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Experimental studies of Tetric Ceram composite material and Syntac Sprint bonding system applied to dental pulp and hard tissues in rats

Badania doświadczalne materiału kompozytowego Tetric Ceram i systemu wiążącego Syntac Sprint na miazgę i tkanki twarde zębów u szczurów

Tetric Ceram is a light cured composite material used for filling of cavities in front and lateral teeth. It belongs to a generation of materials manufactured using state of the art technology. Usage of these materials with modern bonding systems allows for more efficient preparation of dental hard tissues, removal of only the dentine altered by caries and extends the time of filling retention in the mouth (2, 6, 10, 11, 13).

Tetric Ceram belongs to a group of hybrid materials containing microfiller, which gives it good gloss and smoothness, as well as high cosmetic value. Good adhesiveness of the material does not allow for creation of marginal fissure and microleak. Additionally Tetric Ceram material has the ability to release fluoride ions. The sources of fluorine are: ytterbium fluoride and fluorine–barium–aluminium–silicon glass. Concentration of fluorine released from Tetric Ceram material is comparable to the concentration emitted by compomers (7, 8, 10). Binding system designed to be used with Tetric Ceram material is Syntac Sprint. The purpose of application of the new generation of indirect binding systems is to increase adhesion of material to enamel and dentine. Clinical examinations suggest that modern bonding systems can be efficiently used as materials for direct pulp coating. It was observed that these materials can perform the function of a base, similar to previously used cements and varnishes. The influence of toxic effect of modern composite materials and their bonding systems on dental pulp has not been explicitly explained and the results presented by authors of various studies are not always identical (6, 7, 8, 10, 11, 12, 13).

The purpose of this study was evaluation of the influence of Tetric Ceram material and Syntac Sprint bonding system on dental pulp in rats and the adhesiveness to the hard tissues of teeth.

MATERIAL AND METHODS

The experiment was performed on animal subject – 20 rats of the Wistar breed aged 6 weeks and weighing 40–150g coming from an animal-breeding laboratory in Warsaw. The rats went through a mandatory one-week quarantine period in order to adapt themselves to new surroundings. The Ethical Commission on Research Using Animals has approved the study. Each animal received a premedication of ketamine hydrochloride (100 mg/ml) administered intramuscularly in the dose of 10 mg per 1 kg of body weight. In order to improve the anaesthetic effect Promasine was also administered subcutaneously in the dose of 2 mg per 1 kg of body weight (14).

Class V cavities according to Black's classification were drilled in the rats' lower lateral incisors corresponding to deep caries criteria. The cavities were as deep as the pulp denudation point. Pulp denudation was from 1 to 1.5 mm in diameter. The cavities preparation was performed with sterile diamond burs using water and air cooling. The cavities were washed with 0.9% NaCl and tried with sterile cotton swabs. Tetric Ceram material and Syntac Sprint bonding system were used as fillers.

The surface of enamel and dentine were etched with 37% phosphoric acid for 15 seconds, which was subsequently washed with water and dried with compressed humidity and oil free air. After isolating the cavity with cotton swabs Syntac Sprint was applied to the etched dental tissues using a disposable brush and delicately rubbed in into dentine for about 10 seconds. After waiting for 15 seconds the excess of the material was removed with gentle stream air. Then thin layer of Tetric Ceram was applied and hardened with Helilux polymerising lamp emitting visible light of 400–500 nm wave length for 40 seconds (6, 7, 8, 12). The control group consisted of healthy undrilled teeth – mandibular incisors.

Two observation periods were adopted for Tetric Ceram and Syntac Sprint: the first observation period lasted 72 hours and the second one 168 hours from the time of material application. The animals were put to sleep using ether. The studied teeth were extracted from the tooth sockets and cut along their long axis with a diamond bur. Then the teeth were preserved in formaline for 7 days after which ultrastructural tests of tooth tissues were performed in a scanning electron microscope (SEM) (1, 3, 4, 5, 9).

The study material for the scanning electron microscope examination was prepared through initial preservation with 4% glutaric aldehyde in a phosphoric buffer of pH of 7.4 for 3 hours. Then the examined fragments were dehydrated in methyl alcohol of increasing concentration from 30% to 100%.

