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Comparison of Lengths of Gutta-Percha Cone Tip Fragments after Cutting at Different Magnifications

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Abstract

Background: Because there are significant differences between instruments and guta-percha cones of the same size, cutting and adapting the guta-percha cone to the desired size is very important for apical sealing. The aim of this study was to evaluate the accuracy of the cut lengths of guta-percha cones cut with a scalpel blade under different magnifications using stereomicroscope-based measurements.
Materials and Methods: The tips of the gutta-percha cones were cut 2 mm with the naked eye and under different magnifications using a scalpel blade and stainless steel endodontic finger ruler. The use magnifications were 2.5x Galilean loupe (Keeler, Windsor, UK), a 7.5x prismatic loupe (Admetec, Haifa, Israel) and a 25x operating microscope (Zeiss, Oberkochen, Germany). Each cut guta-percha tip was imaged under a 40x Zeiss Stemi 305 stereomicroscope (Zeiss, Oberkochen, Germany) using Zeiss Zen Lite 2 software and lengths were measured by two observers. Inter-observer agreements were calculated utilising the weighted kappa coefficient. Data were analyzed by Kruskal Wallis H test at $P<0.05$ significance level.
Results: There was no statistically significant difference between cut-lengths of gutta-percha cones depending on the magnification ($p>0.05$). Although there was no statistically significant difference, the mean values of the 25x magnification group were lower than the other groups (26,03).
Conclusions: Given the limitations of this study, similar guta-percha cut lengths were obtained under the naked eye, 2.5x, 7.5x and 25x magnifications. In order to better evaluate the magnification efficiency, studies with larger sample sizes, along with evaluating the morphological surface, are needed.

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Keywords: Gutta-percha, gutta-percha adaptation, magnification, stereomicroscope.

Introduction

Optimally, root canal filling materials should adequately seal the root canal system and prevent microleakage within the root canal space (1). For root canal treatment to be successful, the treated canal must be sealed hermetically (2). This is a critical step to prevent bacterial entry and support healing in the treated area, thereby preventing reoccurrence of infection (2, 3).

Classically, the most commonly used filling materials for root canal obturation are gutta-percha and root canal sealers (4). Gutta-percha cones are available in standard and various custom sizes and can be selected according to the root canal's diameter and morphology, and they can be modified by cutting (5). Regardless of the obturation technique used, it is essential to choose a master cone that is well-adapted to the canal for achieving a fluid-tight apical seal (6).

Unfortunately, significant differences exist between files and gutta-percha cones of the same size. Therefore, cutting the gutta-percha cone to the desired size and adapting it to the apical diameter is crucial for ensuring an effective apical seal (7). To our knowledge, the accuracy of gutta-percha cutting lengths under different magnifications has never been compared before. Therefore, the aim of this study was to compare the accuracy of the lengths of the cut pieces measured with a steromicroscope after cutting guta-percha cones under different magnifications using a scalpel.

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Material and Methods

Gutta-percha cones (Pearl Endo, Ho Chi Minh City, Vietnam) of the same size (40/.02) were taken from the same box, and the tips were cut 2 mm using a scalpel (Beybi, İstanbul, Türkiye) (Figure 1) and a stainless-steel endodontic finger ruler (Kelibiz, Sialkot, Pakistan) (Figures 2a and 2b). All cuts were made by the same researcher (EM), with the scalpel placed perpendicularly to the endodontic ruler (Figure 3). The magnifications used were 2.5x Galilean loupe (Keeler, Windsor, UK) (Figure 4a), 7.5x prismatic loupe (Admetec, Haifa, Israel) (Figure 4b), and 25x dental operating microscope (Zeiss, Oberkochen, Germany) (Figure 4c).

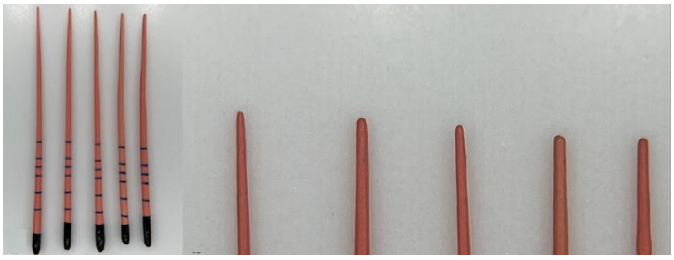

Figure 1. Gutta-percha samples from the same box

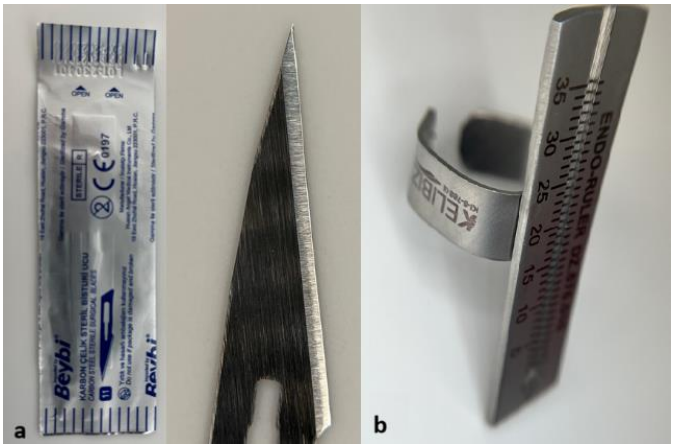

Figure 2. Materials used for the cutting of gutta-percha cones **a.** Scalpel blade **b.** Endodontic finger ruler

