AJNR Am J Neuroradiol 19:317–319, February 1998

Dental Bur Fragments Causing Metal Artifacts on MR Images

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PURPOSE: **Our purpose was to define the role of dental bur fragments in producing metal artifacts on MR images.**

METHODS: **Dental prosthetic reconstructions were made for two dogs. The two lower second premolars were prepared for full-cast crowns by using a diamond bur. The crown margin was placed subgingivally on the right side (1 mm below the free gingival margin) and at the same level as the free gingival margin on the left side. After 1 week, full-cast crowns were cemented in place. MR imaging was performed 7 days later.**

RESULTS: **Metal artifacts appeared in both second premolar regions of the mandible on MR images, with the right side, in which the crown margin was positioned subgingivally, displaying a larger signal distortion than the left side. After removal of the crown, the artifact remained on the right. On histopathologic examination, bur fragments were detected in the gingiva, more on the right than on the left. X-ray fluorescent element analysis showed iron in the gingival tissue containing bur fragments.**

CONCLUSION: **Distortion of MR images was considered to be attributable in part to the damage of the gingiva and in part to the presence of dental bur fragments.**

Various metallic prostheses may limit the usefulness of magnetic resonance (MR) imaging because they cause image degradation (1, 2) in which artifacts may obscure the lesion as well as the normal anatomy. This is a serious problem in head and neck imaging, because many patients have had significant metallic reconstructive dental work. Artifacts have been reported to result primarily from the types of materials commonly used in dental restorations (3); however, we have often observed a difference in severity of the artifacts, even among patients in whom the same type of metallic dental materials have been used. Moreover, some authors have reported that the effects of dental material on MR images are difficult to predict (3, 4). The purpose of this study was to evaluate the potential contribution of bur tip fragments to MR imaging artifacts.

Received May 1, 1997; accepted after revision August 2.

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Methods

Animal Experiment Protocol

Two dogs, with a mean weight of 10 kg, underwent dental prosthetic treatment. The dogs were anesthetized with 0.1 mL of pentobarbital intravenously, and ventilated with a mixture of oxygen and halothane. Both lower second premolars were prepared for full-cast crowns using a round-end tapered diamond bur (Fig 1). The crown margin was placed subgingivally on the right side (1 mm below the free gingival margin) and at the same level as the free gingival margin on the left side. After preparation, an impression for full-cast crowns was taken with silicone-based material. Seven days later, full-cast crowns (12% gold, 56% silver, 20% protactinium, 10% copper, 1.5% zinc, and 0.5% indium in composition) were cemented with glass ionomer cement (Ketac silver glass cement, ESPE, Pharmazeutischer Praparate GmbH & Co, Seefeld, Germany) on both second premolars. Seven days later, the animals were examined by MR imaging. MR studies of the mandible were performed twice. After completing this MR examination, we removed the full-cast crown in the right lower second premolar and cemented on an anterior tooth with glass ionomer cement. No procedure was done to the crown on the left side. MR examinations were again performed using the same pulse sequence (see below). The animals were killed as part of a separate investigation unrelated to the head and neck region. Both lower second premolar regions were examined histopathologically and by X-ray fluorescent element analysis (element analyzer; JEOL Ltd, Tokyo, Japan).

The care and use of the animals reported in this study were approved by the Institution Animal Care and Use Committee.

MR Imaging Protocol

MR examinations were performed using a 1.5-T superconductive system with a body coil. All MR images were obtained using a fast spin-echo technique with the following parameters: 4000/99/4 (repetition time/echo time/excitations), 11 echo trains, 154 × 256 matrix, 150 × 150-mm field of view, 3-mm-thick sections, and 4.5-mm section interval.

Results

In both dogs, the MR images showed considerable artifacts in the second premolar regions of the mandible (Fig 2A). The artifact in the right lower premolar region was larger than that in the left. The right premolar region in the mandible produced the same large artifact even after the crown was removed (Fig 2B). The full-cast crown cemented onto the anterior tooth did not produce a significant artifact on MR images. Histopathologic examination detected foreign bodies, so-called bur fragments, in the gingiva (Fig 2C). The right premolar region (subgingival preparation) showed more bur fragments than did the left region. X-ray fluorescent element analysis of the right premolar region showed iron fragments, presumably from the bur tips in the gingival tissue.

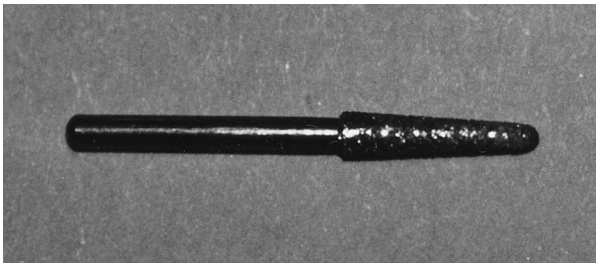

FIG 1. Round-end tapered diamond bur.

