*Pharmacology Biochemistry & Behavior*, Vol. 15, pp. 663–664, 1981. Printed in the U.S.A.

# The Use of Fluoride for the Prevention of Chronic Intracranial Implant Dislodgment

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Received 19 June 1981

YAMAMOTO, B. K. AND C. L. KUTSCHER. *The use of fluoride for the prevention of chronic intracranial implant dislodgment.* PHARMAC. BIOCHEM. BEHAV. 15(4)663–664, 1981.—A procedure is described for treating the skull with an acidulated fluoride solution at the time of intracranial implantation of cannulas or electrodes. Fluoride has a stabilizing effect on the hydroxyapatite structure of bones and teeth. In our experience, fluoride treatment has reduced the incidence of dislodgment of intracranially implanted appliances.

Fluoride Intracranial implants

A USEFUL technique in experimental brain research is the chronic intracranial implantation of appliances for electrophysiological recording, electrical stimulation, drug infusions and cerebrospinal fluid sampling. Typically, the electrode or cannula is secured by a pedestal composed of dental cement adhering to the electrode or cannula, the bone of the skull and small set screws mounted in the skull. The screw heads provide an anchor around which the cement can mold [6]. Occasionally, the pedestal may become disolodged for various reasons: (a) Blood may seep beneath a portion of the pedestal, breaking the seal between cement and bone; (b) Blood seepage may lead to infection which produces softening and dissolution of bone; (c) Torque can be produced by head movements of the animal sufficient to dislodge the implant, even in the absence of infection; (d) Loss of patency of set screw placement may occur especially when screws are implanted in a thin section of the cranium.

We have found that incidence of these problems can be greatly reduced by hardening the bone with an application of fluoride at the time of implantation. Fluoride is a ubiquitous substance found to be clinically useful in medicine and dentistry because of its ability to harden teeth and bones. Original investigations found that communities with large amounts of naturally occurring fluoride in the drinking water had significantly fewer dental cavities than communities with little or no fluoride in the water [1].

Subsequent studies have elucidated the mechanism of this prophylactic action. Impact on tooth enamel was studied since the enamel is the site of most tooth decay [8]. Ninety-seven percent of tooth enamel is composed of an inorganic component comprised mainly of a crystalline compound, hydroxyapatite ($Ca_5(PO_4)_3OH$), and small amounts of carbonate, magnesium, fluoride and other trace substances [8]. Hydroxyapatite is also the inorganic component of the bone matrix and accounts for 65% of the weight of bone [5].

The cariostatic action of fluoride is produced by the substitution of the fluoride ion for the hydroxide ion of the hydroxyapatite structure resulting in the formation of fluorhydroxyapatite, a more stable compound and one more resistant to decay [1]. Fluoride acts on bone apatite in the same manner. A spherically symmetrical ion replaces a larger, asymmetrical one without disturbing the remainder of the structure. The ionic bond between fluoride and the calcium ions clustered around it is thereby shorter and more stable than is the case when the hydroxyl ion occupies this position [6]. Various studies have clinically confirmed this finding by linking high levels of fluoride in drinking water with reduced incidence of bone fractures, faster healing of fractures and decreased incidence of osteoporosis, compared to populations with low fluoride in water [9]. Consequently, fluoride has been used to treat osteoporosis with moderate success [4].

Fluoride is commercially available in three forms: sodium fluoride, stannous fluoride and acidulated phosphate fluoride. Acidulated fluoride is the most effective when a single application is used [10], possibly because the acidification produces deeper penetration of the ion and greater accumulation [3].

In view of the above actions of fluoride on bone we have used topical application of acidulated fluoride to attenuate the incidence of intracranial implant dislodgment.

## METHOD

Intraventricular cannulas were implanted in male, hooded rats bred in the Syracuse University Psychology Research Laboratory from stock obtained from Blue Spruce Farms. At the time of implantation, rats were 90–101 days old and weighed 387–470 g. The rats were anesthetized with 65 mg/kg sodium pentobarbital. A longitudinal incision was made

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through the scalp and the skull exposed and dried. Acidulated fluoride solution (Luride Phosphate, pH=3.2) was applied to the skull with a cotton swab and allowed to remain in place for approximately 2 min. Then the skull was wiped dry and a hole drilled for the cannula and the three set screws. Screws were inserted and the cannula assembly (Plastic Products, Roanoke, VA) was lowered into the brain. The cannula was cemented to the skull and screws using Plastic Products Cranioplastic cement. When the cement was dry, a scalp suture was made caudal to the implant. The animals were allowed at least 5 days for recovery prior to experimentation.

## RESULTS AND DISCUSSION

Of the 63 chronic intracranial implants performed using the acidulated fluoride solution, only one was dislodged. The term of implantation has been as long as 8 months. When fluoride was not used, approximately 15% of cannulas were dislodged.

In addition to its bone stabilizing effect, the antimicrobiol action may contribute to the prophylactic action of the acidulated fluoride solution [11]. Furthermore, evidence for the general nontoxic action of topical fluoride application is the history of safe clinical usage.

Many investigators have used plastic cages with little or no wire mesh to minimize the risk of dislodgment produced by the entrapment of the cranial appliance in the cage wire. However, we have used standard steel and hardware cloth cages. If aged rats are to be used, cranial thickness and brittleness might be of concern and thus fluoride in this case may again prove beneficial in maintaining the patency of the implant.

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