Short Communication

Bone Formation Around Immediately Placed Oral Implants In Diabetic Rats

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Research has shown a decrease in femoral bone-to-implant contact in rats with uncontrolled diabetes. The present study aimed to test the hypothesis that this decrease may be the result of a decreased mineral apposition rate. In 20 normal and 20 diabetic rats, a titanium implant was inserted into the tooth extraction socket immediately after the right maxillary molars were extracted. There was a significantly reduced mineral apposition rate in the diabetic rats compared with the normal rats ($P = .0001$), but no difference between rats sacrificed at 20 and 40 days ($P = .297$). The results suggest that implant insertion immediately following tooth extraction in patients with poorly controlled diabetes is contraindicated. *Int J Prosthodont 2006;19:513–514.*

There have been few detailed studies of the effects of diabetes on the process of osseointegration. One study has shown that femoral bone-to-implant contact in rats with uncontrolled diabetes decreased over a 4-month period.[1] The present study aimed to investigate the bone healing and mineral apposition rate around immediately placed oral titanium implants in rats with uncontrolled diabetes.

Materials and Methods

Forty 35-day-old Sprague-Dawley rats were randomly divided into a diabetic group and a control group. Twenty rats (diabetic group) were injected intraperitoneally with streptozotocin (60 mg/kg body weight).[2] The remaining 20 rats (control group) were injected with citrate buffer only. The diabetic group and the control group were then divided into 2 subgroups based on the time of sacrifice. On day 21, the right maxillary molars were extracted under general anesthesia and a titanium implant (2 mm in length, 0.5 mm in diameter) was immediately inserted into the socket. Ten normal and 10 diabetic rats were sacrificed at 20 days postsurgery using a carbon dioxide overdose, and the remainder were sacrificed at 40 days. All rats were injected intramuscularly with 2 doses of a calcein fluorochrome (10 mg/kg body weight) with a 7-day interval between injections, and then sacrificed the following day.

The craniomaxillary tissues from 5 diabetic and 5 normal rats sacrificed at 20 and 40 days were processed for paraffin wax histology. The titanium implants were removed gently from the tissues following decalcification. Consecutive 5-µm-thick frontal sections were collected and stained with hematoxylin-eosin.

The craniomaxillary tissues from the remaining rats in each subgroup were processed for resin histology and sectioned. The mean mineral apposition rate was calculated for each rat.[2]

Results

The mean body weight of the rats at the start of the experiment was 170 g, (SD = 20, range 135 to 215 g). At 20 days postsurgery, the mean blood glucose was 155 mg/dl (SD = 31) for normal rats and 696 mg/dl (SD = 123) for diabetic rats. At this time, the implants of the diabetic rats were surrounded by woven bone and fibrous tissue (Fig 1), whereas the tissue around the implants of the normal rats contained mostly lamellar bone (Fig 2).

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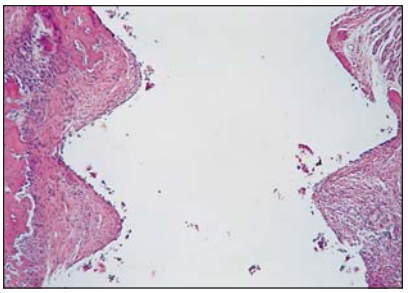


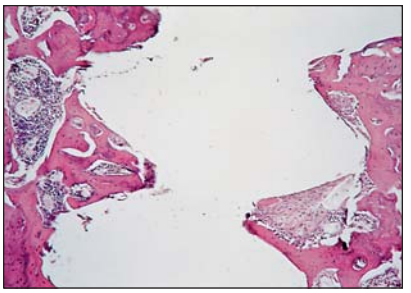
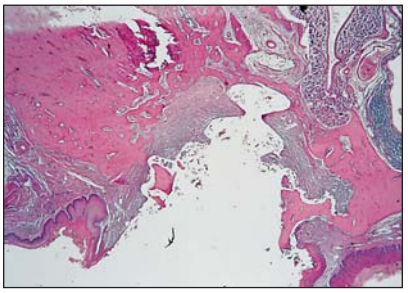


Fig 1 *(left)* Implant site of a diabetic rat at 20 days after implant placement (decalcified section, hematoxylin-eosin, magnification ×10).

Fig 2 *(right)* Implant site of a normal rat at 20 days after implant placement (decalcified section, hematoxylin-eosin, magnification ×10).



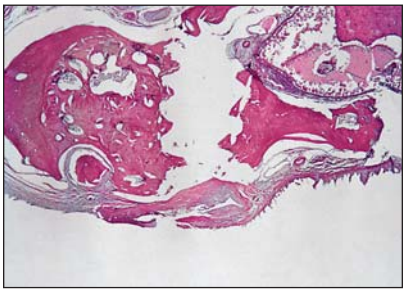


Fig 3 *(left)* Implant site of a diabetic rat at 40 days after implant placement (decalcified section, hematoxylin-eosin, magnification ×2.5).

Fig 4 *(right)* Implant site of a normal rat at 40 days after implant placement (decalcified section, hematoxylin-eosin, magnification ×2.5).

At 40 days postsurgery, there was a large amount of fibrous granulation tissue and extensive bone resorption around the implants of the diabetic rats (Fig 3). In the normal rats, the lamellar bone around the implant was dense and well organized (Fig 4).

Mineral Apposition Rate

At 20 days postsurgery, the mean mineral apposition rates for the diabetic and normal rats were 3.60 (SD = 3.02) and 14.07 (SD = 2.02), respectively. At 40 days postsurgery, the mineral apposition rate was 1.60 (SD = 1.19) for the diabetic rats and 13.25 (SD = 4.43) for the normal rats. Analysis of variance showed a significant difference between mineral apposition rates for the normal and diabetic rats ($P = .0001$), but no difference for rats sacrificed at 20 and 40 days ($P = .30$). There was no significant relationship between the diabetic state and the time of death ($P = .66$).

Discussion

The inflammatory response around the implants was greater in the diabetic rats than in the normal rats, which would be expected to stimulate an increased bone resorption and formation rate in the diabetic group. This is because the activities of osteoblasts and osteoclasts are normally linked. However, a decreased mineral apposition rate was observed in the diabetic group, which suggests an impaired osteoblastic function or mineralization defect.

Numerous animal studies have shown that placing implants in the long bones of animals with uncontrolled diabetes results in less bone-to-implant contact, but greater formation of woven bone. The present study, which used severely hyperglycemic diabetic rats, does not necessarily indicate that osseointegration is compromised in patients with well-controlled diabetes. However, Fiorellini et al[3] found that implants have a slightly reduced survival rate (86%) even in patients with well-controlled diabetes.

Studies using the long bones of rats as the site of implant placement have usually used favorable transcortical stabilization of the implants. Our study is the first detailed analysis of implants placed in alveolar bone following tooth extraction, which more closely simulates the clinical situation in the maxilla, where fixation in 2 thick cortical layers is impossible. The placement of titanium implants in the maxilla of diabetic rats resulted in a poor soft tissue and bone healing response, caused by poor initial healing following tooth extraction.

In conclusion, the results suggest that implant insertion immediately following tooth extraction in patients with poorly controlled diabetes may be contraindicated.

References

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3. Fiorellini JP, Chen PK, Nevins M, Nevins ML. A retrospective study of dental implants in diabetic patients. Int J Periodontics Restorative Dent 2000;20:366–373.