* et al., 1981] shows considerable potential as a caries-preventive and reversal measure. It is anticipated that modification of toothpaste formulation can provide similar benefits to the solution. The results indicate that a treatment period of 14–30 days may be sufficient. Although the intraoral tests reported here demonstrate marked remineralization, full clinical testing is necessary to establish the true efficacy of the system.

Acknowledgements

The volunteers who wore the oral appliances are thanked for their cooperation and assistance.

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HERBAL ORAL HYGEINE

MOUTH WASH ---

Sage	Wild Geranium
Sumac	Oak bark
Gold Thread	Bayberry
Cinnamon	Rosemary
Cloves	Life-Everlasting
Cinquefoil	Sweet Fern

TOOTHACHE ---

Celery	Chaparral
Catnip	Sassafras
Hops	Prickly Ash bark
Summer Savory	Gelsenium
Arnica	Horseradish
Larkspur	Linden
Mint	

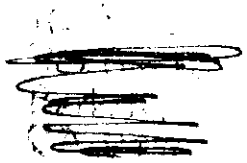
GUMS ---

St. John's Wort	Strawberry leaves
White Pond Lily	Chamomile
* Elecampane	Golden Seal
Bearberry	Blue Flag (Iris)
Cypress	Witch Hazel
Cinquefoil	Sanicle

TEETH ---

Henbane	Elecampane
Thuja	Crawley
Alder	

Horsetail Grass
Comfrey
Coltsfoot
Lobelia



Baking Soda Used To Treat Gum Inflammation

SAN FRANCISCO—An age-old home remedy for treating the inflammation of the gums known as periodontal disease has been given some scientific support in a study by researchers at the University of California, San Francisco.

In a paper presented last week at the meeting of the International Association for Dental Research, Ernest Newbrun, UCSF professor of oral biology, and research associate Charles Hoover reported that ordinary baking soda, table salt and epsom salts are particularly effective at killing the bacteria that cause periodontal disease.

In periodontal disease, several types of bacteria attach themselves to the hard surface of the tooth, much as barnacles cling to a rock. As more bacteria and their toxins accumulate, pockets form between the tooth and the gums. The body often tries to defend itself by sloughing out the infected tooth. The disease eventually affects three out of four adults and is the major cause of tooth loss in adults.

Conventional therapy for periodontal disease has been to scrape the bacterial colonies off the root of the tooth, to prescribe antibiotics, and in serious cases, to surgically cut away and reshape some of the gum tissue.

But in 1978 researchers at the National Institutes of Health aroused the dental community by announcing that a home-care regimen that includes irrigating the pockets with salt water and brushing with baking soda and hydrogen peroxide had been clinically observed to retard periodontal disease.

In order to find out which part of the NIH multi-step regimen was working, Newbrun pitted salt, baking soda and epsom salts against bacteria from different parts of the body.

All these substances, especially the soda, were found much more effective against the bacteria that cause periodontal disease than they were against fecal, skin and soil bacteria or even bacteria from other parts of the mouth.

Although clinical trials are still needed, the results do indicate that home use of salt and sodium bicarbonate may be helpful in treating periodontal disease, Newbrun says. The treatment could be used in conjunction with conventional therapies and as a preventive measure as well as for treating those who already have the disease.

"From the patient's point of view, it's a cheap and relatively harmless treatment," Newbrun says. "It's a folk remedy that has some real basis."

Toothpastes containing baking soda were once quite common.

—Wendy Jalonen (415) 666-2557

BAKING SODA CURBS GUM DISEASE

An old home remedy that keeps the fridge smelling clean may also help people avoid expensive surgery.

Though largely forgotten in recent years, baking soda has long been known to be a good tooth powder; and now there's laboratory evidence for its effectiveness in preventing gum disease.

Back in 1978, researchers at the National Institutes of Health startled the dental community by observing that a home-care regimen that, among other measures, included the use of salt and baking soda retarded periodontal (gum) disease.

More recently, scientists at the University of California, San Francisco, conducted tests that focused on the power of baking soda (sodium bicarbonate), Epsom salts (magnesium sulfate) and table salt (sodium chloride) to kill oral bacteria. The research is funded by the makers of Arm & Hammer baking soda.

"We took organisms found to be associated with periodontal disease and exposed them to the various salts, then checked to see if they grew," says oral biologist Ernest Newbrun, who made the tests with associate Charles Hoover.

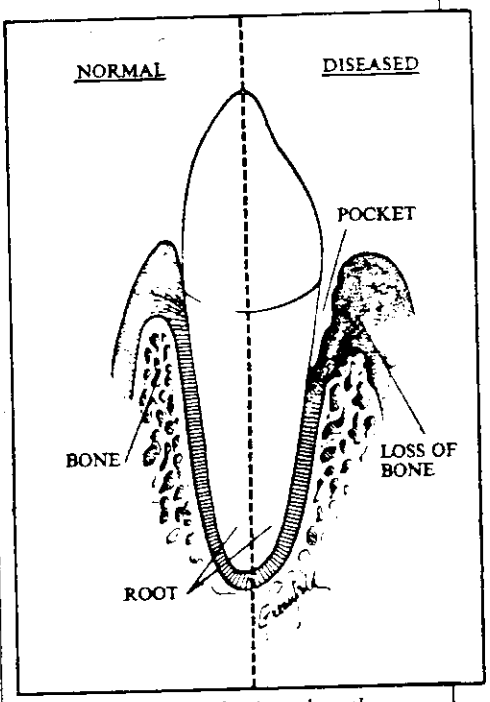
The next test was to determine the lowest amounts at which the salts were effective. The bacteria were inhibited by baking soda at lower concentrations than were necessary with Epsom salts or table salt. And the baking soda seemed to take special aim at gum-disease-causing bacteria, affecting them more than they did other bacteria. Newbrun adds, "Now we're doing rate studies, to see how fast they're killed."

Periodontal disease is an advanced stage of inflammation of the gums. It begins when harmful bacteria gather between gums and teeth, combining with food to form plaque, which hardens into tartar. As the inflammation worsens, surrounding tissue is broken down and pockets form—where the process continues.

Treatment involves scaling the teeth and root surfaces to remove the tartar. If the inflammation is extensive, surgery is also undertaken: the gums are repositioned to shorten the pockets. "It's difficult to maintain a clean pocket deeper than four or five millimeters," Newbrun observes, "so surgery may be required. But it's always a last resort."

An estimated 75 percent of children over 14 have some form of gum disease, and two out of three Americans have serious gum trouble by middle age.

The research team is now planning clinical trials. Experimental and control groups will receive a full periodontal cleaning and instructions in home care: use of floss and toothpicks as well as proper brushing. Also, the experimental group will apply baking soda to the gums, in powder or paste form. The groups will be evaluated in about a year.



Periodontal disease begins when the gum, which normally rests snugly against the tooth (left), moves away. This creates a pocket (right) in which bacteria gather.

"The scaling and root planing alone will shrink the pockets," Newbrun says. "The question is, will the baking-soda users show even less inflammation than the normal home-care group?" □

Chem. Abstr. 96-223028

96: 223028y **Dental cleaning slurry.** Madsen, Erik H. U.S. US 4,322,207 (Cl. 433-216; A61K5/00), 30 Mar 1982, Appl. 652,566, 26 Jan 1976; 3 pp. A tooth cleaning slurry consists of an aq. suspension of particulate material such as *polyethylene* [9002-88-4] which is softer than the softest exposed part of teeth. The slurry is directed against the teeth under sufficient water pressure for the material to penetrate and dislodge any plaque or food particles adhering to teeth. The material must have a Knoop hardness of <68 and the vol ratio of the material of aq. soln. is 1:1.5-10. The diam. of the material is 0.002-02 in. The slurry also contains a breath sweetener and a disinfectant.

TECHNOLOGY

Sci. News 121 : 332 May 15 '82

Shifting teeth faster electrically

Wearing braces to move and straighten teeth can be a lengthy, painful experience. Now, two University of Pennsylvania researchers believe electrical stimulation of the gums may cut in half the time braces must be worn. The researchers are just beginning a three-year clinical study with 60 female patients to test the method.

Orthodontist Zeev Davidovitch, who began the work in 1975 with materials scientist Edward Korostoff, says orthodontists have conventionally used mechanical force to shift teeth. Mechanical devices that push or pull a tooth apply force to a tooth's crown. The force is transmitted downward to the root and into the tissues, including bone, that surround the root. There the bone tends to dissolve or resorb ahead of the moving tooth's root where the pressure is high and to build up behind the root where the pressure is low. The problem, says Davidovitch, is that tissue remodeling doesn't happen overnight. "What we're doing with electricity is simply enhancing the rate of tissue remodeling," he says. Although braces are still necessary, they are needed for a shorter time.

The electricity source is approximately the size and shape of two nickels stuck together. It consists of a transistor and several resistors and batteries, encased in epoxy and dental acrylic plastic. The device provides a constant current of between 15 and 20 microamperes at about 1.5 volts. Korostoff says the easily removable circular unit attaches to the bracket already installed for orthodontic wires and lies against the gum, between the gum and the cheek. One major effort during the first year of the clinical trials will be to reduce the size of the device, Korostoff says. A graduate student researcher, who has worn the device for a short time, says its presence is noticeable, but it is not uncomfortable compared with the normal discomfort people suffer when they wear orthodontic braces. He says he did not feel the electric current at all.

Although the method was tested successfully on cats, Davidovitch admits that testing it on humans is a new field. "We don't know what will happen," he says. "There are many questions we haven't answered yet." Initially, patients will wear the device for about 8 to 10 hours at night. "We may find that it's not sufficient," says Davidovitch, "but this is why we plan to conduct these experiments, to get the bugs out of the system."

Both Korostoff and Davidovitch are optimistic that their method will work on humans as well as it did on cats, and they are very excited about their work. Through the University of Pennsylvania, they hold a patent on the method and device now being tested at the university's School of Dental Medicine.

Sr in Tooth

"The Handbook of Stable Strontium"
Stanley C. Skoryna, ed
Plenum Press (1981)

34

Strontium in Human Dental Enamel

M. E. J. Curzon and P. C. Spector

During the last 20 years some aspects of dental research have been concerned with the role of trace elements, other than fluoride, in the dental caries process. One element which has attracted attention has been Sr^{2+}, which from both human and animal studies appears to have an association with low caries prevalence. The close relationship of Sr^{2+} to Ca^{2+} in the periodic table, with very similar properties, means that it can readily be substituted for Ca^{2+} in the hydroxyapatite crystal of human enamel (3). The possible influence of Sr^{2+} in increasing a tooth's ability to resist dissolution by incorporation in the hydroxyapatite is appealing, and is currently emphasized in dental research.

HUMAN STUDIES

The low level of caries prevalence in Bonn (Germany) school children, when compared with children in Oslo (Norway) was ascribed by Lodrop (21) to higher levels of Sr^{2+} and V^{2+} in the drinking water. Anderson (1), however, could not find any reduction in caries prevalence in English children living in an area of high geologic Sr^{2+} in Gloucestershire. In this English study the influence of dietary composition and drinking water supplies was not adequately considered, and the Sr^{2+} intake in the examination subjects was probably low. The results of an exhaustive survey of trace elements in soils, food, and water related to dental decay in New Guinea (2), indicated an inverse relationship of Sr^{2+}, as well as some other trace elements, to low caries. This last study was repeated with more emphasis on the analysis of enamel, saliva, and plaque (bacterial and food accumulation found on the teeth), as well as the geochemical environment (36).

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The relationship of Sr^{2+} to dental caries was found to be weaker than that previously (2) reported.

A survey of caries-immune recruits (men who had never experienced any dental decay) inducted into the U.S. Navy (22) indicated that a disproportionate number of such men originated from a small geographic area of northwestern Ohio. Subsequent epidemiological studies on school children living in northwestern Ohio showed them to have significantly lower levels of caries prevalence than comparable children in a control area (7). Since the fluoride levels in the water supplies were comparable in all study towns, it was suggested that the low levels of caries were due to factors such as trace elements other than fluoride.

The identification of an area of Wisconsin, U.S.A., where geologic deposits of celestite ($SrSO_4$) and strontianite ($SrCO_3$) occurred, afforded an opportunity for further dental research (11). Groundwater supplies in this study area were known to have Sr^{2+} concentrations as high as 39 mg/liter (31). Seven towns in the area were chosen for study, all with comparable levels of drinking water fluoride (1.0–1.2 mg F^-/liter), but with varying levels of Sr^{2+}, 0.02 to 34.5 mg/liter, as determined by atomic absorption spectrophotometry. During October 1975 dental examinations were carried out on 12- to 14-year-old school children who were lifelong residents of the seven towns. The distribution of decayed, missing, and filled permanent tooth surfaces (DMFS) within the mouth of each child was recorded. All examinations were carried out in the same way, and by the same examiner who had completed the northwestern Ohio studies (7). Results for the mean number of DMFS scores for 12- to 14-year-old children for each town (Table 1) indicated that caries prevalence scores in Little Chute were the lowest. Further, the distribution of caries prevalence relative to water concentrations of Sr^{2+} suggested a curvilinear relationship.