The preparations were dried in the temperature of 30°C in liquid carbon dioxide in the pressure of 60 atmospheres. The dried preparations were sprinkled with gold powder in an UNIMED Sputter Coaters CS 100 vacuum sprinkler. The obtained preparations were viewed through the TESLA BS300 scanning electron microscope magnified 100 to 600 times. Photographic documentation consists of 10 black and white pictures.

RESULTS

Observation of dental pulp condition and adherence of studied material to hard tissues of rats teeth after 72 hours:

Figure 1 shows adhesion of Tetric Ceram material to teeth surface. In Figure 2 the dental canal with denuded pulp can be seen. Between the dentine and pulp there is a tissue of dentine structure but lower density resembling reparation dentine. Its presence is an evidence of efficient protective activity

Fig. 1. Tetric after 72 hours – visible appiled Tetric material (T)
on the tooth surface in the vicinity of incisal edge Enamel (S)

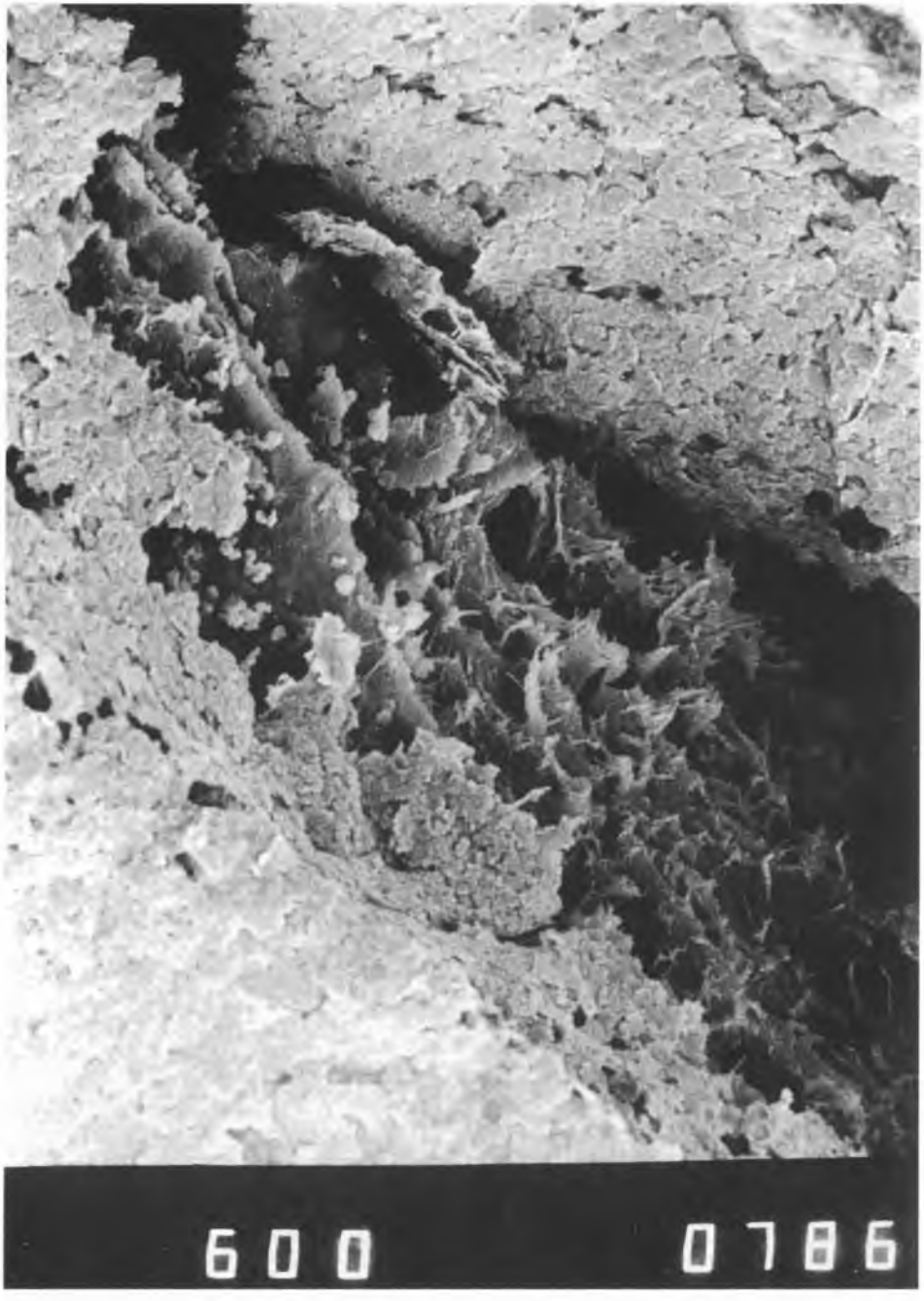

Fig. 2. Tetric after 72 hours – visible pulp in tooth canal, between dentine (Z) and pulp (M) there is a thin lamellar structure of lower density compared to dentine – reparatory dentine (B)

Fig. 3. Tetric after 72 hours – proper dental pulp. Odontoblasts (O) with visible Tomes' fibres (W), which penetrate into dentine canaliculi

Fig. 4. Tetric after 168 hours – Tetric material (T) applied.
Visible marginal adhesion of the material to enamel (S)

