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ORIGINAL ARTICLE

Influence of preparation design on the quality of tooth preparation in preclinical dental education

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Abstract *Background/purpose:* One of the major educational goals in preclinical dental education is to learn tooth preparation techniques. The purpose of this study was to evaluate the influence of different preparation designs on the development of the manual dexterity of students, in order to perform a state-of-the-art tooth preparation.

Material and methods: Seventy-two 1st semester students were divided into two groups and educated in tooth preparation for a ceramic anterior single crown. One group received cylindrical burs with a rounded edge to prepare a typodont model with a shoulder finishing line, while the other group had cylindrical burs with round noses to prepare a chamfer finishing line. All preparations were digitized and evaluated using special software focusing on the parameters of preparation depth and preparation angle. In addition, violation of the adjacent teeth was estimated. Data was statistically evaluated at a level of significance of 5%.

Results: The preparation design used did not show a statistically significant influence on the preparation depth or on the preparation angle. A trend to a higher tooth structure removal as required was detected. Furthermore, no influence of the type of preparation design on the number of violated adjacent teeth was found.

Conclusion: In preclinical dental education, the type of preparation design was found to have no influence on the measured parameters representing the quality of the preparation.

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Introduction

There is a general recognition that adequate tooth preparation is essential for the fit of fixed prosthodontics. Insufficient tooth preparation appears to be responsible for premature failures due to biological aspects, such as caries and endodontic or periodontal disease complications.¹ Therefore, tooth preparation is an important skill that has to be taught in dental education.

However, although various techniques and programs containing manikin exercises and computer-based simulation training have been developed, acquiring the desirable manual dexterity needed for intraoral tooth preparation seems to be one of the most challenging tasks within pre-clinical training.² This might be aggravated by the fact that there is almost no consensus among clinicians concerning the preparation technique and the most suitable finish line, resulting in a large number of aspects that have to be taken into consideration by preparation novices.

Thus, particularly in the case of finish lines, different recommendations have been made to improve esthetics, minimize marginal fitting irregularities, and reduce stress concentration at the margins.³ The most popular designs are modifications of the shoulder or chamfer finishing line, which generate surfaces almost perpendicular to the loading direction and are clearly identifiable to both the dentist and the laboratory technician.^{1,4–6} Moreover, both the distinct chamfer and a shoulder finishing line with a rounded inner edge are used for comparable indications, e.g., the production of all-metal as well as milled all-ceramic crowns.^{7–9} According to a survey concerning pre-clinical prosthodontic programs in German-speaking dental schools, about 95% of all educational institutions declared they taught the chamfer finishing line. The shoulder finishing line was taught in about 60% of the institutions.¹⁰

In the past decade, in order to strengthen contemporary aspects within the dental curriculum, preclinical training time has been reduced to address more clinical content to dental students.² Thus, the question arises of whether the skilled handling of only one finish line could be enough. This would lead to a desirable reduction of the instruments and acquisition costs for the students.¹¹ Additionally, in terms of organization and hygiene, it seems more valid to provide a reduced number of instruments for dental treatment. This aspect was enhanced by the results of Morrison and Conrod.¹² They showed that used burs are often sterilized ineffectively before their reutilization.

However, there are few investigations evaluating whether the chamfer or shoulder finishing line is easier for students to learn. No scientific studies have stated that chamfer finishing lines are superior to other finish lines.¹³

Based on the results of the above mentioned survey, the chamfer finishing line is more often taught and therefore might be easier to learn. The purpose of this investigation was to evaluate whether dental students' performance in defined finish-line production would be consistently improved by the use of a certain preparation design: a chamfer or a shoulder finishing line. The working hypothesis tested whether it would be easier to achieve the requirements of a state-of-the-art preparation using the chamfer instead of a shoulder finishing line. The dimensions

of particular interest were the width of the preparation, the preparation angle, and the number of the affected adjacent teeth.

Materials and methods

The study was conducted during the first preclinical training courses within the School of Dentistry at the Martin Luther University, Halle-Wittenberg, Germany in 2012 and 2013. Ethics approval was obtained from the institutional review board. Seventy-two dental students participated in the study and were randomly divided into Group A and Group B. First, students were introduced to ideal preparation parameters including a smooth, 1.0–1.5 mm wide chamfer or shoulder finishing line that follows the rise and fall of the gingiva, a distinct and continuous finish line void of spikes and lips, 6–10° combined convergence angle, a 90-degree angle of the preparation line to the tooth surface, a functional cusp bevel, 1.5–2.0 mm occlusal reduction, and an overall rounded and smooth finish. A practical demonstration of the preparation technique was provided and an additional presentation was placed on the virtual learning environment prior to the preparation session. Prior to this study, the 1st semester students had completed manual dexterity exercises in order to develop the necessary dexterity and skill with an electric handpiece using the "Learn-a-Prep" resin layers (No. 15810; Whip Mix Corp., Louisville, KY, USA). After this first practical exercise, students prepared solitary premolars and molars performing all the working steps necessary to prepare a tooth.

At the end of the 1st semester, all students were instructed to prepare an upper first incisor (11, OK V16; KaVo Dental GmbH, Biberach, Germany) with a finish line width of 1.0–1.5 mm for an all-ceramic crown fabricated by computer-aided design and computer-aided manufacturing. This was prepared using an electric handpiece on a typodont in a phantom head. To control the reduction, a sectioned index made from addition-cured silicone impression material (Panasil Putty; Kettenbach, Eschenburg, Germany) was fabricated prior to tooth preparation.

Group A's students ($n = 36$) used cylindrical burs with a rounded edge with $\emptyset 1.2$ mm and $\emptyset 1.6$ mm (ISO 806 314 111 534 012 / 016; 806 314 111 514 012 / 016; Komet Dental, Lemgo, Germany) to prepare a shoulder finishing line and Group B's students ($n = 36$) used cylindrical burs with a round nose with $\emptyset 1.2$ mm and $\emptyset 1.6$ mm (ISO 806 314 141 534 012 / 016; 806 314 141 514 012 / 016; Komet Dental) to prepare a chamfer finishing line.

During the preparation process, students were supervised by experienced assistant professors to avoid manipulation. Additionally, adjacent teeth were controlled visually by an experienced assistant professor and divided into "affected" and "not affected." In the case of an affected adjacent tooth, the whole preparation had to be redone.

To determine the preparation angle and width of the preparation margin depending on preparation line, each preparation was digitized (D710; 3 Shape, Copenhagen, Denmark). Shoulder width and preparation angle

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