In an attempt to determine the concentration of Sr^{2+} having the maximum effect upon dental caries, the results of the northwestern Ohio dental examinations (7) were incorporated into a statistical analysis, together with the Wisconsin survey results. This was justifiable, since the same examiner had carried out the examinations for both studies. Plotting the mean caries scores for each town

Table 1. Mean Caries Indices (DMFS) of 12- to 14-Year-Old Life-long Residents in Wisconsin Towns

Town	Sr^{2+} in water mg/liter	n	DMFS scores (mean ± SE)[a]
Eau Claire	0.022	122	6.96 ± 0.49
Beaver Dam	0.278	150	6.19 ± 0.45
Little Chute	5.37	113	3.14 ± 0.32
Kimberly	8.27	303	4.00 ± 0.24
Kewaskum	10.4	49	5.08 ± 0.75
Union Grove	15.1	47	4.93 ± 0.74
Menomonee Falls	33.9	134	6.49 ± 0.48

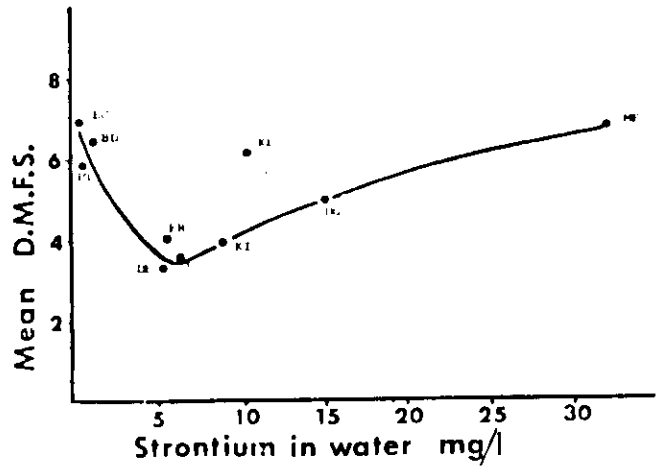

Fig. 1. Sr^{2+} content of drinking water supplies related to dental caries prevalence in 12- to 14-year old-lifelong residents. Towns: Wisconsin: EC, Eau Claire; BD, Beaver Dam; LC, Little Chute; KI, Kimberly; KE, Kewaskum; UG, Union Grove; MF Menomonee Falls, Ohio: DE, Delphos; FR, Fort Recovery; PT, Portsmouth.

against the water Sr^{2+} concentrations indicated a curvilinear relationship of Sr to dental caries did indeed exist (Fig. 1). No relationship was found when the caries scores were evaluated against either other trace element concentrations found in the water supplies concerned or Ca^{2+}. It would appear that the optimum effect of Sr^{2+} in reducing dental caries occurred when the drinking water Sr concentrations were between 5 and 6 mg/liter in the presence of 1.0 mg F/liter.

It is of interest that the association of Sr^{2+} in drinking water to caries prevalence has also been demonstrated in animals (16,30). Preliminary reports show that in the rat and hamster, Sr^{2+} may reduce caries and will also be deposited in rodent tooth enamel (30). This association of high Sr^{2+} concentrations in drinking water with low caries prevalence raises the question of by what mechanism of action the Sr^{2+} exerts its effect. Either a prevention of initiation of the carious lesion may occur or perhaps there are continued changes in the surface chemistry of the enamel by a remineralizing process. In either case, the trace element composition of the dental enamel might well be pertinent to an understanding of which trace elements affect the carious process. The trace element composition of whole enamel has, therefore, been a further field of research in dentistry.

Sr^{2+} IN WHOLE HUMAN ENAMEL

Since the early work of Drea (14), a number of studies have considered the presence of trace elements in enamel by various analytical methods. The

similar pattern was found in enamel developed in an optimally fluoridated (1.0 to 1.2 mg F/liter) environment. The 12- to 14-year old children from Ft. Recovery and Delphos, Ohio, had significantly lower caries prevalence (7), and enamel samples from persons living in these communities had greater Sr^{2+} and fluorine concentrations, than found in enamel from comparable people in Portsmouth, Ohio (1.0 mg F/liter).

Recently a study carried out in South Africa by Retief and co-workers (34), showed significantly higher concentrations of Sr^{2+} in whole enamel samples derived from low-caries blacks when compared with high-caries whites. Not only does this study add more evidence of an association of Sr^{2+} in tooth enamel with low caries prevalence, but also makes an interesting comparison with the earlier study of Curzon and Losee (10). Concentrations of Sr^{2+} in enamel from high- vs. low-caries donors were 103.0 and 177.7 μg Sr^{2+}/g, respectively, in the South African study. Corresponding values in the United States study were 104.6 and 183.0 μg Sr^{2+}/g. The similarity of these findings is most intriguing, even though different racial and cultural populations were used as well as different sampling and analytical methods.

In the Dalmatian area of Yugoslavia, a recent study (42) has again shown a relationship of Sr^{2+} in soil, water, and human enamel to low-caries prevalence. In the town of Novigrad, 3.9% of school children, aged 8–15 years, were caries-free and analysis of enamel gave mean concentrations of 83 μg Sr^{2+}/g. By comparison, 29.6% of school children in Zamunik were caries-free with mean concentrations of 113 μg Sr^{2+}/g. The differences in Sr^{2+} concentrations were significantly different at the $p = < 0.0005$ level.

If the Yugoslavia results are compared with those of the United States (10) and South Africa (34) studies, then it is seen that the mean Sr^{2+} concentrations are rather low. This is no doubt because of the lower Sr^{2+} concentrations in the drinking water of Zamunik and Novigrad, which were 0.44 and 0.23 μg Sr^{2+}/liter, respectively. These drinking water Sr^{2+} concentrations were markedly lower than those found in northwest Ohio (7). Nevertheless, it is of interest that significant inverse relation of Sr^{2+} to caries has been found in a population with lower water Sr^{2+} concentrations than previously reported.

Although these studies on whole human enamel have provided some interesting results to dental caries, nevertheless, the earliest carious lesion starts at the outermost enamel surface. Analysis of whole enamel may only give results indicating the intake of Sr^{2+} during a limited period of tooth development. Although the whole enamel may record the Sr^{2+} content of the environment, this may or may not affect the subsequent caries history of a tooth. The Sr^{2+} concentrations in the outermost layers of enamel may, therefore, be very important.

Sr^{2+} IN SURFACE ENAMEL AND CARIES

The concentrations of Sr^{2+} found in permanent teeth surface enamel by a number of authors are summarized in Table 7. The [illegible]

Table 7. Sr^{2+} Concentrations in Human Surface Enamel; Results of Previous Reports

Author	Year	n	Concentration of Sr^{2+} (μg/g)		
			Minimum	Mean ± SD	Maximum
Cutress (12)	1972	8	97	222 ± 145	495
Brudevold *et al.* (5)	1975	35	26	67 ± 20	132
Little and Barrett (20)	1976	84	NG	449 ± 238	NG
Spector and Curzon (37)	1978	439	5	366 ± 435	2077

varies widely, but may just reflect the disparity of populations studied. Thus, the samples of Spector and Curzon (38) were largely from the high-Sr^{2+} areas of northwestern Ohio and Wisconsin, U.S.A., while those of Brudevold *et al.* (5), at the other end of the scale, were from metropolitan areas of Massachusetts, U.S.A.

Cutress (12) recently suggested that there may be an increase in both Sr^{2+} and F^{2+} in the outer enamel layers of some teeth obtained from low-caries individuals. Although Steadman and co-workers (39) found an even distribution of Sr^{2+} across the depth of enamel, this has not consistently been a finding (20). In relation to caries the work of Steadman *et al.* (39) was not designed to consider caries prevalence in relation to Sr^{2+}, and no information was given as to the caries history of the tooth donors used.

Little and Barrett (20) used an acid-etch biopsy technique on enamel samples from extracted teeth collected for the whole-enamel studies previously discussed (10). For this study the caries history of each individual tooth donor was known as well as the caries prevalence in the geographic area of tooth origin (29). The etchant solutions were analyed for Sr^{2+} by atomic absorption spectrophotometry, and the results showed a gradient of Sr^{2+} concentrations from the enamel surface inward. These results would indicate that Sr^{2+} may be acquired by the surface enamel after tooth eruption, possibly affecting the ability of a tooth to resist carious attack. A conclusion by Little and Barrett (20) was that teeth derived from high-caries prevalence areas had overall less Sr^{2+} (as well as fluoride) in the surface enamel than those from low-caries areas. When enamel samples from high- and low-caries groups of individuals were compared, there was at least twice as much Sr^{2+} (and fluoride) in the surface enamel of the low caries group.

The evidence of a relationship of Sr^{2+} to dental caries by Little and Barrett (20) and by Curzon and Losee (10), although identifying significant differences of Sr^{2+} between high- and low-caries individuals did so by comparing groups of individuals. Both Sr^{2+} concentrations in enamel and caries indices vary widely, even in individuals within a small geographic area. Accordingly, the relationship of Sr^{2+} to caries on an individual basis merited further study.

Collecting extracted teeth from towns in northwestern Ohio and Wisconsin, U.S.A., used in previous epidemiological studies (7,11), we analyzed surface enamel from teeth of individuals of known caries history (38). Although both

relationship between Sr^{2+} concentrations in surface enamel and individual caries experience could be formed. Since Sr^{2+} has been shown to be cariostatic (7,11), it may therefore exert its effect by some means other than by simple incorporation in surface enamel. Other possible mechanisms of action might be by affecting bacterial growth, acid production, or bacterial adhesion to the surface enamel by cariogenic bacteria. Alternatively, the surface effect of Sr^{2+}, in relationship to enamel acid dissolution, may take place at depths far less (below 1 μm) than have been studied so far.

The relationship between Sr^{2+} concentrations in drinking water and Sr^{2+} concentrations in surface enamel was also considered by us (38). For drinking water concentrations of less than 10 mg Sr^{2+}/liter we found a linear relationship between Sr^{2+} in water and surface enamel. This relationship did not hold true, however, for towns with Sr^{2+} drinking water levels of from 15 to 33 mg/liter. This finding would seem to indicate that Sr^{2+} in surface enamel may be a good indicator of environmental Sr exposure, in all but the highest Sr areas.

CONCLUDING COMMENT

Similarly to Ca^{2+}, Sr^{2+} is preferentially deposited in calcified tissues, and it comes as no surprise that Sr^{2+} has been found in all whole-enamel samples analyzed and in virtually all surface enamel samples. The mechanism by which Sr may bring about a cariostatic effect is as yet unknown. There is sufficient epidemiological and analytical evidence to show that there is an inverse relationship of Sr^{2+} in human enamel to dental caries. The concentrations of Sr^{2+} in both whole and surface enamel are directly related to environmental exposure, but the exact role of Sr^{2+} in human enamel to caries is unclear.

SUMMARY

During the last 20 years some aspects of dental research have been concerned with the role of trace elements, other than fluoride, in dental caries research. One element that has attracted attention has been strontium, which, from both human and animal studies, appears to have an association with low caries prevalence. The disparity of results from the analysis of strontium in human enamel has been less varied than for most other trace elements and some evaluation of the data available may be made. In human enamel strontium occurs in all samples analyzed, irrespective of origin and the strontium concentrations identified so far have ranged from 14 μg/g to 1200 μg/g.

In the attempt to determine the concentration of strontium which has the maximum beneficial effect on the incidence of dental cases, the results of the northwestern Ohio dental examinations were incorporated into a statistical analysis, together with the results of the Wisconsin Dental Research ...

the optimum effect of strontium in reducing dental caries occurred when the drinking water concentrations were between 5 and 6 mg/liter in the presence of 1.0 mg fluoride/liter. The simultaneous increase in the strontium and fluoride concentrations in enamel developed in a low-fluoride water environment, such as New England and South Carolina becomes very interesting, since our earlier studies disclosed a similar pattern in the trace metal content of enamel in an optimally fluoridated (1.0–1.2 mg F/liter) water. The concentrations of strontium in both whole and surface enamel are directly related to environmental exposure, but the exact role of strontium in human enamel and its mechanism of action is not known. There is sufficient epidemiological and analytical evidence to show that there is an inverse relationship between the content of strontium in human enamel and dental caries.