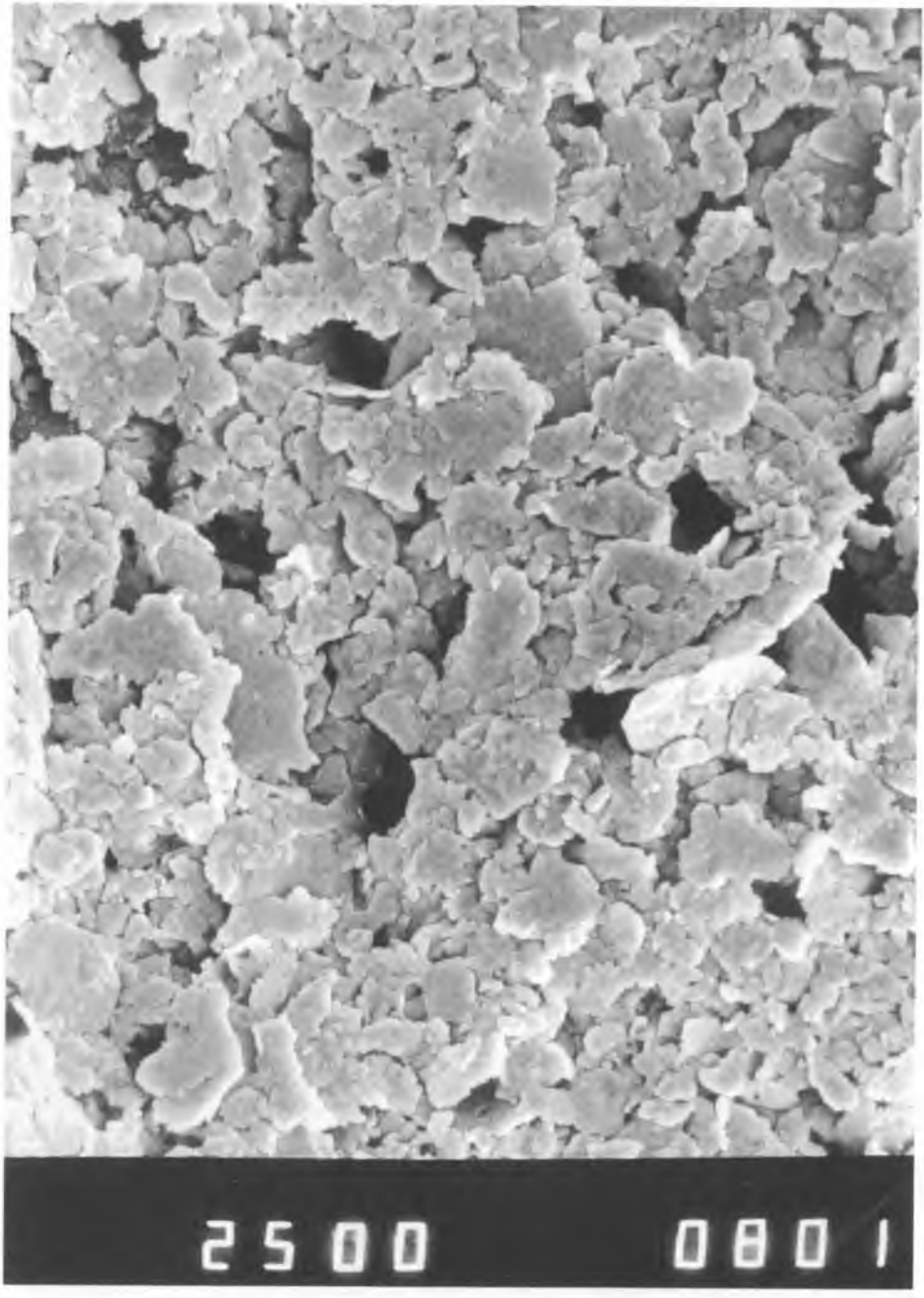

Fig. 5. Tetric after 168 hours – lamellar structure of thin layer between dental pulp and dentine–reparatory dentine

Fig. 6. Tetric after 168 hours – tooth canal. Inlying you can see an odontoblast (O) with Tomes' fibres (T)

