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HISTOMORPHOLOGICAL REACTION OF THE TEETH AND PARODONTIUM TO DRILLING BENEATH A METAL–CERAMIC CROWN

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Metal–ceramic crowns are the most functional, esthetic, biologically inert, yet sufficiently strong type of fixed dental prostheses [1, 3, 5, 7]. However, when the tooth is drilled under this type of artificial crown, there is much more abrasion of the hard tissues than under a metal crown.

No information could be found in the accessible literature on the histochemical and neurohistological reaction of the teeth and parodontium to drilling beneath a metal–ceramic crown, despite its great scientific and practical importance. The aim of the investigation described below was to study this problem.

EXPERIMENTAL METHOD

Experiments were carried out on 36 mongrel dogs with an intact maxillodental system and aged between 10 months and 2 years. In each dog three teeth were drilled with an electric drill, the bit of which revolved at a speed of 10,000 rpm, beneath metal–ceramic crowns: with no projection, with a cervical projection on the vestibular and occlusal surfaces, and with a circular projection. The hard tissues of the teeth were drilled under morphine-thiopental anesthesia, using the standard technique and cooling the tooth with water while it was being drilled. The animals were killed under morphine-thiopental anesthesia by exsanguination through the femoral artery immediately after the operation and also after intervals of 1 h and 1, 3, 7, 14, 21, 28, and 35 days. The teeth and the parodontal tissues were fixed in 10% neutral formalin solution (18 dogs) and in Shabadash's fluid (18 dogs). Fragments of the jaw with the teeth were decalcified in a 25% solution of Trilon B. The teeth and parodontal tissues of 10 dogs not undergoing the procedures served as the control. Sections through the teeth and parodontal tissues were stained with hematoxylin and eosin and by Van Gieson's method and impregnated with silver nitrate by the Bielschowsky–Gros and Rasskazova methods. Sections through the pulp were stained for RNA by Brachet's method, for glycogen by Shabadash's method, and for acid mucopolysaccharides by Steedman's and Hale's methods. The enzyme-chemical control consisted of incubation of the sections with bovine ribonuclease, amylase, and bacterial hyaluronidase.

EXPERIMENTAL RESULTS

Unlike the teeth of the control dogs, many of the small blood vessels of the capillary and aterial network of the crown pulp of the drilled teeth in dogs killed immediately after drilling were sharply dilated and congested with blood. Intensification of the pattern of the precapillary and capillary network of the odontoblastic and subodontoblastic layers was observed, and it was denser because of dilatation of the functioning vessels and filling of the reserve vessels with blood. The nerve endings and fibers of the subodontoblastic plexus, preterminal and terminal branches of the perivascular nerve fibers of the crown pulp of the tooth, and axons of most of the large-caliber myelinated and unmyelinated nerve fibers of the crown and central layers of the root pulp were thickened, hyperargentophilic, irregular in outline, and possessed many varicose expansions, circular, oval, or fusiform in shape. Morphological changes affected both the freely lying nerve fibers and those contained in bundles and trunks. In the same bundle some axons were in a state of irritation, others preserved their normal structure. This confirms data in the literature on the existence of more or less resistant nerve fibers [2, 4, 6]. The terminal branches and axons of some nerve fibers in the periapical region of the parodontium of the alvelus and of the alveolar septa were uniformly and strongly impregnated with silver, with uneven outlines and with numerous varicose expansions (Fig. 1). The intensity of staining of both nucleolar and cytoplasmic RNA and of glycogen was appreciably

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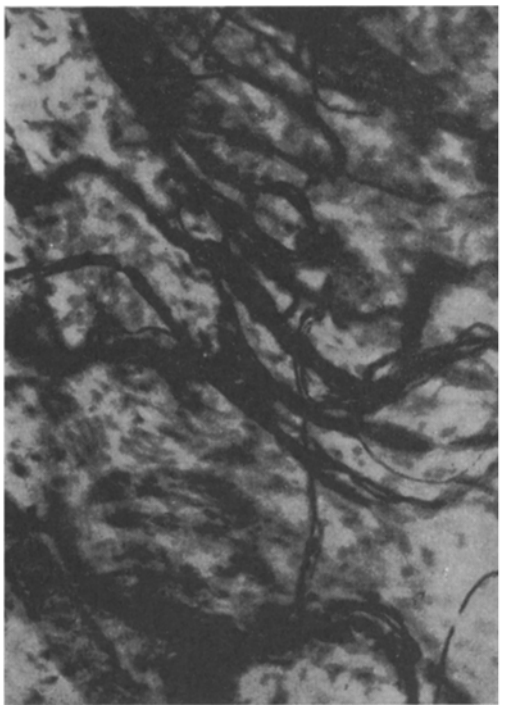