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Biochemistry

Cashew oil may conquer cavities


Kubo

Cashew fruit: Will it join the fight against tooth decay?

Don't be surprised if a nut-flavored toothpaste makes its way to the drugstore shelf sometime in the next decade. Increased consumer demand for all-natural products has revived interest in tapping foods – edible plants in particular – for useful chemicals. In this quest, two organic chemists have discovered that the cashew may fight tooth decay and other bacterial infections, according to a report in the February JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY.

In their research, Masaki Himejima and Isao Kubo tested various tropical fruits and vegetables for antimicrobial activity. The oil from the cashew nut shell, normally a waste product of the food industry, seemed to hold some potential, so the researchers extracted and tested 16 compounds from it. The oil and some of the extracts worked well against gram-positive bacteria, in particular *Propionibacterium acnes*, which causes acne, and *Streptococcus mutans*, which causes tooth decay.

When killing bacteria in the mouth, these compounds also appear to interfere with production of the microbes' enamel-eroding acids. "It has anti-plaque activity, too," says Kudo.

The shell oil is not edible, but Kubo notes that its bacteria-fighting components also exist in the nut and in the juice of the surrounding fruit. This fruit, called cashew apple, is eaten in tropical countries with no ill effects. Kubo thinks the cashew compounds may prove safe when mixed into toothpaste or mouthwash. And he sees another benefit of their commercialization: The cashew represents a renewable resource and potentially important product from tropical forests.

held in long sliding tongs. Take a piece of shellac, heat it and roll it into a cylinder between the fingers; again heat the extremity and draw it out into a fine thread. This thread will break off, leaving a point at the end of the lac. Now heat the tongs at a little distance from the pallets, testing the degree of heat by touching the tongs with the shellac. When it melts easily, lightly touch the two sides of the notch with it; a very thin layer can thus be spread over them, and the pallet stone can then be placed in position and held until cold enough. The tongs will not lose the heat suddenly, so that the stone can easily be raised or lowered as required. The projecting particles of cement can be removed by a brass wire filed to an angle and forming a scraper. To cement a ruby pin, or the like, one may also use shellac dissolved in spirit, applied in the consistency of syrup, and liquefied again by means of a hot pincette, by seizing the stone with it.

DENTAL CEMENTS:

Fairthorne's Cement.—Powdered glass, 5 parts; powdered borax, 4 parts; silicic acid, 3 parts; zinc oxide, 200 parts. Powder very finely and mix; then tint with a small quantity of golden ocher or manganese. The compound, mixed before use with concentrated syrupy zinc-chloride solution, soon becomes as hard as marble and constitutes a very durable tooth cement.

Huebner's Cement.—Zinc oxide, 500.0 parts; powdered manganese, 1.5 parts; yellow ocher, powdered, 1.5-4.0 parts; powdered borax, 10.0 parts; powdered glass, 100.0 parts.

As a binding liquid it is well to use acid-free zinc chloride, which can be prepared by dissolving pure zinc, free from iron, in concentrated, pure, hydrochloric acid, in such a manner that zinc is always in excess. When no more hydrogen is evolved the zinc in excess is still left in the solution for some time. The latter is filtered and boiled down to the consistency of syrup.

Commercial zinc oxide cannot be employed without previous treatment, because it is too loose; the denser it is the better is it adapted for dental cements, and the harder the latter will be. For this reason it is well, in order to obtain a dense product, to stir the commercial pure zinc oxide into a stiff paste with water to which 2 per cent of nitric acid has been added; the paste is dried and heated for some time at white heat in a Hessian crucible.

After cooling, the zinc oxide, thus obtained, is very finely powdered and kept in hermetically sealed vessels, so that it cannot absorb carbonic acid. The dental cement prepared with such zinc oxide turns very hard and solidifies with the concentrated zinc-chloride solution in a few minutes.

Phosphate Cement.—Concentrate pure phosphoric acid till semi-solid, and mix aluminum phosphate with it by heating. For use, mix with zinc oxide to the consistency of putty. The cement is said to set in 2 minutes.

Zinc Amalgam, or Dentists' Zinc.—This consists of pure zinc filings combined with twice their weight of mercury, a gentle heat being employed to render the union more complete. It is best applied as soon as made. Its color is gray, and it is said to be effective and durable.

Sorel's Cement.—Mix zinc oxide with half its bulk of fine sand, add a solution of zinc chloride of 1.260 specific gravity, and rub the whole thoroughly together in a mortar. The mixture must be applied at once, as it hardens very quickly.

Metallic Cement.—Pure tin, with a small proportion of cadmium and sufficient mercury, forms the most lasting and, for all practical purposes, the least objectionable amalgam. Melt 2 parts of tin with 1 of cadmium, run it into ingots, and reduce it to filings. Form these into a fluid amalgam with mercury, and squeeze out the excess of the latter through leather. Work up the solid residue in the hand, and press it into the tooth. Or melt some beeswax in a pipkin, throw in 5 parts of cadmium, and when melted add 7 or 8 parts of tin in small pieces. Pour the melted metals into an iron or wooden box, and shake them until cold, so as to obtain the alloy in a powder. This is mixed with 2½ to 3 times its weight of mercury in the palm of the hand, and used as above described.

CEMENT COLORS:

See Stone.

CEMENT, MORDANT FOR:

See Mordants.

CEMENT, PAINTS FOR:

See Paint.

CEMENT, PROTECTION OF, AGAINST ACID:

See Acid-Proofing.

United States Patent Office

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COMPOSITION FOR ORAL INFLAMMATORY DISEASES COMPRISING HYDROGEN PEROXIDE AND CHROMIUM TRIOXIDE

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2 Claims. (Cl. 167—60)

ABSTRACT OF THE DISCLOSURE

Oral inflammatory diseases, such as gingivitis and pyorrhea, are treated by the oral application of a mixture of 3–10 weight percent hydrogen peroxide in aqueous solution and chromic acid in an amount, per fluid ounce of hydrogen peroxide solution, of 0.0025–0.1 g. of chromic acid on the dry basis.

This invention relates to the treatment of oral inflammations. It is more particularly concerned with oral treatments of inflamed tissues and a method for dispensing them.

As is well known in the art, gum inflammations, such as gingivitis and its more manifest forms, e.g., pyorrhea, are characterized by the presence of anaerobic bacteria in the gum pockets. Various proposals have been made to combat such inflammations. In the main, such proposed treatments require professional administration and have little room for intermediate private, personal continuation of treatment. This occurs because, in general, the treating material should be freshly prepared and such treatment is not generally available to the average patient, even on a supplementary basis, outside of professional treatment. As will be readily recognized, supplementary treatment, complementing professional treatment, is a highly desired objective.

In accordance with the present invention there have been discovered freshly-prepared mixtures for the treatment of inflamed tissues, particularly in the gums, and a convenient means for non-professional administration thereof.

Accordingly, it is a broad object of this invention to provide a means for treating inflamed tissues. Another object is to provide for treatment of inflamed gum areas. A specific object is to provide a dispensing device for treating inflamed tissue and means for supplying therefrom freshly prepared treating mixtures. Other objects and advantages of this invention will become apparent to those skilled in the art from the following detailed description considered in conjunction with the drawings, in which:

FIGURE 1 is a sectional view of an embodiment of the dispenser and dispensing means of this invention; and

FIG. 2 is a sectional view of another embodiment of the dispenser and dispensing means of this invention.

In general, this invention provides a mixture for treating inflamed tissue that consists essentially of freshly admixed aqueous hydrogen peroxide solution and chromium trioxide; said hydrogen peroxide solution containing between about 3 and about 10 weight percent hydrogen peroxide and the amount of chromium trioxide being, per fluid ounce of hydrogen peroxide solution, between about 0.0025 g. and about 0.1 g. on the dry basis. It also provides a method for treating inflamed tissue that comprises applying the freshly prepared mixture to said tissue.

This invention further provides a dispensing unit for treating inflamed tissue that comprises a substantially main body portion, made of resilient material, which tapers and curves to a capped discharge opening, which main body portion contains a first oxygenating component; a puncturable waterproof barrier near the bottom end of said main body portion, which forms a compartment separate from said main body portion, which compartment contains a second oxygenating component; and an end seal for said compartment.

As indicated heretofore, the primary purpose of this invention is to provide treating mixture that can be used, when freshly prepared, in home gum treatment; and a flexible means for mixing and applying the treating mixture. In describing this invention use is made of the terms "first oxygenating component" to designate the materials to be admixed to form the oxygen-releasing treating mixture. It is not intended to imply that one is primary to the other. In many cases, both components can release oxygen when the two are combined. The "first" component in the main body portion is used in the greater amount, volume-wise.

The preferred treating mixture of this invention is a freshly prepared mixture of chromium trioxide and aqueous hydrogen peroxide solution. It has been proposed to use chromium trioxide solution for gum treatment, but due to its relatively high acidity, this material actually attacks healthy tissue in the mouth and burns it. Surprisingly when chromium trioxide is admixed with hydrogen peroxide solution, the resultant mixture when admixed with saliva and blood in the mouth is nearly neutral. This mixture can be made completely neutral or alkaline (up to pH of 9) by adding to the hydrogen peroxide solution a few drops of a saturated aqueous solution of sodium perborate or borax ($Na_2B_4O_7 \cdot 10H_2O$). It is significant to note that either mixture will not adversely affect the delicate, normal healthy surrounding tissues covering the tongue, the cheeks, the floor of the mouth, the gingivae, or the throat. Thus, when admixed in proper proportions this mixture is safe and effective for home gum treatment.

The chromium trioxide can be added in the form of an aqueous solution or in the solid form, as a tablet or crystals. In general, per fluid ounce (30 cc.) of 3–10% aqueous hydrogen peroxide solution, there will be used 0.25 to 1 cc. of an aqueous solution containing 1–10 weight percent (preferably 6–8) chromium trioxide. On a dry weight basis the amount of chromium trioxide used will be between 0.0025 g. and 0.1 g. Preferably, per 30 cc. of 3% hydrogen peroxide solution there will be used 0.03–0.04 g. chromium trioxide (dry weight basis) or 0.5 cc. of 6–8% solution. Preferably, but not necessarily, the hydrogen peroxide solution will contain a very small amount of a preservative, such as urea or acetanilid, and flavoring agent.

EXAMPLE

To 30 cc. 3% aqueous hydrogen peroxide solution (containing not over 1/10 grain acetanilid per fluid ounce) in a vial were added 6 drops (0.5 cc.) of an 8 weight percent aqueous solution of chromium trioxide. Within a minute, the resulting mixture darkened and vigorous evolution of nascent oxygen was observed. After about 2 minutes, the mixture was applied to inflamed gum tissue. This mixture can be applied either in a light spray or a light stream (liquid).

There are other mixtures which, when freshly prepared will produce nascent oxygen. Examples of such mixtures of solutions of chromium trioxide and potassium permanganate; of hydrogen peroxide and sodium chloride; and of chromic trioxide and sodium perborate. The mixture of this invention, such as shown in the example, however, is outstandingly effective for treatment of inflamed tissues. More significantly, it is completely safe for use in home treatment. For best results the user should have the tartar removed periodically by the dentist, so that the mixture can reach the affected areas more readily. Between dental visits, the mixture of this invention will be

Chocolate reportedly can fight tooth decay

R/ST HOUSTON TX CHRONICLE

NEW YORK (AP) — Recent studies conducted at the Massachusetts Institute of Technology and the Forsyth Dental Center in Boston show that chocolate can help fight tooth decay, reports Chocolatier magazine.

Findings indicate chocolate contains a protein team component that inhibits activity of a mouth enzyme which is the key element in the formation of plaque.

Also, the cocoa butter in chocolate helps to clear food quickly from the mouth. The faster food leaves the mouth, the less its cavity-producing potential.

MEDICINE SCI. DIGEST

Digging into Gum Disease FEB 86

■ Gum disease troubles 90 percent of the adults in the United States, but dentists are baffled by the infection process. Now researchers at the University of California, San Francisco, have devised a test-tube model that indicates that the bacteria implicated in gum disease, unlike those of tooth-enamel decay, adhere to the root surface, causing red, swollen gums and, ultimately, gum and tooth deterioration. New toothpastes and mouthwashes that prevent or weaken bacterial adherence are being studied.

Biomedicine

MARCH 29 86 SCI. NEWS p203

Julie Ann Miller reports from Washington, D.C., at the meeting of the American Association for Dental Research

Colonizing the mouth with benign bacteria

Mutant bacteria especially adept at establishing themselves in the human mouth have been developed by scientists at the Forsyth Dental Center in Boston. They expect these bacteria to serve as the missing link in attempts to replace cavity-causing bacteria with mutant strains that do not generate the large amounts of acid that decay teeth.