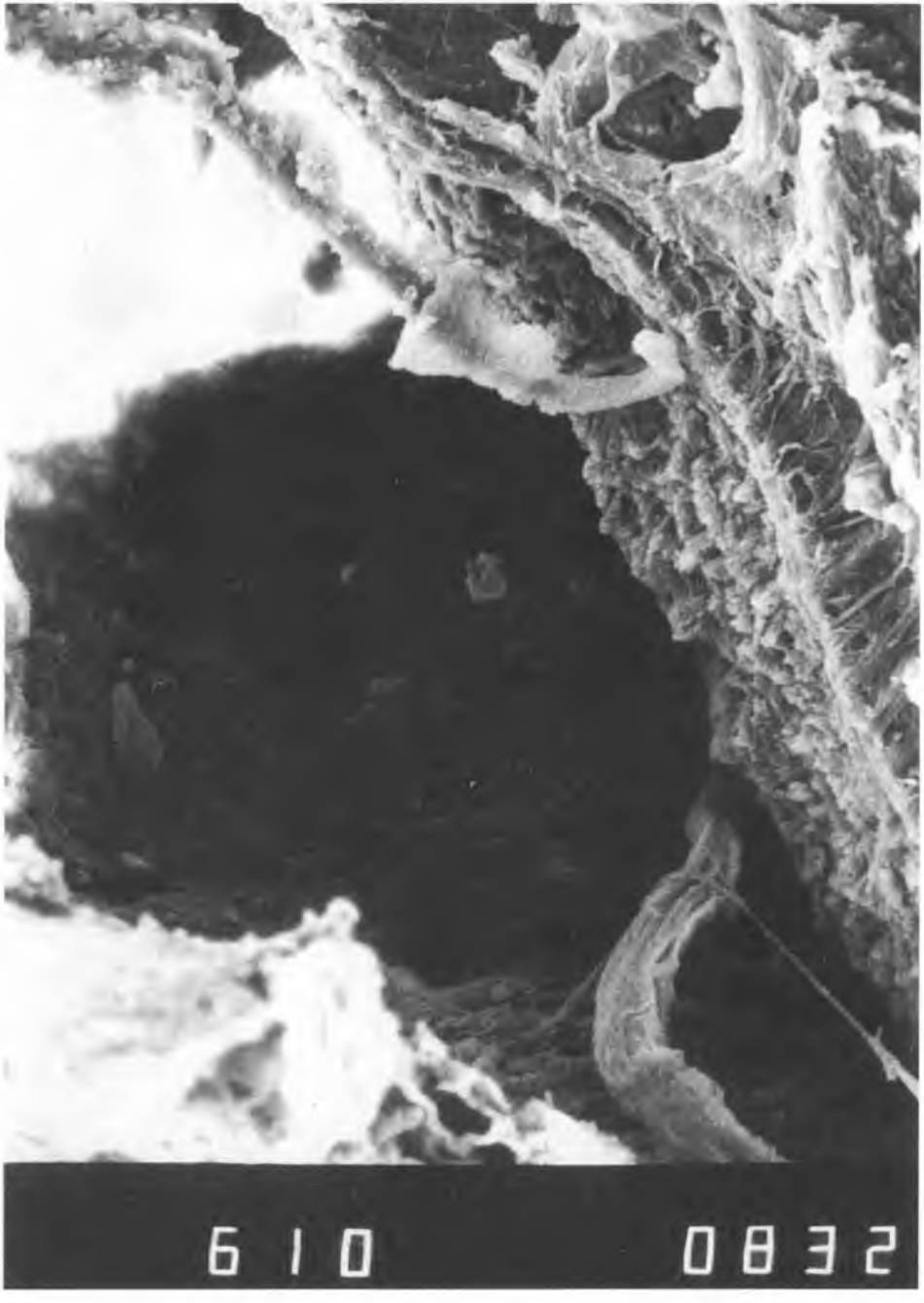

Fig. A. Control group. Dental pulp. Visible pulp cells – odontoblasts (O) and Tomes' fibres

