Tooth preparation plays an important role in prosthodontics, especially in esthetic dentistry and perio-prosthodontics. The horizontal and vertical marginal fit between dental prostheses and abutments affect the prognosis, longevity, and esthetics of the restorations.

The operating microscope offers higher resolution and magnification, brighter and enlarged three-dimensional working images, and an optimal ergonomic treatment posture for the dentist. Visual guidance provides for a more precise movement of the dental handpiece and dental instruments. Combining an operating microscope and visual guidance supports the achievement of minimal marginal gaps.

The optimal horizontal marginal gap between dental prostheses and abutments (tooth or implant) is 0 µm. This is easily achieved with the use of a dental operating microscope, precise laboratory technique, and training. On the other hand, the optimal vertical marginal fit between dental prostheses and abutments is 50 µm. Tooth preparation, impression technique and material, working casts, and prostheses fabrication method all influence the size of the vertical microgap.

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STUDY OF SURFACE ROUGHNESS AND MARGINAL FIT USING A NEWLY DEVELOPED MICROFINISHING BUR AND NEW PREPARATION TECHNIQUE

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MATERIALS AND METHODS

For the test specimens, 243 human teeth were extracted and preserved in sterilized saline. Each tooth was secured in a mold with gray gypsum stone and then preserved again in the sterilized saline solution.
To minimize the influence of technical sensitivities in the fabrication of the prostheses and to standardize their volume and size, two computer-aided design/computer-assisted manufacture (CAD/CAM) systems were used to scan the prepared teeth: the Procera system (Nobel Biocare) and the Decsy system (Media & Digital Process). For the Decsy system, a ceramic ingot (Ivoclar Vivadent) was used in the fabrication of the prostheses. The cement space was set at 0 µm at the margin. Other cement spaces were set at the optimal number for each dental CAD/CAM system.

To reduce the influence of microscope performance, three different dental operating microscopes were used: Denta 300 (Moller-Wedel) (Fig 1), M 300 (Leica), and OME 100 (Olympus).

Nine dentists were divided into three groups according to their postgraduate clinical experience: group A = 1 to 3 years of experience, group B = 4 to 6 years, and group C = 7 to 10 years. None of the dentists had experience using a dental operating microscope. Each was given 1 hour of instruction on each dental microscope. All dentists then performed tooth preparations with the three microscopes using three different preparation methods three different times of day: morning, afternoon, and evening.

Two types of burs were used: a superfine diamond bur (Shofu) and a newly developed microfinishing bur (Shizaisha). The newly developed microfinishing bur has no blades or diamond grains on the lateral or top surface, and has only one or two grooves on the top surface. The edge of the cylinder has a beveled shape to avoid generation of undercuts during tooth preparation. This bur uses the vibration of the handpiece to cut the tooth.

Three tooth preparation methods were tested. The shoulder marginal finish shape was selected to demonstrate the influence of tooth preparation on the fit of the dental prostheses.

The methods of tooth preparation were standardized as follows:
1. Conventional tooth preparation using the superfine diamond bur in which the bur is moved around the tooth surface in a counterclockwise rotational motion.

2. Preparation using the newly developed microfinishing bur in the same conventional counterclockwise rotational motion.

3. Preparation using the newly developed microfinishing bur in which the bur is pulled or pushed in only one direction from inside to outside of the shoulder in the same orientation as the enamel rods.

A color laser three-dimensional profile microscope (VK 8500, Keyence) (Fig 2) was used to measure the surface roughness and the distance between the abutment tooth and the dental prostheses, with a precision of 0.001 µm. The surface roughness of each prepared tooth was measured in Ra (arithmetic mean deviation of the roughness profile, Ra), Rmax (maximum height of the profile, Ry), and Rz (10-point height of irregularities, Rz) (Fig 3). Ten areas were measured on each specimen. The distance between the abutment tooth and the dental prostheses was measured from the roughness profile. Ten roughness profile data points were acquired for each specimen.

Statistical analysis was accomplished using one-way analysis of variance. The Scheffe F test was used for all post-hoc pairwise comparisons at a 99% confidence level.

**RESULTS**

The mean surface roughness of teeth prepared using method 1 resulted in an Ra of 8.934 µm, an Ry (Rmax) of 141.116 µm, and an Rz of 63.017 µm. The mean surface roughness of teeth prepared using method 2 resulted in an Ra of 7.431 µm, an Ry (Rmax) of 115.404 µm, and an Rz of 54.956 µm. The mean surface roughness of teeth prepared using method 3 resulted in an Ra of 6.585 µm, an Ry (Rmax) of 63.882 µm, and an Rz of 40.296 µm (Figs 4 to 6).

Preparation method 3 resulted in the smoothest Ra, Ry, and Rz values when compared to the other two methods. There were significant differences between method 3 and
the other two methods in terms of $Ra (P < .05)$, $Ry (P < .001)$, and $Rz (P < .001)$. There were no significant differences when comparing the data of method 1 and method 2.

The mean distance between the edge of prepared tooth specimens and the edge of the dental prostheses was 108.396 µm in method 1, 34.398 µm in method 2, and 16.165 µm in method 3 (Fig 7). Method 3 resulted in the smallest marginal gaps. There were significant differences between the measurements obtained for method 2 and method 1 ($P < .001$), method 3 and method 1 ($P < .001$), and method 3 and method 2 ($P < .01$).

There were no significant differences among the experienced-based dentist groups (group A: 1 to 3 years of experience, group B: 4 to 6 years, group C: 7 to 10 years).

DISCUSSION

Ray and Trope\(^1\) studied the relationship between periradicular inflammation and the technical quality of the root canal filling and coronal restoration for endodontically treated teeth. The absence of periradicular inflammation was shown in 91.4\% of both endodontically and coronally good situations, in 44.1\% of endodontically good and coronally poor situations, in 67.6\% of endodontically poor and coronally good situations, and in 18.1\% of both endodontically and coronally poor situations. This result suggests that the marginal adaptation of dental prostheses is important not only for endodontically treated teeth, but also for teeth that have not been endodontically treated.

The roughness profile of each preparation method in the present study also supports this result. The roughness profile of method 1 showed higher peaks and deeper valleys, whereas that of method 3 showed lower peaks and shallower valleys. This is because the newly developed microfinishing bur does not have blades or diamond grains on its surface. The diamond grains on the diamond burs or the blades on the conventional microfinishing burs scratch or cut grooves into the shoulder during tooth preparation and will sometimes cause enamel fractures.

Figure 8 shows the CAD/CAM prostheses and the tooth prepared using method 3. No marginal gaps were observed under high magnification.

CONCLUSIONS

1. With the use of the dental operating microscopes, the newly developed microfinishing burs and the one-way pulling/pushing preparation technique (along the plane of the enamel rods) showed significantly smoother surface roughness of the prepared teeth compared to the conventional preparation method using either the same bur or a superfine diamond bur.

2. A minimal marginal gap of 16.165 µm was obtained with the combination of the newly developed microfinishing burs and the one-way pulling/pushing preparation technique.

REFERENCE