About nine years ago Jeffrey D. Hillman and his colleagues at Forsyth, working with colonies of the bacterium *Streptococcus mutans*, isolated a mutant that produces only low levels of acid. Later, when they introduced the mutant strain into mouths of germ-free rats, the rats remained cavity-free throughout their lives despite a diet high in sugar (SN: 12/8/79, p. 394). But this promising bacterium never succeeded as a dental therapy because it was unable to take over a human mouth already occupied by the natural, cavity-causing strain. "The human mouth is a more complex ecosystem than that of the rat," Hillman says.

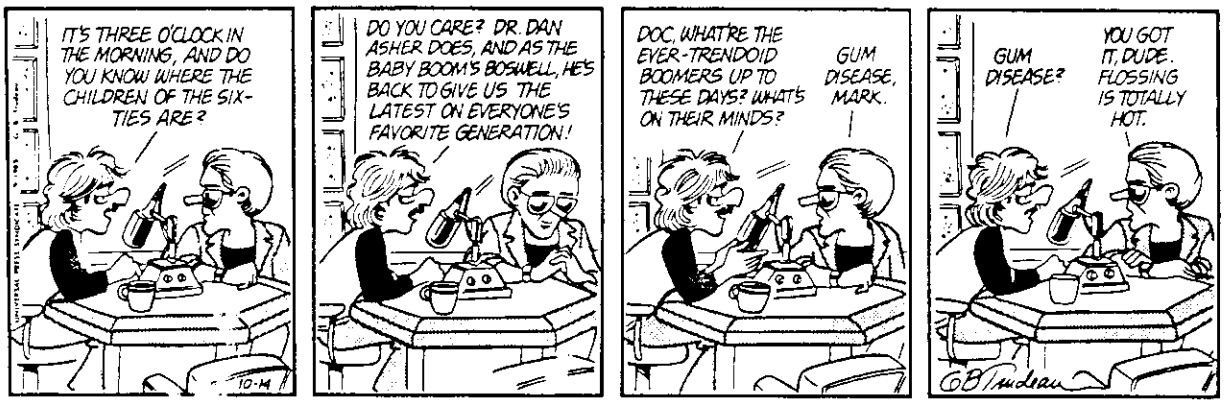
So Hillman and his colleagues went back to natural bacterial populations from human mouths to find a strain that is a better colonizer. They now report they isolated such a bacterium (called JH1001) and created a mutant of it that is an even more successful colonizer (JH1005). These bacteria produce a chemical, called a bacteriocin, that stops the growth of closely related strains.

Three Forsyth staff members had their teeth cleaned, then brushed and flossed with JH1005 cells for five minutes. Now, almost a year later, that strain is the dominant *S. mutans* in their mouths. An unexpected finding is that in these volunteers the total number of all *S. mutans* bacteria in their mouths is significantly depressed. However, levels of a similar bacterium, *S. sanguis* that occupies a similar niche was not depressed by the *S. mutans* mutant.

Now the scientists plan to combine in a single strain the characteristics of low acid production and successful colonization. "Hopefully we'll have such a strain in a couple years," Hillman says. "Colonization has been the major stumbling block." According to the American Association for Dental Research, "The findings to date lend strong support to the practical application of replacement therapy for the prevention of tooth decay."

Doonesbury

BY GARRY TRUDEAU



Fluoride Tea

Ah, Oolong, So Long To Cavities

High in fluoride, tea tackles decay

A cup of tea is good for whatever ails you, according to age-old lore. While mythic mothers have pushed the drink for everything from alcoholism to rheumatism, science now comes up with a new one: Tea helps prevent tooth decay.

Studies of English school kids show that those who drink tea have fewer cavities than those who don't. One or two cups of tea daily cut tooth decay, and the more tea kids drank, the less decay they had.

The reason: fluoride. An average cup of tea has up to three times as much fluoride as a cup of commercially fluoridated water. And oolong contains more fluoride than other teas.

"Tea is one of the few plants known to absorb fluoride from the soil it grows in," says Dr. Subba Rao, chief of biochemical research at the American Dental Association Health Foundation in Chicago. "We believe it can be an important source of fluoride in the diet."

Instant tea mixes have even more fluoride than brewed tea, according to Dr. Memory Elvin-Lewis of the Washington University School of Dental Medicine in St. Louis. Herbal teas contain virtually no fluoride.

Whether from tea leaves or treated water, fluoride helps teeth resist the destructive acids produced by plaque. But tea also has other ingredients that inhibit formation of plaque. Elvin-Lewis thinks it's the tannins, although the process is not fully clear.

Add milk to tea and you stir up a bit of scientific controversy. Some studies suggest the milk may interfere with fluoride absorption. Others say that milk simply dilutes. The dental association hopes to settle the matter with a study of milk's effect on fluoride.

— Jay Butera

TEA COUNCIL OF THE USA

Anxiety Rx

Lending an Ear to Dental Fear

Whirr-rrr, gurgle, hummmmmm, clink, scrrr-rrtch, plii-nnk, whoosh, click, gurgle, SQUIRT.

Nobody loves a dental appointment. To out-and-out dental phobics, however, the sounds of drills, suction devices, x-ray machines, probes, picks and irrigators spell terror so overwhelming that many avoid appointments for years at a stretch. Now, in a tactical twist, a team of French psychologists and dentists is working with these sounds to lessen the fear, instead of arousing it.

Fourteen high-anxiety dental patients, all adults, were "flooded" with the noises of dentistry. They spent two weekly two-hour sessions listening to the sounds of extraction, cleaning, injection and bridge building. They also learned relaxation and assertiveness techniques as ways to gain control over open-mouthed destiny.

The soundtrack flooding worked as well as the coping skills training—and it was easier, reports the Laval University team. Both produced impressive improvements for up to four months: Most patients made and kept dental appointments.

Why does flooding help? People with an excessive fear of fillings have usually had a bad experience with a dentist. But what keeps them away from the dentist long after the bad experience has passed is fear of the fear itself, says psychologist Janel Gauthier.

Flooding therapy immerses the patient in elements, like sounds, that set off the once-removed anxiety. But by supplying the fear triggers without supplying the pain, the therapy disconnects the two. The drill whirrs, but not for thee. Instruments clink, but there's no injection.

Thus deconditioned, would-be patients at least make an appointment. Relaxation techniques then work best—provided the patient keeps the appointment.

—Joann Rodgers

AN ACID TEST

To the teenager whose mouth is already filled with braces and other hardware, it may seem like more of the same, but dentists should be delighted with a new sensing device that can detect acid (which leads to cavities) simultaneously at seven different sites in the mouth. Developed by Imants Lauks and Samuel Yankell, engineers at the University of Pennsylvania, it uses seven microsensors, each so small that it can fit virtually anywhere in the mouth—between teeth or even inside a cavity. Slender wires lead from each microsensor to a console that displays the level of acid at each location. The device will enable dentists to determine how different foods change mouth chemistry and cause tooth decay.

Lauks and his colleagues are working on an even more advanced sensor that could monitor 16 chemicals in the blood stream, as well as in the mouth. It would transmit its measurements by radio signals, making lead wires unnecessary. Such sensors could have many applications in medicine, measuring such things as the level of sugar or the concentration of antibiotics in the blood. ❑

Lingual Braces "Outta Sight"

by Barbara Leal

LIFESTYLE
FEB.-MAR. '84

Does she or doesn't she? Only her dentist knows for sure. Only he knows for sure she is wearing braces . . . especially the lingual kind.

As the name indicates, lingual braces are cemented to the lingual or tongue side of the teeth, so wearers need not be self-conscious about their smile. Often they are used only on the front teeth, while conventional bands or outside glue-on brackets are used on the molars and sometimes the bicuspids.

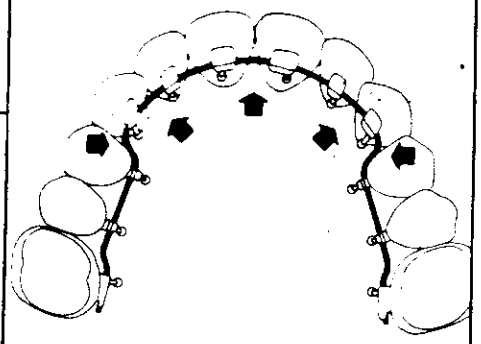
It may take a few years for lingual orthodontic appliances — "invisible braces" — to become readily available, and they aren't for everyone says Dr. George Markle, a Bay Area dentist. But for many adults, especially those who deal with the public in their jobs, lingual braces may mean the difference between getting their teeth straightened or forever suffering with a bad bite and impaired appearance.

"For many adults . . . lingual braces may mean the difference between getting their teeth straightened or forever suffering with a bad bite and impaired appearance."

Further comments Dr. Markle, "Patients who've used these kind of braces say they make the tongue sore for about two weeks and may cause some speech impairment for a month or so, but conventional braces also may cause these problems to occur." Brushing and flossing the teeth meticulously is especially important for anyone wearing braces; patients seem to agree that cleaning is easier with either inside or outside glued-on brackets than with full bands around their teeth.

Even though the costs might be slightly higher, lingual braces are a much more attractive alternative, especially if your physical appearance plays a strategic role in your career.

"People are still often unaware of this new development in dentistry," states Dr. Markle. So if you'd like to catch up on the newest dental trends — give him a call at (415) 781-4725.



Space-age tooth

POP SCI
MARCH 84

Look closely at the dazzling array of teeth in the picture below. Now, which one is the phony?

Did you guess the second from the left? That tooth wears a crown made from a crystalline, high-alumina ceramic originally developed for "space-age" needs in the electronics and other industries. Unlike many conventional crowns (or caps, as they are sometimes called), it is completely metal-free.

Called the Cerestore Crown, it is being introduced by Johnson & Johnson Dental Products Company; the material is made by Coors Porcelain Company. Its development was launched,

in part, by the wish of Dr. Ralph B. Sozio, Harvard School of Dental Medicine, for a better crown.

Sozio saw problems with traditional all-metal, porcelain, or porcelain-metal crowns, and turned to the ceramics industry for a better choice. Among the claimed advantages of this first true crystalline ceramic crown are precise fit, natural appearance, exceptional strength, and superior insulation from heat and cold. Moreover, unlike metal-containing crowns, the ceramic cap won't hinder diagnosis by blocking X-rays. PS

Dentists hail sealants for curbing cavities

A thin plastic film painted over the grinding surface of molars could safely and effectively prevent most of the tooth decay that afflicts children and teenagers, suggest dental researchers.

An 11-member panel, sponsored by the National Institutes of Health (NIH), last week urged U.S. dentists to increase their routine use of dental sealants in children, and encouraged health insurance companies to include the plastic sealants in their dental coverage.

The sealants are "highly effective" in curbing cavities, says James Bawden, a professor of dentistry at the University of North Carolina in Chapel Hill, who chaired the NIH Consensus Development Conference. "And yet they are vastly underutilized in the health care system."

The first sealants of the 1960s were less effective than today's brands, which may have discouraged widespread use, Bawden says. But "remarkably consistent and positive" evidence from studies in the last decade indicates that current sealants are 100 percent effective in protecting teeth as long as the plastic film is retained, the panel reports. Studies show more than 80 percent of the newer sealants are still in place after seven years. The sealants seemed to wear off in the remaining patients.

Herschel S. Horowitz of the National Institute of Dental Research in Bethesda, Md., estimates the average charge for sealant application at "$6 or $7 per tooth," though national statistics have yet to be compiled, he says.

Not all teeth need the protection, Bawden says. He suggests that parents consult their child's dentist about sealant application soon after the molars appear — at about age two or three for primary molars and six years for permanent teeth. The panel targeted children and adolescents as a group most likely to benefit from the treatment because of eating and oral hygiene habits that tend to make them cavity-prone, though some adults might also benefit.

U.S. citizens average 10 decayed, extracted or filled teeth by the age of 16, the panel reports, despite the finding that water fluoridation, dental treatments and toothpastes have reduced the incidence of dental caries in the last decade by 50 to 65 percent (SN: 7/10/82, p. 27). About 53 percent of all U.S. residents drink fluoridated water. Fluoride seems to best protect the smooth surfaces of teeth, but leave vulnerable the crevices and pits of molars, while a thin coat of plastic on the uneven surfaces prevents the entrapment of food and bacteria that produce enamel-eating acids. The two forms of treatment "work best in concert," Bawden reports.