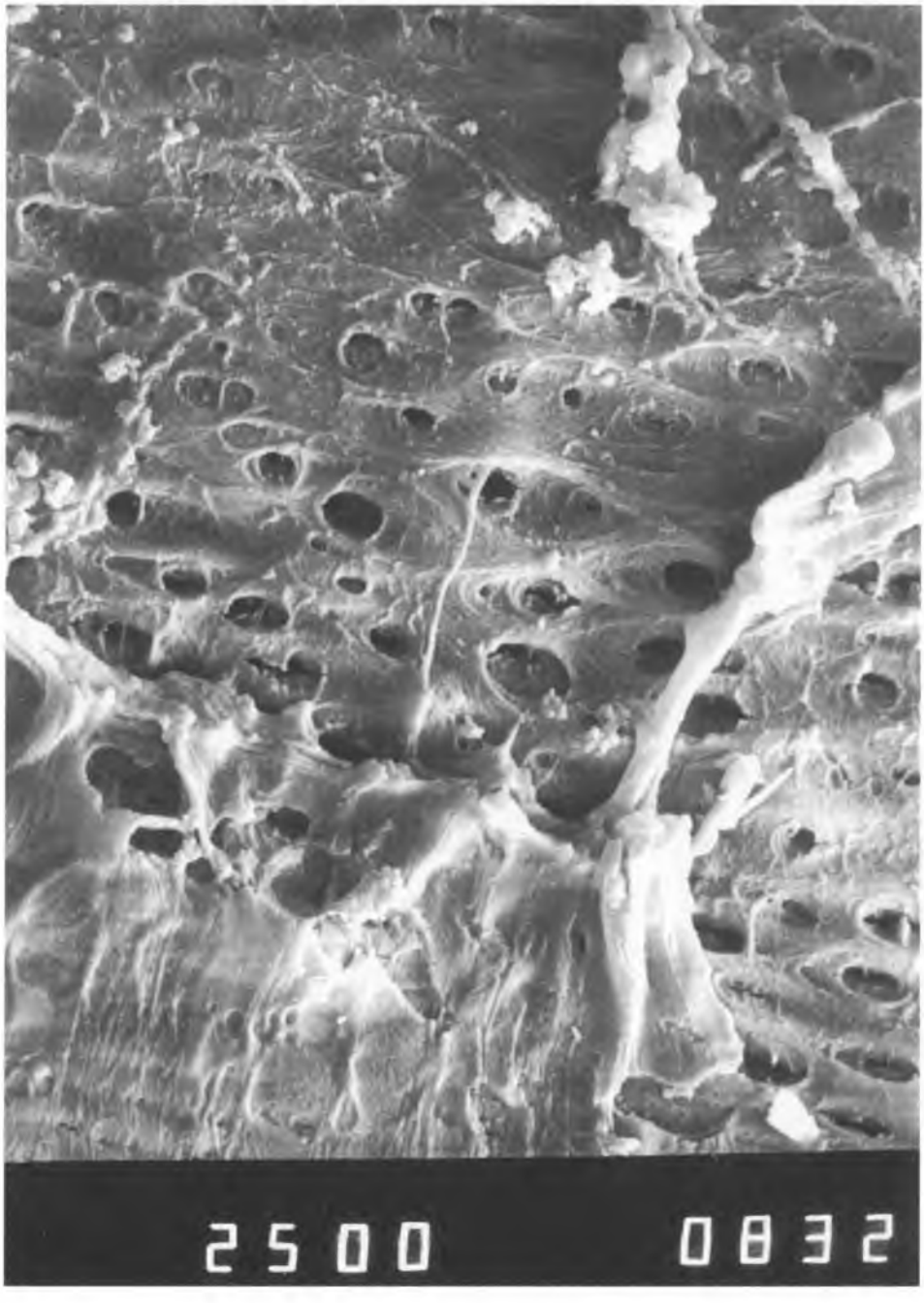

Fig. B. Control group. Dentine canaliculi outlets (K),
dental pulp cells – odontoblasts (O)