Each cut piece of gutta-percha was visualized under 40x magnification using the Zeiss Stemi 305 stereomicroscope (Zeiss, Oberkochen, Germany) with Zeiss Zen Lite 2 software (Zeiss, Oberkochen, Germany). First, the microscope was calibrated, and the image clarity was adjusted in the desired magnification. The image from the stereomicroscope was transferred to a computer (Figure 5). The length of the cut gutta-percha, as displayed on the computer, was measured linearly from the most prominent part of the cone (Figure 6). All measurements were performed by two observers with over 7 years of clinical experience.

The agreement between the observers was assessed using the kappa coefficient. To determine if there was a significant difference in the lengths of the cut gutta-percha pieces based on magnification levels, the Kruskal-Wallis H test was applied at a significance level of $p = 0.05$.

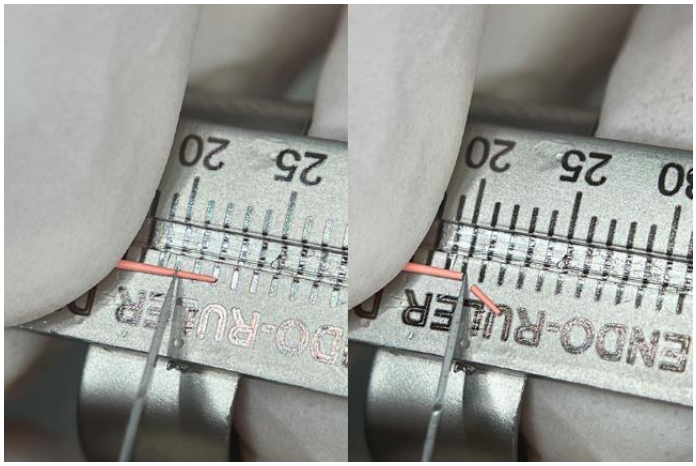

Figure 3. Cutting of the gutta-percha cone on the endodontic ruler

Figure 4. Magnification tools **a.** 2.5x Galilean loupe **b.** 7.5x prismatic loupe **c**. 25x dental operation microscope

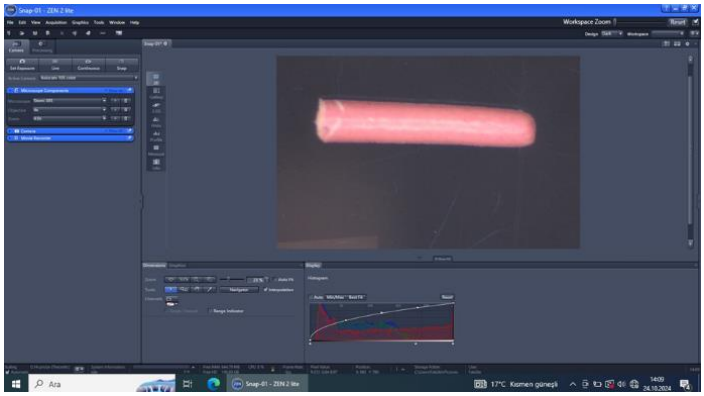

Figure 5. The interface of the Zeiss Zen Lite 2 software

Results

The inter-observer agreement was moderate (.71) in the group measured with the naked eye (Table 1), and strong (.78) in the 2.5x magnification group (Table 2).

No significant difference was found in the rank mean scores of the gutta-percha cutting lengths based on magnification levels (X^2 (3), n=60, 1.845; p>0.05). Although no statistical difference was found, it was observed that the rank mean scores of dental operating microscope measurements (25x) were lower compared to the other groups (Table 3).

