Effects of the diameter and shape of orthodontic mini-implants on microdamage to the cortical bone

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**Introduction:** The purpose of this study was to investigate the effects of the diameter and shape of orthodontic mini-implants (OMIs) on microdamage to the cortical bone during implant placement.

**Methods:** Twenty-eight self-drilling OMIs (Biomaterials Korea, Seoul, Korea; length, 6 mm; diameters, 1.5 and 2 mm; cylindrical and tapered shapes; classified as 1.5C, 2C, 1.5T, and 2T) were placed with a surgical device in the tibias of 7 New Zealand white rabbits (mature males; mean age, 6 months; mean weight, 3.1 kg). Four OMIs of each type per rabbit were placed randomly. Maximum insertion torque (MIT) was measured. Immediately after placement of the OMIs, the block of bone with the OMI was harvested. Cortical bone thickness was measured by using microcomputed tomography, and histomorphometric analyses of the number of cracks (NC), accumulated crack length (ACL), maximum radius of the crack (MRC), and longest crack (LC) were performed. Kruskal-Wallis and Mann-Whitney U tests with the Bonferroni adjustment were done for statistical analyses.

**Results:** Increased diameter (1.5C>2C and 1.5T>2T) and tapering (1.5C>2T) resulted in increased values of MIT, NC, and LC (P<0.01, respectively). Similarly, with increased diameters (1.5C and 1.5T<2C and 2T), there were increases of ACL and MRC (P<0.001, respectively). However, there were no differences in the values of MIT, NC, ACL, MRC, and LC between the cylindrical and tapered OMIs with the same diameters (1.5C and 1.5T, 2C and 2T).

**Conclusions:** OMIs with larger diameters and tapered shapes caused greater microdamage to the cortical bone; this might affect bone remodeling and the stability of the OMIs.

Read the full text online at: www.ajodo.org, pages 8.e1-8.e8.

**EDITOR'S COMMENT**

After reading a number of implant studies in various journals, I came away with the impression that the larger the OMI, the more stable it would be. But is that always the case? Are there situations when differences in size and shape of an OMI cause less stability? According to the authors of this study, “various factors such as age, sex, skeletal pattern, placement location, screw design, type of placement surgery, immediate loading, oral hygiene, and inflammation are associated with their stability.” Also, OMI failures occur most frequently within the first 4 months. Therefore, the purpose of this study was to investigate the effects of the diameter and shape of OMIs with regard to microdamage in the cortical bone during OMI placement.

These researchers placed 4 types of OMIs in 7 rabbits each. The 6-mm self-drilling implants from Seoul, Korea, were classified into 4 subtypes according to diameter (1.5 or 2 mm) and shape (cylindrical or tapered). They used a round-robin method to randomize the placements. When they evaluated the results, they found that excessive placement torque might cause microfracture and ischemia of the surrounding bone, delay the bone healing, and cause failure of the OMIs. In terms of microdamage, tapered OMIs with a 2-mm diameter were identified as not the best option because the tapering and the large diameter resulted in a significant increase of MIT. The OMIs with a larger diameter and a tapered shape resulted in greater microdamage to the cortical bone. This might affect bone remodeling and stability. These results can be used as a guideline for choosing appropriate types of OMIs to prevent or minimize microdamage in daily orthodontic practice.
Q & A

Turpin: With your experience in the use of mini-implants for orthodontic anchorage, were you surprised by the amount of cortical bone microdamage observed in this study?

Baek: Although we hypothesized that there would be differences in cortical bone microdamage according to diameter and tapering of the OMIs, we were also surprised by the differences in the amounts. The most interesting findings in our study were that increases of diameter and tapering resulted in significant increases in the values of MIT, NC, LC, ACL, and MJRC. However, there were no differences in these values between cylindrical and tapered OMIs with the same diameter. This suggests that the size of the diameter has a direct effect on microdamage in the cortical bone during placement. Placement torque was affected by screw position, screw type, and bone mineral density of the cortical bone, in that order (Cha JY, Kil JK, Yoon TM, Hwang CJ. Miniscrew stability evaluated with computerized tomography scanning. Am J Orthod Dentofacial Orthop 2010;137:73-9). If OMIs are placed in the dense buccal cortical bone of the posterior area of mandible, tapered OMIs with larger diameters might need predrilling because there was a gradual decrease in placement torque with decreased diameters between the OMI and the predrilling hole. In addition, modification of the thread structure—e.g., cervical threadless OMIs—would be helpful to reduce possible excessive insertion torque.

Turpin: Do you plan additional studies of other OMIs with differing sizes and shapes?

Baek: Yes, we plan to investigate the effects of OMIs with differing sizes and shapes on the stability according to the amount of microdamage and the time factor.

Turpin: How much of the alteration in microstructure of the cortical bone would it take to seriously affect the stability of OMIs clinically?

Baek: How much of the microstructural alterations in the cortical bone could seriously affect the stability of OMIs clinically is an important issue for clinicians who are using OMIs in daily practice. Unfortunately, we still do not know exactly what amount of microstructural alterations in the cortical bone can affect the stability of OMIs. But we can guess that the more microdamage in the cortical bone, the more bone remodeling occurs. Investigation of stability according to the amount of microdamage will be another research topic for us.