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VACUUM-MIXING OF SILICATE CEMENT

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INTRODUCTION

A silicate cement mixed by ordinary spatulation on a glass slab will — like most other highly viscous mixtures of dry powder and liquid — contain air bubbles of varying size. The bubbles are relatively small, frequently up to $50\ \mu$, rarely more than $100\ \mu$, and are usually shaped like irregular spheres. As a rule, the air bubbles cannot be seen with the naked eye, but are readily observed under the microscope at moderate magnification.

If the cement is mixed in a vacuum the total volume of air bubbles is visibly reduced, at the same time as the individual bubbles become smaller in size.

The purpose of this work is to show to what degree the porosity of a silicate cement is reduced by mixing under vacuum, and what influence such a reduction has upon selected properties of the material.

Lyon & Cosca (1967, 1968), in a study of vacuum-mixed silicate cements, were the first to demonstrate that vacuum-mixing reduced the porosity of the cement. They further stated that vacuum-mixed cement has a shorter setting time, is more translucent, and less soluble in water, citric acid, and artificial saliva.

MATERIALS AND METHODS

The test specimens were prepared from Silicap powder (batch No. b.057) and Silicap liquid (batch No. 661D) supplied by Etablissement Vivadent,

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27 pairs of permanent contralateral teeth from young patients, to be extracted for orthodontic reasons were used. Uniform cavities, 2 mm in diameter and about 2.5 mm deep were prepared in the intact buccal surfaces. The preparation technique was standardised and the cavities were made as uniform as possible. After preparation of the cavities in each pair, the cavity to be insulated with the liner containing diiodide dithymol and the fluorine salt (A¹) hereafter called was decided by lot. The cavity was rinsed with water, dried with cotton pellets and an air blast for 5 seconds. A drop of the liner was deposited in the cavity and immediately blown out with compressed air. A second drop was then applied to the cavity and allowed to evaporate in order to secure a relatively thick film, since the purpose of the investigation was, above all, to find out whether the liner itself had any irritating effect. The barely discernible film deposited on the outer margin of the cavity was not removed. The cavity in the contralateral tooth was dried and insulated in the same way with the other liner which did not contain the diiodide dithymol and the fluorine salt (hereafter called B²). In 18 pairs of teeth the cavities were then filled with amalgam, condensed with a hand instrument and the teeth were extracted one month later. In the remaining 9 pairs of teeth the cavities were filled with silicate cement and extracted one week later. The amalgam and the silicate cement were handled and placed into the cavities in as uniform a manner as possible.

The teeth were fixed in formalin, decalcified and cut in serial sections through the middle of the cavity and the corresponding pulp, with about 100 sections per tooth, and stained with Htx-eosin. The sections of the pulp were evaluated without knowledge of which liner had been used.

The above experimental principles have been used in previous investigations by the authors and have recently been commented upon elsewhere (*Brännström & Nyborg, 1969*).

RESULTS

During the clinical work it was found that liner B, but not liner A, had a tendency to crack during the evaporation period.

The distance between the pulp and the cavity was measured in those sections where the floor of the cavity was nearest the pulp. The wall that sepa-

¹) *Liner A*

Calcium hydroxide	5 parts
Zinc oxide	5 parts
Polystyrene	2 parts
Calcium monofluorophosphate	2 parts
Diiodide dithymol	1 part
Chloroform	ad 100

²) *Liner B*

Calcium hydroxide	5 parts
Zinc oxide	5 parts
Polystyrene	2 parts
Chloroform	ad 100