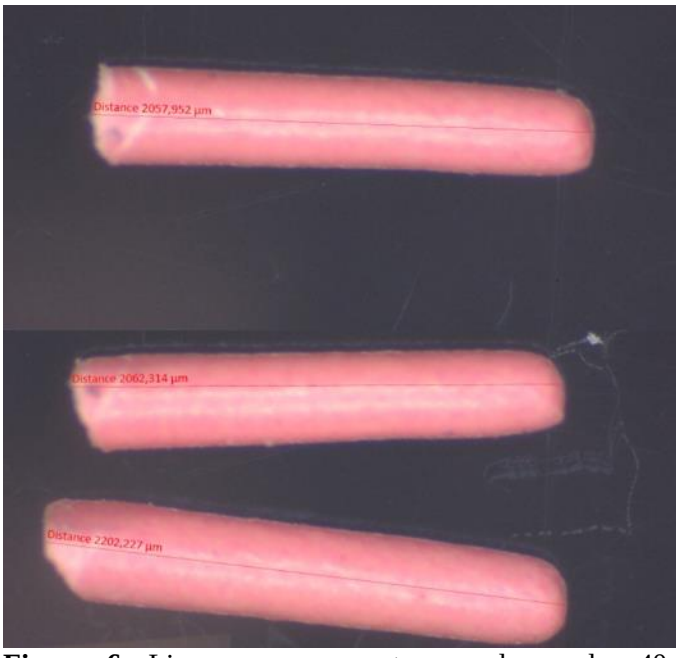

Figure 6. Linear measurement examples under 40x magnification with a stereomicroscope

Discussion

In a successfully completed root canal treatment, coronal and apical sealing is of great importance to prevent the passage of oral flora and toxins to the periapical tissues via the root canal system. Proper adaptation of gutta-percha plays a critical role in achieving an effective apical seal (8).

To this end, root canal instruments and gutta-percha cones are typically manufactured with the same diameter and taper. However, there are studies that report that gutta-percha cones are not standardized (9). To ensure an effective seal in the apical region, gutta-percha cones can be customized (10). A review of the literature revealed that the accuracy of gutta-percha cone cuts performed under different magnifications has not been previously compared. Therefore, the aim of this study was to evaluate the effects of different magnification levels (2.5x, 7.5x, and 25x) on the cutting lengths of gutta-percha cones. According to the results of this study, the cutting lengths of gutta-percha were not affected by the magnification levels. However, it was observed that the closest cut to the
desired length was achieved using the dental operating microscope, followed by cutting with the naked eye. The cuts made with 2.5x and 7.5x magnification loupes followed.

Table 1. Inter-observer agreement for measurements of cuts made with the naked eye.

			Asymptotic		95% Asymptotic Confidence Interval	
Ratings	Weighted Kappa	Std. Error	Z	*p*	Lower Bound	Upper Bound
obs_1- obs_2	,714	,083	4,485	<,001	,551	,876

Table 2. Inter-observer agreement for measurements of cuts made with 2.5x magnification

			Asymptotic		95% Asymptotic Confidence Interval	
Ratings	Weighted Kappa	Std. Error	Z	*p*	Lower Bound	Upper Bound
obs_1- obs_1	,785	,041	5,026	<,001	,703	,866

There is no similar study in the literature to compare the findings of this study. However, Silva et al. (11) investigated the effects of different cutting techniques on the surface properties of gutta-percha and

reported that the smoothest cut surface structure on gutta-percha could be achieved using a specially designed instrument for this procedure. Asgary et al. (12), on the other hand, compared cutting tools such as a scalpel and scissors, and found that the best surface properties were obtained with cuts made using a scalpel on glass surfaces.

In the present study, most measurements, both under all magnifications and with the naked eye, were found to be longer than the desired length. This could be due to the formation of additional edge protrusions as a result of cuts not being made at a perfect perpendicular angle, leading to longer measurements. In other words, angular errors during the cuts may have negatively affected the accuracy of the measurements. Furthermore, to avoid overfilling, it is also possible that the operator unintentionally might cut the cones longer. This could result in the actual length of the cuts deviating from the targeted length. Additionally, the cuts made with the naked eye were found to be more ideal compared to those made with loupes may be due to the clinician making the cuts routine use of the naked eye, which allows for better hand precision compared to working with loupes.

Table 3. Comparison of gutta-percha cut lengths

Dependent Variable	Groups	n	Mean Rank	X^2	Df	*p*
Gutta-percha lenghts	Eye	15	29,60	1,845	3	0,605
	2.5X	15	32,10			
	7.5X	15	34,27			
	25X	15	26,03			

n: sample size, X^2: chi-square value, Df: degrees of freedom, Significance level: p value < 0.05

A limitation of the present study is the lack of examination of the cut surfaces. Therefore, it may be recommended to consider morphological surface analyses in addition to measurement data in order to better evaluate the effect of magnification on cutting accuracy. To comprehensively investigate the effect of magnification on the cutting efficiency of gutta-percha cones and clarify its accuracy, further studies with larger sample sizes are needed. Such studies could increase the generalizability of the results and provide a clearer understanding of the impact of magnification on the cutting accuracy of gutta-percha cones. Furthermore, although gutta-percha cones can not be produced as standard, using files and gutta-percha cones from the same company can improve the apical fit of the cone.

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Author contributions: Literature search, Writing-original draft preparation: HU, EM; Study conception and design, review and editing: EM; Data collection and measurements: HU, EM.

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