Fig. 1

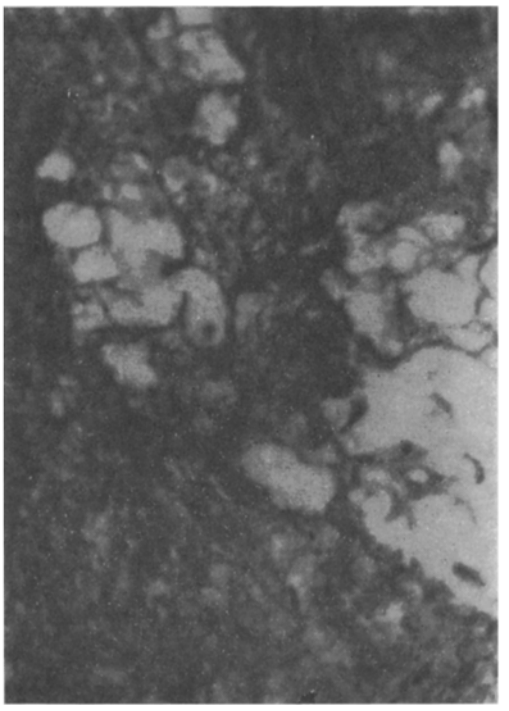

Fig. 2

Fig. 1. Hyperargentophilia, unevenness of outlines, and varicose expansions in axons of parodontal nerve fibers. Bielschowsky–Gros silver impregnation, 400 X.

Fig. 2. Reticular atrophy of crown pulp of tooth. Hematoxylin and eosin, 400 X.

increased in the odontoblasts and also in the walls of the blood vessels in reactions for glycogen and hyaluronic acid.

The layer of odontoblasts 1 h after the operation became loose in places. Marked congestion and variation in diameter appeared in the capillaries, arteries, and veins of all calibers in the crown and root pulp. The character of the neurohistological and histochemical changes in the pulp, parodontium, and alveolus was exactly the same as that described above, but in many thick myelinated nerve fibers signs of irritation were expressed as uneven impregnation of the axons and pooling of the axoplasm.

Changes in the blood vessels of the pulp 1-3 days after the experiment were more marked than at the times of the earlier observations. Many veins were bead-like in appearance because their lumen in some parts was filled with blood cells, indicating the development of stasis. Impregnation of the argyrophilic walls of the blood vessels was disturbed. Some vascular membranes were hyperargentophilic, others hypoargentophilic with indistinct outlines. Hemorrhages were noted in the connective tissue surrounding the capillaries of the crown pulp. Foci of extravasation and capillary loops dilated and congested with blood caused local disorganization of the peripheral layer of the pulp and deformation of some odontoblasts. Blood vessels in the parodontium, alveolus, canals of the osteons, and the medullary cavities of the jaw were dilated and contained an increased volume of blood. The structural changes discovered in the early periods of observation spread to many of the nerve endings and fibers in the teeth and parodontal tissues. In some myelinated nerve fibers of the pulp adjacent to the vestibular surface of the crown of the tooth and to the cervical and circular projection, dyschromia and fragmentation of the axons were observed. Reactions of odontoblasts and pulp cells for RNA and glycogen were extremely strong. At the periphery of the cytoplasm in many pulp cells large RNA granules were merged into continuous masses, and in the perinuclear zone glycogen granules formed accumulations. Considerable accumulations of glycogen and hyaluronic acid were found in the vascular membranes.

Examination of the pulp and parodontal tissues 7-14 days after the operation showed a decrease in arterial and venous hyperemia and in the trophic disturbances of the nerve cells. However, hyperimpregnation and disintegration into fragments were still found quite frequently in the axons of the pulp nerve fibers. Foci of infiltration with round cells and plasma cells were mainly perivascular in distribution, in the form of cuffs. Proliferation of macrophages was distinct. Sometimes single vacuoles, cysts, and areas of reticular atrophy could be seen between the odontoblasts (Fig. 2). The more intensive staining of the predentine will be noted, reflecting its increased mineralization. The content of RNA and glycogen in the odontoblasts and pulp cells and of glycogen and hyaluronic acid in the blood vessel walls was reduced.

The vascular disorders in the pulp and parodontium were mild in degree 21-28 days after drilling of the hard tissues of the teeth. Small foci of round-cell infiltration still remained along the course of some of the congested arteries and veins. Most nerve endings and fibers were moderately and uniformly impregnated with silver, their outlines were clear and even, and their thickness was uniform throughout their length. The zone of predentine was slightly widened. The content of histochemically detectable substances in the odontoblasts, pulp cells, and blood vessel walls was the same as in the control.

The histomorphological state of the teeth and parodontal tissues was completely normal again 35 days after the experiment. In the region of the vault and in the walls of the cavity in the tooth secondary dentine was deposited: Its formation must be regarded as a purposive protective reaction of the body, helping to compensate to some degree for the loss of some of the soft tissues of the tooth. The neurohistological and histochemical changes found in the pulp and parodontium, incidentally, were most marked in the coronal pulp adjacent to the vestibular surface of the teeth, where a thick layer of hard tissues was drilled away, and in teeth drilled to form a circular projection.

The results of this investigation may prove useful in the choice of a conservative technique for drilling teeth under metal–ceramic crowns and in the development of effective anesthesia for use in orthopedic stomatologic practice.

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