—D. Franklin

A Cure for Pyorrhea

FROM the University of Toronto, which gave the remarkable serum insulin to the world a year or so ago, came an announcement recently of another amazing discovery in medical science—a cure for pyorrhea, the supposedly incurable disease of the teeth and gums from which, physicians tell us, half the people in the world suffer.

Like Doctor Banting, discoverer of insulin, Dr. Harold Box, who is responsible for this new gift to science, is a young and hitherto obscure research worker.

According to the announcement made by the university, Doctor Box has discovered that pyorrhea is not caused by infection, but by degeneration of tissues, and after five years' work, has found a means of arresting this action. Pyorrhea causes the gums to become painfully inflamed and to recede from the teeth, which eventually become loose. Hitherto, dentists believed there was no way of coping with the disease except by extracting the teeth.

Like insulin, Doctor Box's method of treatment has been turned over to the Government without restrictions, to be made available to the public.

Pop Sci 1929

Germ warfare stops cavities

Sci. 01, P.19 9/84

Preventing decay may be as easy as letting bacteria battle bacteria.

Cavities are caused by bacteria in the saliva called *Streptococcus mutans*. Once these bacteria adhere to the teeth, they transform sugar into an acid that dissolves tooth enamel. But a genetic variation has produced a bacterial cousin called the LDH mutant that lacks the enzyme—lactate dehydrogenase, or LDH—that converts sugar to acid. But in lab experiments, the LDH-mutant strain prevented cavities only in rats.

Jeffrey Hillman of Boston's Forsyth Dental Center has isolated another strain of *S. mutans* that is an "exceptional colonizer." The newly discovered JH1001 strain produces a protein a called a microcin that can kill cavity-causing bacteria in humans and quickly crowds out any new ones that enter the mouth. Hillman is now trying to create a new colonizing strain that will combine a non-virulent microcin and the LDH-mutant trait for extra protection. ■

Are Your Fillings Poisoning You?

Mercury in metal tooth fillings may cause allergic reactions such as rashes and even lead to serious illness.

A recent study, conducted at the University of Iowa and reported in the *Journal of Dental Research*, found that the more fillings a person had, the more mercury was in the blood.

Mercury is a known poison. Metal fillings, called amalgam, are half mercury, half silver and other metals. They are used in most cavities.

Amalgam's possible health hazards have been debated for several years, but no one has stirred more controversy than Colorado dentist Hal Huggins. He says almost 400 patients have come to him with illnesses traceable to mercury poisoning. "I've treated people with multiple sclerosis and epilepsy," he says. "Seventy-five percent were helped significantly when their amalgam fillings were replaced."

The American Dental Association stresses that there is no scientific link between fillings and illness. But it concedes that 5 percent of the public is allergic to mercury. Next month, the National Institute of Dental Research will hold a workshop to explore the safety of amalgam and other metals. ■

Scientists study drug as dental treatment

BEAUMONT, TX ENTERPRISE 9/84

BOSTON (AP) — A powerful form of a newly approved over-the-counter painkiller dramatically reduces one form of dental disease in animals, and researchers soon hope to learn if it will save people's teeth.

An experiment begins this month to see if daily doses of the drug, called ibuprofen, can slow or stop periodontal disease, the No. 1 dental problem of adulthood.

This condition erodes the bone that supports the teeth and is a major cause of tooth loss. In the United States, an estimated 94 million people have periodontal disease, and it is one of humanity's most common infections.

In the new study at the Harvard School of Dental Medicine, volunteers will take a medicine called flurbiprofen. Harvard researchers already have found that the drug can reduce bone loss around the teeth by 66 percent in dogs, which are often used to study periodontal disease.

Flurbiprofen is a more potent version of ibuprofen, which was approved in May for over-the-counter sales and has been used in prescription form since 1974 to treat arthritis, pain and other problems.

Like aspirin, ibuprofen and flurbiprofen are classified as non-steroidal anti-inflammatory drugs, which stop the swelling and redness of bodily injury.

Doctors believe this same response to injury, when caused by some dental bacteria, eats away the bone around the teeth. So their strategy is to save the teeth by thwarting one of the body's reactions to infection.

"I am optimistic that flurbiprofen and other not-yet-tested, non-steroidal anti-inflammatory drugs will prove to be an effective way of slowing down bone loss around the teeth," said Dr. Ray C. Williams, who is conducting the research with Dr. Marjorie Jeffcoat.

Flurbiprofen has not yet been approved for routine use in the United States, although it has been available in Europe for about a decade. It is among the most powerful non-steroidal anti-inflammatory drugs known.

The researchers plan to recruit 60 adults with advanced bone loss that doesn't respond to ordinary treatment. They will take two pills a day, and the experiment will last for 1½ to three years.

Periodontal disease is caused by bacteria that live underneath the gums. The germs injure the tissue, and one of the body's responses appears to be the production of arachidonic acid. Then enzymes turn this acid into three chemicals — prostaglandins, prostacyclines and thromboxane — and scientists believe that, among other things, these chemicals inflame the gums and erode the bone around the teeth.

Flurbiprofen and similar drugs block one of the enzymes that are necessary for all this to happen. And the researchers think this is how the medicine preserved the dogs' teeth.

The prevention of dental caries: ten years later

James P. Carlos, DDS

The program of the National Caries Program of the National Institute of Dental Research toward finding ways to prevent caries on a widespread basis is assessed.

In 1971, Scherp[1] published a seminal paper on the prospects for the prevention of dental caries, in which he summarized the current knowledge of caries etiology and speculated on the most promising directions for future research. In that same year, the National Institute of Dental Research began the National Caries Program. This research and development effort was undertaken for the express purpose of finding cost-effective ways to prevent caries on a widespread basis, so that this ubiquitous disease could be eliminated as a major public health problem. Now, a decade later, it seems appropriate to briefly assess the extent to which progress has been made toward that goal.

From the outset, the National Caries Program has been organized into four areas of research strategy that follow directly from the concept that caries is of multifactorial etiology. Program strategies involve finding ways to: combat caries-inducing microorganisms; increase the resistance of the teeth; modify caries-promoting aspects of the diet; and improve delivery and acceptance of caries-preventive methods.

As the importance of each of these strategies was noted by Scherp,[1] I will examine the current state of development in each. Review periods [illegible] will be cited wherever possible, as the surge of interest in caries research during the last ten years is reflected in an abundance of relevant new contributions to the scientific literature.

Combating caries-inducing microorganisms

In 1971, the importance of *Streptococcus mutans* as a caries-inducing pathogen in laboratory animals had been clearly established by experiments with hamsters, rats, and primates. The ability of these bacteria to readily form plaque on smooth surfaces was observed to be related, at least in part, to their ability to produce extracellular polysaccharides (glucan and fructan) from sucrose. Some hoped that human dental caries could be prevented by the use of glucan-cleaving enzymes, such as dextranase; this technique had been highly successful in hamsters.[2]

Unfortunately, these expectations have not been fulfilled. Clinical trials of dextranase gels applied in mouthpieces resulted in little protection against caries in children,[3] no doubt because of the complexity of the matrix of human plaque relative to that in hamsters, as well as to the inability to deliver the enzyme with sufficient frequency.

No other agent specifically intended to suppress the cariogenic microflora has yet reached the stage of full-scale human testing in this country, but the accumulation of research knowledge about the etiologic role of bacteria in caries, and, of course, possible antibacterial interventions, has progressed extensively during the last decade.

This is especially [illegible] improvement [illegible] the processes by which [illegible] organisms adhere to tooth surfaces. Although recent research has confirmed that sucrose-derive extracellular glucan facilitates colonization of smooth surfaces by *S mutans*,[4] we have learned that other mechanisms including interbacterial aggregation,[5] electrostatic attraction,[6] specific receptor-type reactions,[7] the presence of immunoglobulins in saliva,[8] and mechanical retention may also determine the success or failure of bacteria to adhere to teeth and to other human tissues.

Appreciation of the complexity of the microbial etiology of dental caries was further extended by the report that at least seven serotypes of *S mutans* may be isolated from human plaque,[9] although not all appear to be cariogenic. Indeed, conclusive evidence is still lacking that *S mutans* is the primary initiator of human caries, although data acquired thus far from both epidemiologic studies and animal experiments are strongly suggestive of this.[9] Nevertheless, it has become clear that other species of strep

Research to develop a caries vaccine has already stimulated a major expansion of knowledge about the secretory immune system.

[illegible] well as of the genera *Actinomyces* and *Lactobacillus*, are involved in the caries process; not all of them as pathogens, but certainly as competitors for ecologic niches on the tooth. Preliminary experiments with mixed oral flora suggest that the eventual composition and cariogenic potential of plaques is influenced not only by diet, but also by the order in which specific microorganisms are introduced.[9] It has also been established that mutant forms of *S mutans* that are deficient in their ability to synthesize polysaccharide from sugar have reduced cariogenic potential in animals.[10] The development of a "safe" oral flora, which could successfully compete with pathogenic forms, thus becomes a theoretical possibility.

In his 1971 paper, Scherp[1] expressed the prevailing view of skepticism that caries could be prevented by immunization, even though Bowen had already reported partial protection against caries in monkeys vaccinated with *S mutans*.[12] Since then, reports from several laboratories have confirmed that caries can be partially prevented in monkeys and rodents by vaccination with a variety of antigens; the most consistent success has been achieved by intraoral injection with killed cells of *S mutans*. Evidently, protection depends mainly on the induction of elevated levels of salivary antibody. These studies have been summarized by Bowen.[13]

More recently, increased levels of both salivary and serum antibodies have been observed in humans who swallowed capsules of killed *S mutans* cells, and the ability of these organisms to colonize the teeth of the vaccinated individuals was sharply reduced.[14] This is an extremely important finding, but we should not conclude that a vaccine against human caries is imminent. Much research remains to be done to identify the most potent antigens and the optimal route and frequency of vaccination, and to establish the safety of the procedure, before full-scale clinical trials will be possible. It is encouraging that no noteworthy adverse effects have been reported in the hundreds of animals vaccinated so far. Even so, it can be now predicted with some confidence that partial prevention of caries by vaccination will become a reality. Research to develop a caries vaccine has already stimulated a major expansion of knowledge about the secretory immune system, with broad potential applicability to other areas of biomedicine.

More direct attempts to combat the cariogenic microflora have had less encouraging results. Although Scherp advocated "a vigorous program to develop rational use of antimicrobial agents topically," no such agents have yet become available for general use in caries prevention. The problem is not primarily a scientific one; that the bis-biguanide, chlorhexidine, can prevent plaque formation and caries has been established,[15] and in our laboratories, several antimicrobial agents have been tested that are equal or superior to chlorhexidine in in vitro and animal caries experiments. Rather, progress has been retarded by the high cost of the required toxicity testing of a new drug before clinical trials can begin, as well as the associated problems and uncertainty of eventual regulatory approval. Efforts will continue to develop antimicrobials for use, for example, in mouthrinses or dentifrices, but we have a more realistic appreciation of the economic and regulatory problems involved than we had ten years ago.

Increasing the resistance of the teeth

The use of fluoride in various forms continues to be the most effective way to prevent dental caries. Currently, slightly more than half the population of the United States has access to fluoridated water supplies but, because most metropolitan areas have already adopted fluoridation, it is unlikely that this fraction will increase dramatically in the immediate future. Even in optimally fluoridated areas, it is desirable to attempt to increase the level of protection against caries already attained. As a consequence, fluoride research during the past ten years has been concentrated on the development of more cost-effective ways to deliver dietary fluoride supplements and topical fluorides to complement, and possibly supplement, water fluoridation. Some major advances have resulted.

A decade ago, it was generally believed that the fluoride ion mainly exerted its anticaries effect by incorporation into enamel as fluorapatite, thereby increasing the resistance of the tooth to acid dissolution. Since then, however, it has become increasingly evident that other, possibly more important, mechanisms of fluoride action are operative. Epidemiologic study failed to demonstrate consistent correlations between caries prevalence and the fluoride content of the outer enamel layers.[16] Conversely, very small concentrations of fluoride, continually present in the mouth, effectively prevented caries in rats, and the level of protection was not related to the amount of fluoride acquired by the enamel.[17] Other experiments showed that low concentrations of fluoride were capable of remineralizing incipient carious lesions[18] and of interfering with glycolytic activity and growth of plaque bacteria.[19] These findings were in accord with reports that caries in humans was partially prevented by frequent topical exposure to low doses of fluoride, even though increased levels of enamel fluoride could not be detected.[20]

In the aggregate, this research resulted in a rather drastic change in the methods of topical fluoride therapy; rather than occasional exposures of the teeth to high concentrations of fluoride, it appeared preferable to provide regular, frequent exposure to relatively dilute fluoride solutions. This was confirmed in a series of controlled clinical trials.[21]

Consequently, the National Caries Program began, in 1974, a series of demonstration programs nationwide to test the feasibility, cost, and public acceptance of weekly mouthrinsing in schools with an 0.2% solution of sodium fluoride. The results established that such programs were highly cost effective.[22] Estimates are that

more than 13 million school-aged children, mostly in nonfluoridated areas, are currently enrolled in school-based fluoride rinse programs or the analogous programs of daily fluoride tablet administration. These children can be expected to average 30% to 40% fewer new carious lesions at an annual cost of as little as $1.50 per child. Recent reports suggest these self-applied fluoride programs may provide added protection in fluoridated areas as well.[23] Should communities continue to adopt school-based fluoride programs at the present rate, a major impact on the incidence of caries in children is inevitable within the next few years. The demonstration that 2% sodium fluoride applied daily in gel would prevent the previously intractable problem of extensive caries in patients with severe salivary dysfunction was a striking therapeutic breakthrough and another significant result of recent fluoride research.