Table I.
Amalgam fillings insulated with liners A and B

No.	Tooth	Liner	Distance to the pulp (mm)	Pre- dentine	Odontoblast reduction	Exudate cells
1	+4	B	0.4			
	4+	A	0.4			
2	+4	B	0.3	Widened	Slight	A few lymphocytes cervically
	4+	A	0.12	Widened	Slight	
3	4+	A	0.6			
	+4	B	0.6			
4	4+	A	0.2			
	+4	B	0.4			
5	4+	B	0.4	Reduced	Marked	
	+4	A	0.2	Reduced	Marked	
6	5+	A	0.13			
	+5	B	0.13			
7	4+	B	0.13			
	+4	A	0.3			
8	4+	A	0.25			
	+4	B	0.12		Slight	
9	4+	A	0.10			
	+4	B	0.08			
10	4+	A	0.10		Slight	
	+4	B	0.15		Slight	
11	4+	A	0.15			
	+4	B	0.15			
12	4+	B	0.2			
	+4	A	0.35			
13	5+	B	0.12		Marked	
	+5	A	0.08		Marked	
14	4+	A	0.06			
	+4	B	0.08		Marked	A few lymphocytes (necrosis locally)
15	+4	B	0.48			
	4+	A	0.30			
16	4+	A	0.09		Slight	
	+4	B	0.06	Reduced	Slight	
17	4—	B	0.22			
	—4	A	0.09	Reduced	Slight	
18	4—	B	0.13		Slight	
	—4	A	0.25	Reduced	Slight	

Table II.
Silicate cement fillings insulated with liners A and B.

No.	Tooth	Liner	Distance to the pulp (mm)	Pre- dentine	Odontoblast reduction	Exudate cells
19	4+	A	0.19		Slight	
	+4	B	0.14			
20	4—	A	0.21		Slight	
	—4	B	0.16			
21	4+	A	0.04		Slight	A few leucocytes and lymphocytes cervically
	+4	B	0.14			
22	4—	B	0.21			
	—4	A	0.24			
23	4+	B	0.34		Slight	
	+4	A	0.50		Slight	
24	5+	A	0.20		Marked	
	+5	B	0.12			
25	4+	B	0.27		Slight	A few leucocytes
	+4	A	0.17		Marked	
26	4+	A	0.09		Slight	
	+4	B	0.13		Slight	
27	4+	B	0.27		Marked	A few leucocytes and lymphocytes
	+4	A	0.23		Slight	

rated the cavity from the pulp was usually thin and was fairly equal in the teeth of every pair. The distance varied between 0.6 and 0.04 mm, mean 0.20 mm (Tables I and II). Only changes in that part of the pulp corresponding to the cavity were considered.

Cavities filled with amalgam (18 pairs of teeth). The most severe injury observed in one tooth only, was a small area of necrosis of the pulp corresponding to the cavity. Around this necrotic nidus the tissue was infiltrated with disintegrated erythrocytes and with giant cells. Only a few inflammatory cells could be observed elsewhere in this pulp. The distance to the pulp was 0.08 mm and liner B had been used. No changes could be observed in the contralateral tooth, where the thickness of the dentine was roughly the same and where liner A had been used.