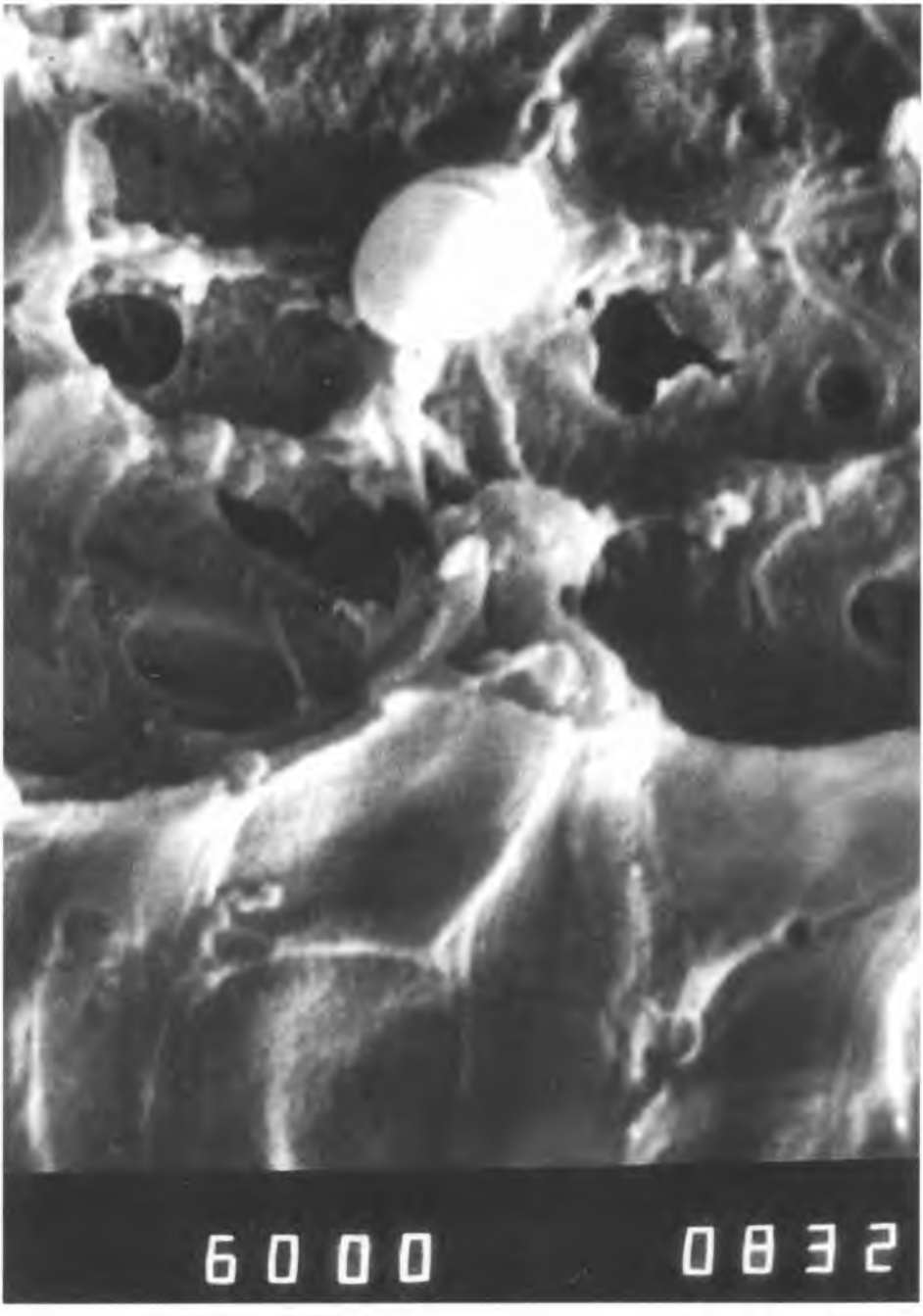

Fig. C. Control group. Dental pulp cells – odontoblasts (O)
with Tomes' fibres (W)

from odontoblasts. In Figure 3 we can observe dental pulp structure. Odontoblasts and their Tomes' fibres, which penetrate into the dentine canaliculi, should be noted.

Observation of dental pulp condition and adherence of studied material to hard tissues of rats teeth after 168 hours:

In Figure 4 we can observe adhesion of the material to the teeth surface. The place of precise adhesion between the two structures can be seen. Figures 5, 6 show dental pulp cells – odontoblasts with Tomes' fibres. Figure 5 shows lamellar structure created between dental pulp and dentine – reparatory dentine.

Control group consisted of healthy undrilled teeth. Figures A, C, D show a control tooth pulp structure, odontoblasts with Tomes' fibres.

CONCLUSIONS

Experimental studies allowed for confirmation of: good marginal tightness between Tetric Ceram material and dental tissues, good cohesion and adhesion of the material, lack of negative influence of direct application of Syntac Sprint and then Tetric Ceram on the structure of dental pulp cells, speed and simplicity of working with the material.

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STRESZCZENIE