We know, however, that fluoride is least effective in preventing caries on the occlusal surfaces of posterior teeth. Whether these especially vulnerable surfaces could be protected by sealing pits and fissures with adhesive polymers was the question studied in a large series of clinical trials that began in the early 1970s. Most studies involved the use of an ultraviolet light polymerized sealant applied to enamel that had been etched with dilute acid. The results of some of these studies have been summarized by Silverstone.[25] With careful attention to the techniques of application, sealants could be retained in more than half the treated sites for more than five years, with near complete prevention of caries.[26] Protection of the etched surface from salivary contamination was found to be critical to successful sealant application, as etched surfaces were rapidly remineralized on contact with oral fluids. More recent trials with chemically polymerized sealants have also been highly successful in preventing occlusal caries.[26] One early concern about the use of sealants was dispelled by the demonstration that when sealant was placed over active caries, the lesions did not progress and tended to become sterile.[27]

It must be concluded that adhesive sealants afford a simple, safe, and highly effective way to protect the most vulnerable areas of the teeth against caries. Why, then, are sealants not more widely used in public health preventive programs? Certainly the answer involves the cost of provision, as state laws restrict the use of sealants to licensed dentists or dental hygienists. We have calculated that, in a hypothetical preventive program for schoolchildren, if sealants were applied once a year to all noncarious occlusal surfaces, the cost of preventing a surface from decay could range from $15 to $20, depending on the inherent caries susceptibility of the population treated. It is improbable that many communities will adopt such programs. Until adhesive sealants can be legally applied by less highly trained auxiliaries, their full effectiveness in caries prevention is unlikely to be realized. Nevertheless, the use of sealants is now recommended in dental offices and clinics, where required personnel are already in place.

Sealants are not widely used in public health programs because of cost, state laws restrict the use of sealants to licensed dentists or dental hygienists.

Topical fluorides and sealants are externally applied preventive techniques intended to increase the resistance of teeth to caries. Natural host defense mechanisms may also be operative in the mouth, a possibility that has received increased attention recently with promising results. Efforts to prevent caries by stimulation of the immune system have already been mentioned. Also of potential significance are the nonimmunologic antibacterial components of saliva including lysozyme, lactoferrin, lactoperoxidase, and other salivary proteins that may be bacteriacidal or may regulate the ecology of plaque and the clearance of bacteria from the mouth.[28] This is a relatively new area of intensive research. Whether these factors have a key role in caries prevention and, if so, whether it is possible to manipulate their concentration and activity in saliva are questions being investigated.

Modifying the diet

Of the research efforts to effectively intervene in the etiologic triad of dental caries, those directed at altering dietary factors have so far met with the least success.

Given the proclivity of a large segment of the population, and especially of children, for sweet foods, it seems futile to strive for major changes in dietary habits, even though there is compelling evidence that a sharp reduction in the amount[29] or even in the frequency,[30] of sugars eaten would have a salutary impact on caries prevalence. Instead, recent research has been directed to identifying and developing substances that might be added to sugars to decrease their cariogenicity, or that could serve as taste-competitive, noncariogenic sugar substitutes.

In 1971, various phosphate compounds appeared especially promising. In more than 100 experiments on animals, phosphates added to food and drinking water had effectively prevented most caries.[31] However, most subsequent trials in humans in which dicalcium or dihydrogen phosphates were added to flour, bread, sugar, chewing gum, and breakfast cereals ended with equivocal results although the phosphate additive appeared to reduce the cariogenic potential of chewing gum.[32] Similarly, sodium trimetaphosphate, which had been the most effective compound of those studied in animals, failed to prevent caries to any significant degree when given in chewing gum to children.[32] It is likely these disappointing results can be explained by the fact that, in experiments with animals, the phosphate compounds were present in all food and water consumed, whereas, in experiments with humans, only intermittent, and probably inadequate, exposure to the compounds was accomplished. Even so, the idea of a sugar additive that would prevent or attenuate the effect of acid production in plaque remains an attractive one; presumably the use of such a substance would require little or no change in food technology or personal

[illegible]. This is an area of investigation that deserves renewed attention by both caries researchers and the food industry.

Ten years ago, it was also thought that glucose and fructose might be less cariogenic substitutes for sucrose. This was not substantiated by subsequent research in animals,[illegible] but many other possibilities exist. For example, when young adults ate diets in which all added sugars had been substituted by the polyol xylitol, virtually no caries occurred during the 2-month study, in contrast to substantial levels of caries incidence among groups eating diets sweetened with sucrose or glucose.[illegible] Because some questions have been raised concerning its safety, xylitol is not yet available in the United States, but it is widely used in confections in some European countries.

Of the many synthetic sweeteners that have been identified, the dipeptide aspartame currently appears most promising as a noncariogenic sugar substitute, especially in dry foods.[illegible] This compound is under review by the Food and Drug Administration. Other potential candidates of natural origin [illegible] a sweet protein, [illegible] from licorice root. Each of the sugar substitutes currently under study has one or more shortcomings, such as high cost or poor solubility or thermolability, that would limit its use to certain types of snack foods. Therefore, we may expect a variety of new sweeteners to eventually be marketed.

Even when suitable sugar substitutes become available, it will not be feasible or desirable to substitute them for all added sugars. Rather, it will be necessary to identify those foods that contribute most heavily to the cariogenic potential of the American diet and that should therefore be given priority for reformulation. Until recently, little research data existed on the cariogenic potential of specific common food items. Because ethical considerations preclude the evaluation of the cariogenicity of foods by conventional clinical trials, several attempts have been made to devise screening systems based on in vitro, animal, or short-term human experiments. The most promising systems reported so far involve the measurement of acid production in plaque in situ while human volunteers eat the test foods,[illegible] and a highly controlled and reproducible rat feeding system developed in the National Caries Program laboratories.[illegible] The latter technique produced data that can be used to assign to each food tested a "cariogenic potential index," relative to that of pure sucrose. A combination of these methods could be used to begin to develop data to identify dietary constituents of greatest interest for caries prevention.

Improving delivery and acceptance of caries-preventive methods

Programs to prevent dental caries must compete for increasingly scarce resources with other health, personal, and societal needs. Unfortunately, dental health is rarely given high priority in such situations. Therefore, it is no longer sufficient to search for caries-preventive methods that have a high degree of clinical efficacy. To have any substantial impact on caries prevalence, preventive methods must also be deliverable to large segments of the population, at low cost and, probably, with minimal requirements for positive action on the part of the intended recipients. Community water fluoridation remains the archetypical example of a preventive program that satisfies these criteria, but other attractive possibilities for improved delivery systems have emerged during the past several years.

School-based, self-applied fluoride programs offer an inexpensive way to provide partial prevention of caries to large numbers of children, interfering only minimally with normal activities. In a series of community demonstrations of this technique conducted by the National Caries Program, more than 80% of eligible elementary school children participated, with parental consent; evidently [illegible] programs are readily accepted in both [illegible] and rural settings. Acceptance has been substantially [illegible]. How this [illegible] successfully motivated [illegible] is a question that needs an early solution. The low cost of self-applied [illegible] programs arises from the fact that adequate supervision can be provided by classroom teachers or adult volunteers after very brief training.

Indeed, improving the cost-effectiveness of techniques to prevent caries [illegible] finding ways to reduce [illegible] provision. [illegible] few preventive methods either available or anticipated are inherently expensive. In general, methods that require frequent one-on-one contact between the recipient and a highly trained provider will tend to have poor cost-effective characteristics, as is currently the case with adhesive sealants.

In this context, research on the adaptation of controlled slow-release delivery techniques to intraoral use has produced some encouraging results. The rationale for slow-release

Each of the sugar substitutes now under study has one or more shortcomings, such as high cost or poor solubility, that would limit its use to certain types of snack foods.

systems rests on the assumption that small concentrations of an active agent can produce a therapeutic result, if the agent is constantly present at the target site. Of equal importance, slow-release chemotherapy requires only occasional contact with the patient, thus reducing provision costs.

At present, the most developed slow-release system for caries prevention is a fluoride-containing, inert polymer device that can be temporarily attached to partial dentures, orthodontic appliances, or directly to a tooth. In tests with human volunteers, these devices were well tolerated and functioned with satisfactory precision. They have been fabricated to release constant, predetermined rates of fluoride for up to six months, and should be suitable for the delivery of other anticaries agents as well.[37]

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Even the most cost-effective methods to prevent caries will not be used unless the intended recipients are aware of the potential benefits and seek or accept the required regimen. Efforts to improve the public's understanding of the causes and prevention of caries have certainly increased during recent years, but much remains to be done. For example, there is no apparent reason except lack of knowledge why all schoolchildren, or at least those in nonfluoridated communities, should not be participating in self-applied programs. This is a short-term goal that is worth a concentrated educational effort by the entire dental profession.

Conclusions

By any standards, progress toward caries prevention has been impressive during the past decade. It is arguable that more information on the precise etiology of caries and on potential new preventive methods has been acquired during the 1970s than in any comparable period previously. Substantial advances have been made toward the understanding of the complex interaction among oral microorganisms, host resistance, and dietary substrate in the initiation and progression of a caries lesion. The various mechanisms of action of the fluoride ion have been further elucidated, vaccination against caries and a reduction in the cariogenic potential of sweet foods have both become realistic possibilities.

Conspicuous successes have also been achieved in the application of existing knowledge. At least 12 million more children than in 1971 are receiving partial protection against caries through self-applied fluoride programs. Other effective preventive methods, including adhesive sealants and possibly, antimicrobial agents, could be widely and advantageously utilized if manpower and regulatory constraints were overcome, as their scientific feasibility has, for the most part, already been demonstrated.

Of course, it would be naive to predict the early disappearance of dental caries as a major health problem. This will occur only gradually, and will require a much more extensive use of preventive methods—those already available as well as those still being developed by research. Nevertheless, a major step toward the goal of caries prevention has already been taken, and there is good reason to expect even more rapid progress during the 1980s.

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March 7, 1983 Berkeley Gazette

ASK DR. LAMB

Brush your tongue

DEAR DR. LAMB — I was reading your column about bad breath. My husband spent most of his life eating mints and breath fresheners and using mouthwash four or five times a day. He brushed his teeth regularly and he still had bad breath.

Then we read that you should brush your tongue and his bad breath stopped. He is 65 years old and he says he is sorry he didn't do that years ago as he worked around people so much. I hope this suggestion will help someone as much as it has him. His kisses are better, too.

DEAR READER — Thank you for sharing your story with others. Your husband's experience has been duplicated by many and there are many, many more who could benefit from the knowledge.