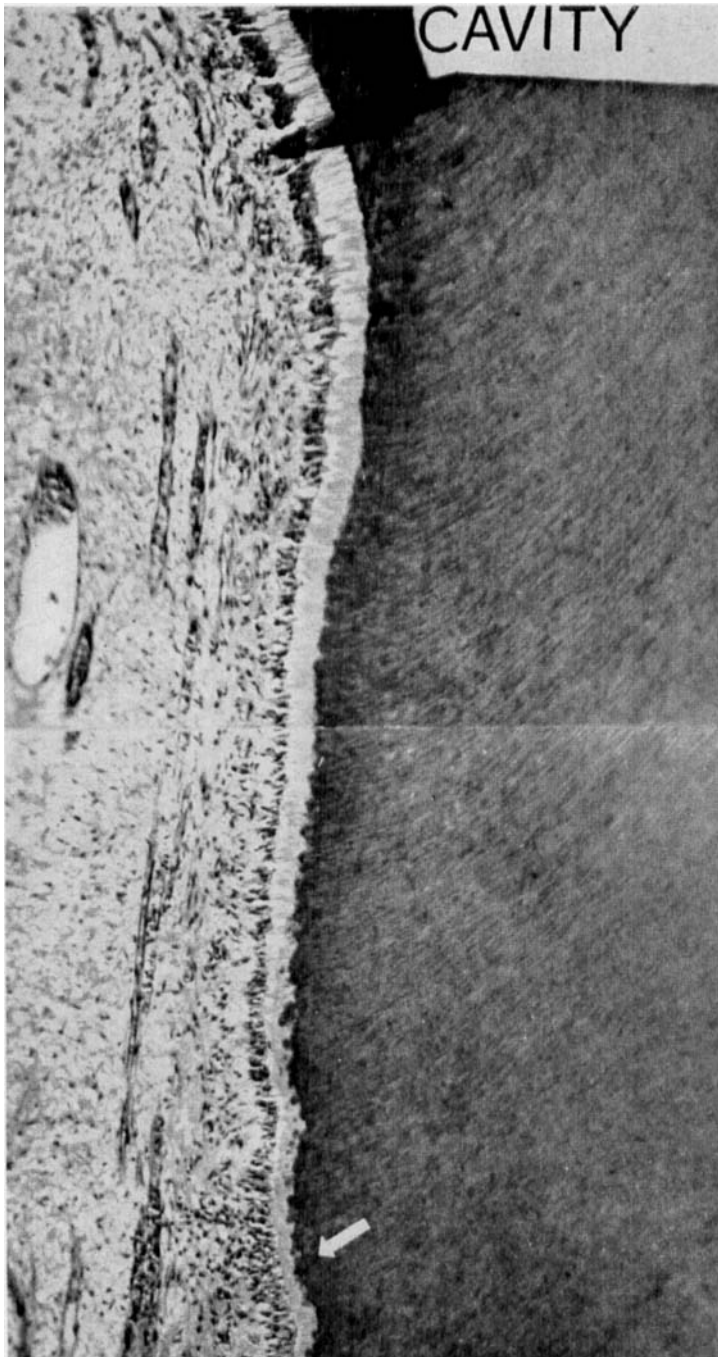


Fig. 1. No. 2., 4+ Liner A. Amalgam filling. Part of the pulp and the cavity. A few lymphocytes (arrow) corresponding to the cervical outer part of the cavity. The arrow also indicate the direction of the dentinal tubules. (Hematoxylin-eosin, $\times 100$).

The injury next in order of severity was an insignificant infiltration of lymphocytes in the area corresponding to the cervical outer part of one cavity, which had been insulated with liner A (Fig. 1). The least significant damage was reduction of the odontoblast layer, which occurred in both teeth of 6 pairs, in the teeth insulated with liner B in two pairs, and in the tooth with liner A in one pair. In 9 pairs no reduction of the number of odontoblasts was seen in either of the teeth (Table 1).

Cavities filled with silicate cement (9 pairs). In 2 pairs there was slight infiltration of leucocytes and lymphocytes corresponding to the cavities insulated with liner B. In one of these cases the infiltration corresponded to the cervical outer part of the cavity. In one pair a slight infiltration was seen under liner A. A reduction in the number of odontoblasts was noted in both teeth in 4 pairs, in the tooth that had been insulated with liner B in one pair and in the tooth insulated with liner A in 3 pairs. In one pair there was no reduction of odontoblasts in either of the teeth (Table 2).

DISCUSSION

With the two liners used and whether amalgam or silicate cement had been applied or not the various pairs of teeth did not differ in the occurrence of cellular infiltration or reduction in the number of odontoblasts. Two cases with cellular infiltration confined only to an area corresponding to the cervical outer border of the cavity were not considered to be ascribable to irritation by the liner or the filling material. A leakage between the filling and the wall of the cavity or from a crack in the enamel at the margin of the cavity might have been responsible for the cellular infiltration in these 2 cases.

The commonest finding was a reduction in the number of odontoblasts. The dehydrating effects of the preparation and of the air stream as well as of the filling material may have contributed to the reduction by aspiration of odontoblasts (*Brännström, 1968*).

Judging from the investigation, both types of liners used may be regarded as inert and offering good protection also when used in deep cavities. The addition of the fluorine salt and diiodide dithymol seems to have no irritating effect. The few and insignificant injuries observed and partly presumably ascribable to biological variation could not be regarded as signs of serious injury to the pulp or as a consequence of irritation by the liners *per se*. There was, however, one case with necrosis in the pulp corresponding to the cavity and where surrounding tissue was infiltrated of disintegrated erythrocytes and where also giant cells were present. The histological picture offered no explanation for this necrotic area.

SUMMARY

Uniform cavities were prepared in the intact buccal surfaces of 27 pairs of permanent contralateral teeth. After preparation of a pair it was decided by lot which cavity should be insulated with a liner composed by Zander *et al.* (1950) and which should be insulated with the same liner but with an addition of a fluorine salt (CaFPO_3) and diiodide dithymol (Tubulitec®).

