Evaluation of a New Ceramic-containing Toothbrush Bristle
1. Questionnaire Survey on Dental Hygienist Students about its Usability and First Impressions

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Abstract
Toothbrushes after use are contaminated by many microorganisms including bacteria, fungi and viruses. We are thinking of making an anti-bacterial toothbrush by including ceramics in the bristle. But if the ceramic-containing bristles are too hard for the tooth and gingiva, it cannot be used as a toothbrush. So, before examining the anti-bacterial properties, we evaluated the feeling by asking students of dental hygiene. In our preliminary experiment, we determined the most appropriate width and length of ceramic-containing bristles. The students used this toothbrush and answered the questions. Almost all the students were satisfied with the new toothbrush with ceramic-containing bristles. Moreover, the new toothbrush was found to be comparable with the world-wide sold toothbrush. We obtained data that the ceramic-containing bristles were acceptable. Further study to investigate the anti-bacterial properties and effective cleanliness are in progress.

Keywords: Toothbrush; Ceramic-containing bristle; Questionnaire survey

Introduction
Dental caries and periodontitis are two major causes of tooth loss in adults [1]. Both diseases are initiated by a bacterial biofilm, so adequate removal of dental plaque is important for maintaining oral health [2-4]. Recently, several types of new toothbrushes were introduced. For example, a conical shape and extra-thin end bristles are widely sold [5-7]. The bristles are arranged to improve the cleanliness of the tooth surface.

On the other hand, a toothbrush after use is known to be contaminated by bacteria, fungi and viruses [8-11]. Now, we are making a toothbrush by applying a new bristle material: i.e., a bristle that contains ceramics. Some kinds of ceramics are known to have antibacterial activity [12], and our preliminary experiments showed that the ceramic-containing bristle material has an antibacterial property (data not shown). This is advantageous as a toothbrush, because a toothbrush is always exposed to bacteria in the oral cavity. And people do not pay much attention to removing bacteria from toothbrushes, although bacteria on a toothbrush are considered to have a bad effect on general health.

Before making a new toothbrush, we need to confirm that the new bristle material is suitable for a toothbrush, because there is a possibility that the ceramic-containing bristle is too hard for the tooth surface and gingiva. So, we tried to determine the appropriate hardness of bristle by arranging the thickness and length of the bristles. Then, we tried to confirm whether the ceramic-containing toothbrush is acceptable by people. First, we discussed with the teachers of a dental hygienist school and decided on the appropriate thickness and length of the bristles. Next, we examined the most important point, usability and feeling on brushing by questioning dental hygienist students. We also compared the first impressions of the new toothbrush with another toothbrush, which is widely used both in Japan and overseas.

Materials and Methods
Selection of bristle size
The bristles and handles of tooth brush was provided by Zen Corporation (Fukuoka, Japan). We prepared four bristle sizes: thickness 0.15 mm/ length 10.0 mm, thickness 0.15 mm/ length 12.0 mm, thickness 0.18 mm/ length 10.0 mm, and thickness 0.23 mm/ length 12.0 mm. We asked seven teachers of Fukuoka College of Health Science to monitor these four types of toothbrushes for a week.

Evaluation of students’ first impressions
After the most suitable bristle size was decided, we made the toothbrush on a large scale. A total of 61 students of Fukuoka College of Health Science enrolled in this research. We provided the students with the new toothbrush and GUM Dental Brush #211 (Sunstar Inc. Osaka, Japan) and asked them to use both toothbrushes for 4 days. On the 5th day, we delivered the questionnaire sheets and collected the responses. The questionnaire sheets with complete answers were further analyzed.

All participants understood the nature of the research project and provided written informed consent to participate in this study.

Keywords: Toothbrush; Ceramic-containing bristle; Questionnaire survey

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Permission for this study was obtained from the Ethics Committee for Clinical Research of Fukuoka Dental College and Fukuoka College of Health Sciences (approval No. 352).

**Results**

**Selection of bristle size**

We did a preliminary experiment to identify the most suitable bristle size. Most of the teachers thought that the toothbrush with a bristle size of thickness 0.15 mm/ length, 10.0 mm was the best. So, we used this toothbrush for the further survey.

**Evaluation of students’ first impressions**

A total of 61 dental hygienist students enrolled in this research, and 54 answer sheets were recovered (recovery ratio: 86.5%). The number of complete answer sheets was 51 (the effective answering ratio: 83.6%).

First, we investigated students’ first impressions of the new toothbrush. We asked about the extent of cleaning on different tooth surfaces (Figure 1). More than 80% of students answered that it was easy to clean the interdental spaces, but they had a more positive impression about the cleaning of other areas, such as the cervical and distal surface of the most posterior teeth and the buccal surface of upper molars. Next, we evaluated other properties of the new toothbrush (Figure 2). More than 80% of students had a good impression. They answered that the hardness of the new toothbrush was good, and the feeling on the gingiva was also good. No student thought the new bristle was too hard for the gingiva. They felt that the tooth surface became smooth after brushing.

Next, we compared the new toothbrush with GUM Dental Brush #211, which is widely used both in Japan and overseas. We compared the impressions about cleaning on different tooth surfaces (Figure 3). The impressions of two toothbrushes were found to be almost the same. Other properties of the two toothbrushes were not different (Figure 4).

**Discussion and Conclusion**

There are many types of toothbrushes, and they have different characteristics [8-11], such as ‘easy to clean the interdental space’, ‘easy to enter the gingival crevice’, ‘gentle on the gingiva’ and so on. Many new toothbrushes are produced focusing on their shape, because a proper shape of the handle and bristles is important to improve the cleaning effectiveness.

On the other hand, toothbrushes are always exposed to bacteria in the oral cavity, and toothbrushes are not necessarily clean [5-7]. Some mouth rinses have been proposed to clean the toothbrushes [13], and chlorhexidine-coatings were made [14]. We are thinking of making an anti-bacterial toothbrush by including ceramics in the bristle. Ceramic is considered to be useful for conferring an antibacterial property on a toothbrush. But if the bristle is too hard for teeth and gingiva, it cannot be used as a toothbrush. So, we confirmed that the ceramic-containing material is acceptable as a toothbrush bristle.
The hardness and feeling on the gingiva varies with the thickness and length of the bristles. So, we first determined the best bristle size by discussing with teachers. We applied the best bristle size to the following questionnaire survey. The dental hygienist students used the new toothbrush, and their impressions were evaluated. Most students had a positive impression, and the impression was almost same with the GUM Dental Brush. The GUM Dental Brush has a long history, and it is used worldwide. From these results, the hardness and feeling on the gingiva of new toothbrush is considered to be acceptable.

The next step, which is to confirm the effectiveness of cleaning and the anti-bacterial activity, is now in progress. We will report the additional properties of the new toothbrush in the near future.

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References