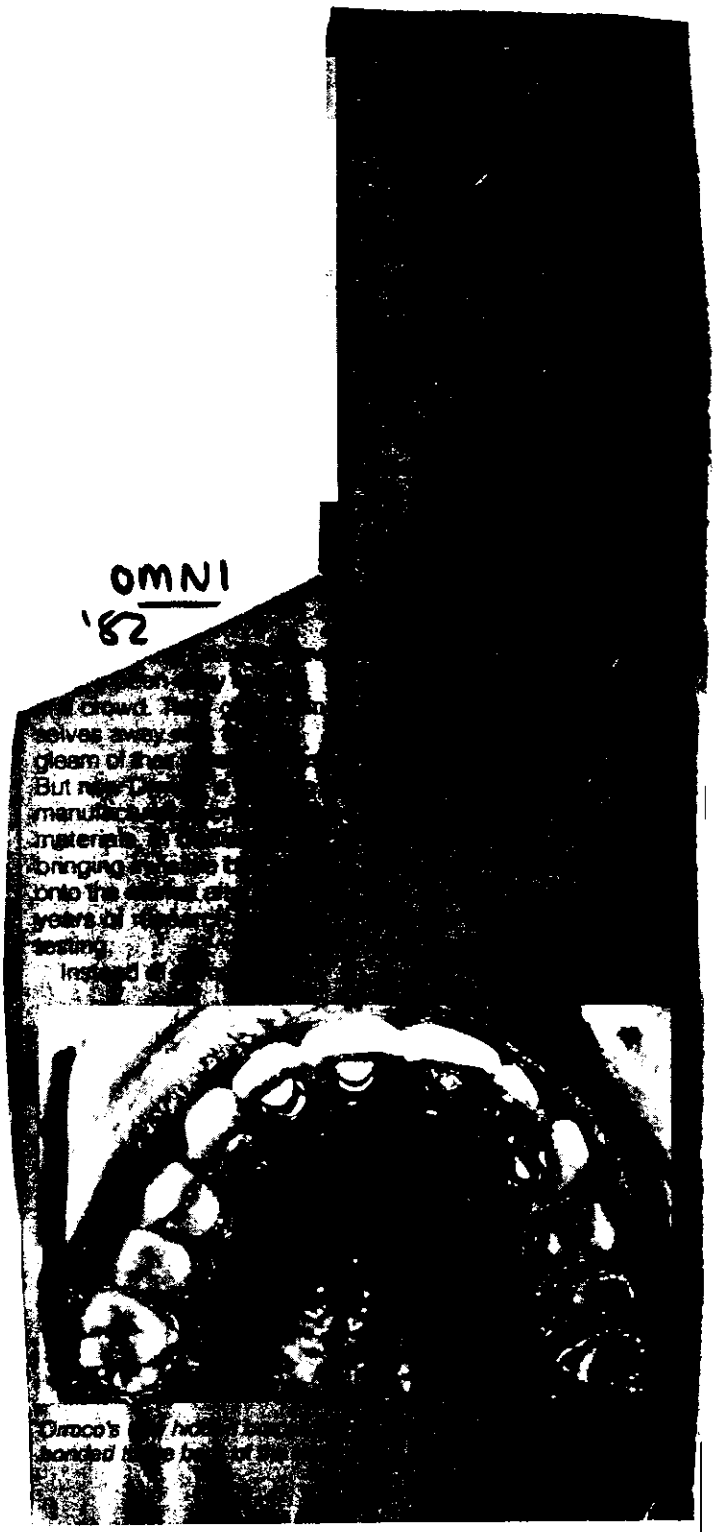
The tongue is covered with a specialized skin but it is skin and it does need to be cleaned.

Food particles coat the tongue. The surface cells die and are shed just as the skin over your body changes. Those dead cells are the common cause of coating of the tongue. The food and coating provide a fertile ground for bacteria.

Bacteria produce noxious odors. You have probably noticed that a person with a severe sore throat may have a bad odor. Infected sinuses often cause bad breath, again from the bacteria that produce the noxious chemicals. Of course all odors are not from bacteria.

It is a good idea to clean the tongue at the same time you brush your teeth.

OMNI
'82



Tom Bloom

Orthodontia

Steel Smiles To Fade Away

Invisible braces on the way

While millions of people with metallic grins grit their teeth and wait, orthodontists in Japan and the United States are furiously working to perfect "invisible" braces—wires and brackets that will cling snugly, and unobtrusively, to the back of the teeth.

Dr. Kinya Fujita, an associate professor at the Kanagawa Dental University of Japan, has already successfully hidden his own teeth-straightening device in the mouths of 40 patients. Though he proudly displayed his invention at the convention of the American Association of Orthodontists in San Francisco, the invisible braces are still experimental and not sold commercially.

Fujita tells dentists that his now-you-don't-see-'em braces are designed mostly for adult patients, who would prefer to greet business associates with a wireless grin. The appliances are also handy for athletes, Fujita claims; they cut down on the risk of injury to the mouth posed by traditional braces strapped to the outside of the teeth.

While Fujita was the first to describe the new orthodontic technique in a scientific journal, the competition is not far behind. A California company, Ormco, is trying out a similar design throughout the United States.

One orthodontist who is testing the Ormco braces expects them to be put on the market in a year. "They're still finalizing the design," he says.

Both Fujita and Ormco apply the same basic principle. A metal bracket glued to inner surfaces holds a flexible wire that "pulls" wayward teeth into line.

Though Ormco and Fujita believe they have cleared all major hurdles to manufacturing effective and comfortable hidden braces, according to an orthodontist who has closely followed the progress of the braces, the path from idea to product has been, quite literally, prickly. At first, the wires irritatingly pierced the tongue. And if not properly protected, they tended to get bent, broken or knocked off. Patients with a marked overbite had the greatest difficulty wearing the new gear. When they closed their mouths, the lower teeth sometimes bit into the barbed upper brace and dislodged it.

The "invisibility" requirement makes design "much, much harder," explains Donald Poulton, D.D.S., chairman of orthodontics at University of the Pacific in San Francisco. "It's like trying to tie shoes from the inside."

—*Erica Goode*

SALIVA CHEMICAL A CAVITY-FIGHTER

DENVER—Three Denver researchers report they have discovered a chemical found naturally in saliva that could prevent tooth cavities. Alfred J. Crowle, Janice M. Joneja and George J. Revis, researchers at the Webb-Waring Lung Institute, said they discovered the chemical while researching gum and tooth disease.

They said the chemical, one of nine antigens found in human saliva, could provide the key to why some people have cavity-free teeth, while others are susceptible to decay no matter how much they brush, floss or avoid sweets.

"Each antigen in saliva or any other body fluid has some function," said Crowle. "While studying these, we noticed that people whose teeth are resistant to dental cavities have a high level of this one component. Others who are susceptible to cavities have lower levels of this chemical or none at all."

Crowle said he and his colleagues now are working toward developing the cavity-preventing chemical synthetically.

Revis, a dentist, said the findings could have a significant impact on the practice of dentistry. "We know that some people have a natural resistance to cavities," he said. "If we could predict early who will be susceptible to cavities, we could take strong measures to prevent them."

MONEYSWORTH '80

FLUORIDE APPLIED TO TEETH FOUND SALUTARY FOR GUMS

BY PATRICIA McCORMACK

NEW YORK—A dividend seems to be developing from the widely used application of fluoride solution to control and prevent dental disease.

According to Dr. Leonard L. Zeldow of Binghamton, N. Y., topical fluoride solutions also may retard development of periodontal (gum) disease.

The value of fluoridation in decreasing dental decay has been documented for over three decades. The new studies showing its role against gum disease were described by Zeldow, who said the solutions can inhibit types of organisms and their byproducts found in the mouth.

By altering the tooth structure and decreasing metabolic activity of plaque bacteria that invade teeth and gum tissues, Zeldow said, topical fluoride solutions guarantee a large measure of protection for the gums.

Zeldow said 90 percent of periodontal breakdown is attributed to bacteria. He claims topical fluoride therapy treatments aimed at knocking out the bacterial causes of periodontal disease in many cases make surgical corrective treatment either unnecessary or secondary.

Zeldow explained that the preferred method of intensive fluoride therapy is by self-medication at home, using a tray-like gadget called a toplicator. This is custom-made to fit tightly over teeth. The dentist would instruct the patient in its use.

The tight fit helps avoid the diluting effect of saliva; it also keeps the device properly in place without necessitating that the user keep his mouth closed.

As Zeldow described the process, the fluoride is dropped in gel form in the tray. The patient is supposed to self-administer treatment once daily until recalled to the dental office. Later, applications are reduced to several a week.

The treatment also is supposed to benefit those suffering from tooth-root decay, a frequent problem in older persons. Zeldow also recommended the therapy as a preventive measure for cavity-prone teenagers and for patients with braces.

Studies have shown that children who drink fluoridated water in school have about 30 percent fewer cavities than those who drink water which is, for the most part, fluoride-free.

MONEYSWORTH

MONEYSWORTH '80

BACTERIA TO HALT ALL TOOTH DECAY?

BY DEAN REYNOLDS

WASHINGTON—There may be a great new way to fight tooth decay, for life: Just spread some bacteria all over your choppers, once.

That is the tentative finding of researchers for the National Institute of Dental Research, an agency of the National Institutes of Health. They conducted tests involving a mutant strain of the "streptococcus mutans" bacteria—the "chief bacterial suspect in tooth decay."

Dr. Jeffrey Hillman and his colleagues at the Forsyth Dental Center in Boston learned that this new mutant strain can stick to teeth and join the protective plaque on tooth crowns.

But this particular strain, discovered two years ago, produces less acid than "its decay-causing parent organism," meaning a cavity will have a harder time getting started. And unlike the parent organism, the mutant strain does not contain the particular enzyme that helps trigger the process of "demineralizing tooth enamel"—making cavities.

Laboratory rats were the guinea pigs in the testing, but researchers expect to try it on monkeys and humans soon.

In the testing to date, one group of rats was infected with the naturally produced streptococcus bacteria and another with the mutant. All were then fed a high-sugar diet for 14 weeks. Results showed the rats infected with the natural bacteria "had significantly more decay than animals infected with the mutant."

One researcher said that if the process is successful in animals, the ideal method would be to swab a culture of the mutant onto the teeth of children before they can obtain the regular streptococcus strain.

In adults, he said, virtually all of whom have the natural strain, "we would have to suppress it or eliminate it by vaccine or mouthwash, then swab the mutant strain onto their teeth."

Tests have shown the process provides the rats "virtually life-long protection against cavities." So, the researchers believe, it has "the potential for being a one-time—one-time only—application."

Laser: a death ray for tooth decay?

SALT LAKE CITY (UPI) — Laser beams may provide a permanent answer to the problem of tooth decay, a 21-year-old University of Utah researcher said yesterday.

Ceramic engineer Lygia Stewart said she may be on the track of a major dental breakthrough to provide lifetime protection against tooth decay by using a mini-laser.

She said her work shows promising results in the use of a carbon dioxide laser to permanently seal a protective compound around decay-prone chewing areas of teeth.

"Our work has progressed to the point where its feasibility can no longer be doubted," the University of Utah chemistry honors graduate said.

The goal is to provide protection for the pit and fissure areas of molars, she said. These areas are vulnerable to decay because they tend to trap food particles and are hard to clean.

Stewart said she hopes the result of her studies, funded by the National Institute of Dental Research, will be lifetime protection against tooth decay.

She has tested several hundred compounds as potential sealants in what she described as a previously untried approach to the tooth decay problem.

She said the most successful substance so far has been a white powder known as hydroxyapatite. It has proved durable and is nearly the same as tooth enamel, she said.

She said the development of a pen-sized laser has provided technology that will give results a functional instrument.

• A secret ingredient in breakfast cereal that may prevent tooth decay is being tested on 1,000 Indiana school children. General Foods, maker of Post cereals, financed the research by Dr. Joseph C. Muhler of Indiana University Medical Center. Muhler, who developed the tin fluoride formula used in Crest toothpaste, says the cereal additive is not a fluoride. It may be a phosphate —such compounds have been promising in experiments with laboratory animals.

Oral bandage

PERHAPS THE MOST DIFFICULT PLACE to bandage a wound or a surgical incision is in the mouth. The bandage must adhere to a wet surface yet produce a tight seal.

The tricky technical problem of producing such a bandage has been overcome with a combination of synthetic and natural materials. The result is a new oral bandage developed by the Squibb Institute for Medical Research, New Brunswick, N.J., and researchers at the College of Dentistry, New York University, New York.

The oral bandage is a wafer consisting of gelatin, pectin, carboxymethyl cellulose, and polyisobutylene. It has a water-impervious polyethylene plastic backing on one side and a silicone parchment release-paper protecting the tissue adhesive side.

The oral bandage absorbs moisture from the oral cavity and becomes progressively more adhesive, until, within a few minutes, it holds firmly to the tissues. The bandage can be used in oral surgery as well as in emergencies to seal off an extended area of gum or tissue.

The intraoral adhesive bandage has been tested by 148 investigators in 1,468 patients. The bandage adhered well to the fixed mucosa of the palate, gingiva, and teeth. The adhesive remained in place at least five hours in about 87% of the patients; in more than 50% of the patients, the adhesive held for nine to 51 hours.

The results of these tests, according to Squibb and NYU, indicate that the new adhesive bandage is safe and that it provides effective cover and protection of wounds and lesions of the mucous surfaces up to 24 hours.

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S.F. CHRON., SEPT. 18

An off-hand toothache remedy

MONTREAL (AP) — Toothache sufferers who can't get to the dentist right away can get relief from an ice cube, says a psychologist after conducting a study of patients here.