Intra individual comparison of the two pulps of each pair was made in order to find out whether one or the other of the two liners gave better protection of the pulp and whether the addition of the fluorine salt and diiodide dithymol had any irritating effect. In 18 pairs the insulated cavities were filled with amalgam and in 9 with silicate cement. The teeth with the amalgam fillings were extracted after one month and those with silicate cement after one week.

No significant difference was found in the reaction of the pulp whether one or other of the two liners had been used and whether the cavities had been filled with amalgam or silicate cement. Both the liner composed by Zander and co-workers, and Tubulitec® were judged as offering good protection when used in deep cavities and as producing no irritation *per se*. The few and negligible changes observed could not be regarded as manifestations of an irritating effect of diiodide dithymol and fluorine in Tubulitec®.

RÉSUMÉ

COMPARAISON ENTRE LES EFFETS DE DEUX SUBSTANCES POUR ISOLEMENT DE CAVITÉS

Des cavités ont été préparées de manière uniforme sur les faces vestibulaires intactes de 27 paires de dents contro-latérales permanentes. Après préparation de chacune des paires, un tirage au sort a permis de choisir la cavité devant être isolée au moyen d'un produit composé par Zander *et al.* et la cavité devant être isolée au moyen du même produit auquel était ajouté un sel de fluor (CaFPO_3) et du diiodide dithymol (Tubulitec®).

Une comparaison intra-individuelle des deux pulpes de chacune des paires a été effectuée afin de déterminer si l'un des deux produits donnait une meilleure protection de la pulpe que l'autre, et pour déterminer si l'addition du sel de fluor et du diiodide dithymol avait une action irritante. Dans 18 des paires, les cavités isolées ont été obturées à l'amalgame et dans les 9 autres paires, avec du ciment au silicate. Les dents obturées à l'amalgame ont été extraites au bout d'un mois et les dents obturées au silicate au bout d'une semaine.

Aucune différence significative n'a été trouvée en ce qui concerne la réaction de la pulpe suivant le produit utilisé pour isoler la cavité ni suivant que l'obturation ait été faite à l'amalgame ou au ciment au silicate. Il est apparu que le produit composé par Zander et ses collaborateurs et le Tubulitec® donnent tous deux une bonne protection lorsqu'on les utilise dans des cavités profondes et qu'ils n'agissent pas eux-mêmes comme irritants. Les modifications observées, négligeables et peu nombreuses, ne pouvaient être considérées comme résultant d'une action irritante du diiodide dithymol du fluor contenus dans le Tubulitec®.

ZUSAMMENFASSUNG

DIE EINWIRKUNG ZWEIER VERSCHIEDENER »LINER« AUF DIE PULPA

An 27 permanenten kontralateralen Zahnpaaren wurden an den intakten Buccalflächen gleichgestaltete Kavitäten präpariert. Nach der Präparation eines Zahnpaares wurde durch Auslosen bestimmt, welche Kavität mit dem »liner« nach Zander und Mitarbeitern (1950) isoliert wurde. Die andere Kavität wurde mit dem gleichen »liner« jedoch mit einem Zusatz eines Fluorsalzes und diiodid-dithymol (Tubulitec®) isoliert. Um festzustellen, welcher »liner« am besten schützte und ob durch den Zusatz von Fluor und diiodid-dithymol eine irritierende Wirkung vorlag, wurden innerhalb eines jeden Zahnpaares die Pulpen intraindividuell morphologisch untersucht. Bei 18 Zahnpaaren wurden die isolierten Kavitäten mit Amalgam, bei 9 Paaren mit Silikatcement gefüllt. Die mit Amalgam gefüllten Zähne wurden nach einem Monat die mit Silikatcement gefüllten nach einer Woche extrahiert.

Ein signifikanter Unterschied betreffend der Pulpreaktion zwischen den beiden »liner« konnte weder bei Verwendung von Silikatcement noch bei Verwendung von Amalgam festgestellt werden. Beide »liner« wurden als gewebefreundlicher und effektiver Schutz, auch in tiefen Kavitäten, beurteilt. Die wenigen und unbedeutenden Veränderungen, die beobachtet wurden, konnten nicht als gewebeirritierender Effekt des Fluors bzw. diiodid-dithymol gedeutet werden.

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