Discussion

A wide variety of metallic materials are used in dentistry, some of which can cause distortion on MR images. Various authors have reported that dental amalgam, gold alloy, aluminum, microfilled resin, and glass ionomer cement produce no imaging artifacts, but that stainless steel used in dentures and orthodontic braces produces extensive artifacts because of variable concentrations of ferromagnetic material (1, 3–6). Ferromagnetic objects among metallic foreign bodies produce artifacts because their higher magnetic susceptibility relative to contiguous tissue causes localized field changes. This results in image distortion and changes in image contrast (7, 8). The metallic artifacts present on postoperative MR studies after anterior cervical diskectomy are thought to be caused by the tips of the metallic instruments used at surgery, with the drill bur implicated most frequently (9–11). In our study, the same phenomenon was caused by dental bur fragments. Alanen et al (12) reported that even microscopic (0.01-mg) magnetic particles cause a notable distortion on MR images, with the size of the artifact dependent on the amount of powdered metallic iron present.

There are many kinds of dental burs in dentistry (13). In our study, we used a diamond bur consisting of a steel core covered with diamond chips. The diamond burs are used at higher speeds of rotation, particularly for extracoronal reduction of tooth tissue. Presumably, small bits of metal from the bur core are chipped when in contact with the tooth. These bits of metal are deposited in the traumatized gingiva. Dentists cannot perform a prosthetic procedure without a diamond bur.

Amalgam tattoo is a pigmentation of the oral mucosa. The amalgam tattoo is a frequently occurring, asymptomatic, dark bluish lesion usually seen on the abraded gingiva where teeth have been restored with silver amalgam (14). When the amalgam

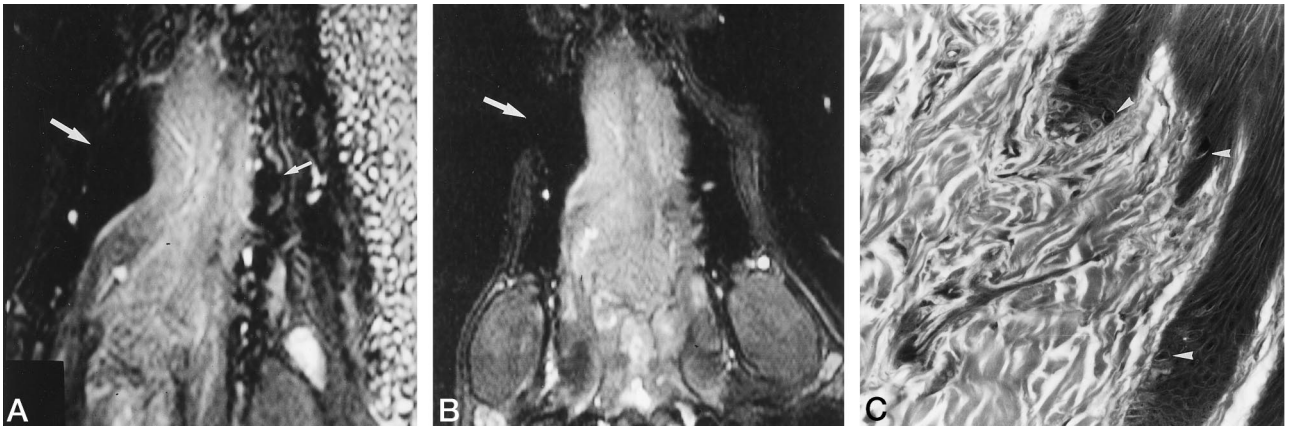

FIG 2. *A*, Fast spin-echo T2-weighted image (4000/99/4) shows severe artifacts in the second premolar regions bilaterally. The artifact on the right (*large arrow*) is larger than that on the left (*small arrow*).

B, Even after the crown on the right premolar has been removed, the artifact remains and is unchanged in size (*arrow*). The crown cemented onto the anterior tooth did not produce any artifact.

C, Tiny fragments of foreign bodies compatible with bur tips (*arrowheads*) can be seen in the gingiva (hematoxylin-eosin, original magnification ×200).

is placed, some of the silver or mercury contacts the abraded tissue and precipitates in the protein of the immature collagen fibers (15). With crown preparation, bur fragments could be directly deposited into the abraded tissues.

Conclusion

Clinically, some injury to the gingiva is unavoidable, and subsequent implantation of dental bur fragments into the gingiva may occur. Because this event is difficult to evaluate retrospectively at the time of the MR examination, the presence and severity of dental filling artifacts in the oral region cannot be anticipated. To reduce artifacts on MR studies of the head and neck, it is well to consider the type of dental filling material used and the severity of gingival damage caused by the dental treatment.

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