McGill University psychologist Ronald Melzack says the trick is not to hold the ice where you would expect to — on the tooth — but to massage it on the back of the hand on the same side of the body as the bad tooth.

Melzack says 80 percent of subjects involved in a recent study had their dental pain reduced by 50 percent or more after ice was applied in the area between the thumb and forefinger.

Melzack's study involved 22 men and 18 women aged 18 and over, chosen at random from the waiting room of a dental clinic at the Montreal General Hospital. All had abscesses or other dental problems.

Half the subjects were given skin massage only. Some were told it was was to reduce the pain, while the rest were given no explanation.

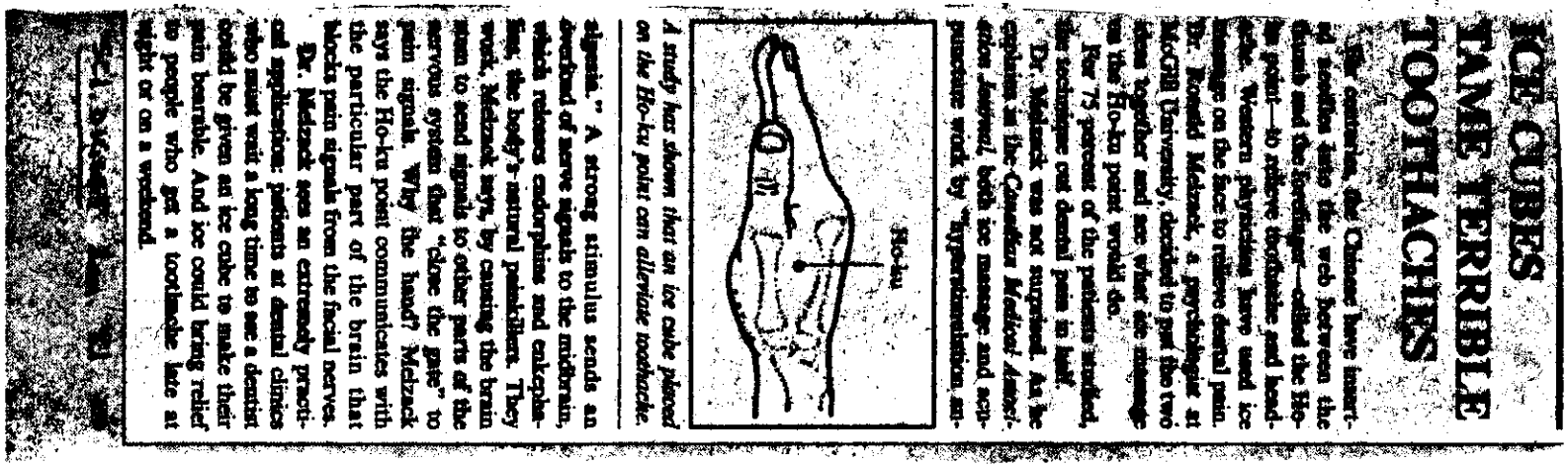
The decrease in pain produced by ice massage was found to be significantly greater than that produced by skin massage, either with or without the explanation.

Melzack said the web of the hand, or Hoku area, has long been recognized as an acupunture point by the Chinese, who have reduced toothache by twirling acupuncture needles there. Modern scientists have gotten similar results using electrical stimulation of the same area.

Acupuncture and electrical impulses hurt, he noted, and ice produces an aching or burning feeling, but none of these side effects is as painful as a toothache. The relief can last for a few minutes or several hours.

Melzack theorizes that the pain message from the hand travels up the arm and spinal cord to an area of the brain called the periaqueductal gray matter that, in turn, sends a message to another part of the brain to block the pain signals from the teeth.

The Chinese say the same method works for headache, he added, but his experiment only dealt with dental pain.



ICE CUBES TAME TERRIBLE TOOTHACHES

The ancient Chinese have inserted needles into the web between the thumb and the forefinger — called the Ho-ku point — to relieve toothache and headache. Western physicians have used ice massage on the face to relieve dental pain. Dr. Ronald Melzack, a psychologist at McGill University, decided to put the two ideas together and see what he discovered. He found that the Ho-ku point would do.

For 75 percent of the patients studied, the technique cut dental pain in half.

Dr. Melzack was not surprised. As he explains in the *Canadian Medical Association Journal*, both ice massage and acupuncture work by "hypostimulation analgesia." A strong stimulus sends an overload of nerve signals to the midbrain, which releases endorphins and enkephalins, the body's natural painkillers. They work, Melzack says, by causing the brain stem to send signals to other parts of the nervous system that "close the gate" to pain signals. Why the hand? Melzack says the Ho-ku point communicates with the particular part of the brain that blocks pain signals from the facial nerves.

Dr. Melzack sees an extremely practical application: patients at dental clinics who must wait a long time to see a dentist could be given an ice cube to make their pain bearable. And ice could bring relief to people who get a toothache late at night or on a weekend.

A study has shown that an ice cube placed on the Ho-ku point can alleviate toothache.

IPSAB-An Herbal Remedy for Gum Problems

by Tom Johnson and Carol A. Baraff

Numerous readings recommend a solution called Ipsab as a treatment for the gums and teeth. It is not known where the name originated – possibly it was coined by Edgar Cayce's source of information. In Cayce's day at least, Ipsab was not a commercial product.

Many readings prescribing it also gave directions for making it, but these formulas varied somewhat. In a few instances it is stated that the finished product should be a paste, but the majority of cases suggest a liquid. If desired, a paste may be easily made by adding salt in sufficient amounts to the liquid.

The Ipsab formula requires prickly ash bark, salt, calcium chloride, peppermint and iodine. Salt acts as an astringent, shrinking the gum membranes between the teeth so that the other ingredients can reach these areas. The primary active ingredient is prickly ash bark. This was known to the American Indians as "toothache bark," and Cayce referred to it by the same terms.

In many cases Ipsab was suggested simply for general upkeep of the teeth and gums:

Using, then for the teeth and gums, to strengthen same, those properties as found in that combination [Ipsab] as has been given for such conditions through these forces. 257-11

Some local attention [to the teeth] is needed. The natural tendency of a disturbance in the circulatory forces to the sensory organs, as indicated, is to make for a lack of the proper circulation through the gums and to the portions of the teeth themselves.

If the solution known as Ipsab is used to massage the gums occasionally, it will make for a *strengthening* of the areas and a preserving of their usefulness. Once or twice a week this would be thoroughly massaged into the gums, and will make a great deal of change in the gums and the teeth. Do that. 987-1

Do use Ipsab as a massage for the gums and it will make a great deal of difference with the teeth, the breath and the general activity. 3598-1

We would use same [Ipsab] not upon cotton, for this body, but upon the finger use it and massage; not only the gums where the teeth are but where they are not! And we will find that the stimulation to the activities of the throat itself, to the salivary glands, to even the tonsil area, will be materially aided by the activity of the combination of the calcium with the iodine in same, as well as the antiseptics that arise from the vegetable forces in same as combined with sodium chloride. 569-23

Ipsab, in diluted form, was recommended for the developing teeth of babies. The following readings were given for a one-year-old and a nine-months-old child, respectively:

Also during this period of the formation of the teeth, keep sufficient quantities of iodine in the food values for the body, as well as calcium and so forth. It will be found that a massage of the gums occasionally with those properties known as Ipsab will be helpful . . . as these processes are carried on through the activity of the thyroid operations in the body. 314-2

Q-2. Are teeth forming normally?

A-2. These are very good. We would find that a weakened solution of Ipsab for the gums would tend to relieve the pressure and make for normalcy in the salivary glands, as well as strengthening the tissue in the mouth. This should be reduced at least half, and the gums massaged with a tuft of cotton with same. This also adds to the amount of saline, calcium and iodine, for the activity of the glands in mouth and throat. 299-2

Ipsab seems to be especially effective in treatment of bleeding or receding gums and for treatment and prevention of pyorrhea. In one reading Cayce stated that some element in the prickly ash bark destroyed the germs that cause pyorrhea. Ipsab was also prescribed for trench mouth and other types of gum problems:

Q-1. What can I do about pyorrhea condition in my teeth?

A-1. Use Ipsab regularly each day and rinse mouth out when it is finished with Glyco-Thymoline. 5121-1

The receding gums and those tendencies towards pyorrhea would be allayed by the consistent use of Ipsab as a massage for the teeth and gums. Also these should be treated, some locally, with the dentist's paraphernalia [and also] – the small wads of cotton saturated with the Ipsab and applied in the areas where the conditions are indicated at the base or edge of the gums. 3696-1

This will *purify* and make for such a condition as to assist in correcting the trouble where there has been the softening of the teeth themselves – or the enamel on same. 1026-1

[redacted]: DENTAL TREATMENTS

Orthodontia

Steel Smiles To Fade Away

Invisible braces on the way

While millions of people with metallic grins grit their teeth and wait, orthodontists in Japan and the United States are furiously working to perfect "invisible" braces—wires and brackets that will cling snugly, and unobtrusively, to the back of the teeth.

Dr. Kinya Fujita, an associate professor at the Kanagawa Dental University of Japan, has already successfully hidden his own teeth-straightening device in the mouths of 40 patients. Though he proudly displayed his invention at the convention of the American Association of Orthodontists in San Francisco, the invisible braces are still experimental and not sold commercially.

Fujita tells dentists that his now-you-don't-see-'em braces are designed mostly for adult patients, who would prefer to greet business associates with a wireless grin. The appliances are also handy for athletes, Fujita claims; they cut down on the risk of injury to the mouth posed by traditional braces strapped to the outside of the teeth.

While Fujita was the first to describe the new ortho-

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(ZNS) IF YOU'RE ONE OF THOSE PEOPLE WHO REALLY NEEDS BRACES BUT CAN'T STAND THE THOUGHT OF FLASHING ALL THAT WIRE WHEN YOU SMILE, THERE'S GOOD NEWS: YOU CAN'T SEE THE LATEST TYPE OF BRACES.

LOS ANGELES ORTHODONTIST DR. RICHARD GROSSMAN HAS DEVELOPED WHAT HE CALLS "HIDDEN BRACES." THE BRACES, ACCORDING TO GROSSMAN, ARE LOCATED ON THE INNER SURFACES -- ATTACHED ON THE TONGUE SIDE -- OF THE TEETH. SAYS GROSSMAN: (QUOTE) "THERE'S NOTHING IN FRONT AT ALL, ALTHOUGH THERE ARE SOME PLASTIC ATTACHMENTS ON THE SIDE TEETH, WAY IN THE BACK OF THE MOUTH."

GROSSMAN SAYS THE BRACES ARE EASY TO GET USED TO. HE ADDS THAT THE DEVELOPMENT OF HIDDEN BRACES MAY HELP PERSUADE PEOPLE WHO HAVE BEEN HOLDING OFF ON DENTAL WORK TO TAKE CARE OF THEIR CROOKED PEARLY WHITES, ONCE AND FOR ALL. -- ZODIAC (4/9/81)

Note to Editors: Grossman can be reached at (213) 348-6883 or (213) 275-8400.

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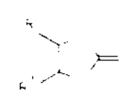
HOW IMPLOSION CAN IMPROVE YOUR SMILE

Orthodontist, Prof. Dr. Balters always disliked the orthodox methods used to straighten teeth and treat gum disorders. In his opinion, freeing the creativity and healing forces of the body is a much better solution. He consulted Schauberger in Linz, Austria to get an introduction to Implosion. Dr. Balters successfully developed the Bionator, braces made of caoutchouc which work from behind the teeth and assume the shape of the desired correction. The patient can remove the Bionator at will. It uses the implosion vacuum caused by the free flow of saliva and the suction of the gum.

140872h Composition and means for oral hygiene. D'Alelio, Gaetano F. (Doan Associates) U.S. 3,819,826 (Cl. 424 49; A 61k), 25 Jun 1974, Appl. 27[illegible], 09 Aug 1972; [illegible] pp. Dental calculus, tartar, and plaque are removed from teeth



and other portions of the oral cavity by use of a compn. contg. Me_2SO and I. Thus, the m.p. of freshly vacuum distd. ethylene carbonate (I; R = R' = H) is [illegible]. It is readily depressed to a liq. at ambient temps. by the addn. of 5% or more of compatible liquefying agents such as H_2O, EtOH, EtOAc, and $CHCl_3$. When said ethylene carbonate is placed in contact with the teeth in the oral cavity, the moisture content in the oral cavity liquefies it on contact and the so liquified material is effective in and for the dissoln. and removal control of plaque and dental calculus in the oral cavity.

S. P. Mar[illegible]