Badano wpływ materiału Tetric Ceram i systemu wiążącego Syntac Sprint na miazgę i tkanki twarde zęba u szczurów. Obserwowano przyczepność, adhezję oraz szczelność brzeżną materiału w mikroskopie elektronowym skaningowym (SEM). Badania przeprowadzono po 72 i po 168 godzinach od momentu założenia wypełnienia. Z badań wynika, że materiał Tetric Ceram oraz system wiążący Syntac Sprint nie wpływa negatywnie na miazgę zęba szczura. Materiał Tetric Ceram charakteryzuje się dobrą przyczepnością, adhezją i szczelnością brzeżną.

	Figure	Picture No.	Magnification	Description
GROUP I	1	0789	61	Tetric after 72 hours – visible applied Tetric material (T) on the tooth surface in the vicinity of incisal edge. Enamel (S)
	2	0786	600	Tetric after 72 hours – visible pulp in tooth canal, between dentine (Z) and pulp (M) there is a thin lamellar structure of lower density compared to dentine – reparatory dentine (B)
	3	0788	2000	Tetric after 72 hours – proper dental pulp. Odontoblasts (O) with visible Tomes' fibres (W), which penetrate into dentine canaliculi
GROUP II	4	0802	100	Tetric after 168 hours – Tetric material (T) applied. Visible marginal adhesion of the material to enamel (S)
	5	0801	2500	Tetric after 168 hours – lamellar structure of a thin layer between dental pulp and dentine – reparatory dentine
	6	0798	5000	Tetric after 168 hours – tooth canal. Inlying you can see an odontoblast cell (O) with Tomes' fibres (T)
CONTROL GROUP	A	0832	610	Control group. Dental pulp. Visible pulp cells – odontoblasts (O) and Tomes' fibres
	C	0832	2500	Control group. Dentine canaliculi outlets (K), dental pulp cells – odontoblasts (O)
	D	0832	6000	Control group. Dental pulp cell – odontoblast (O) with Tomes' fibres (W)