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The Effect of Gates-Glidden Drills on the Quality of Root Canal Treatment by Pre-Clinical Dental Students

Roohollah Sharifi[1], Amin Torabi[2], Reza Hatam[1], Nafiseh Nikkerdar[3], Hamid Reza Mozaffari[4,5], Mohsen Safaei[6*], Seyed Mojtaba Amiri[7]

[1]Department of Endodontics, School of Dentistry, Kermanshah University of Medical Sciences, Kermanshah, Iran; [2]Students Research Committee, Kermanshah University of Medical Sciences, Kermanshah, Iran; [3]Department of Oral and Maxillofacial Radiology, School of Dentistry, Kermanshah University of Medical Sciences, Kermanshah, Iran; [4]Department of Oral and Maxillofacial Medicine, School of Dentistry, Kermanshah University of Medical Sciences, Kermanshah, Iran; [5]Medical Biology Research Centre, Kermanshah University of Medical Sciences, Kermanshah, Iran; [6]Oral and Dental Sciences Research Laboratory, School of Dentistry, Kermanshah University of Medical Sciences, Kermanshah, Iran; [7]Department of Biostatistics and Epidemiology, School of Health, Kermanshah University of Medical Sciences, Kermanshah, Iran

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***Correspondence:** Mohsen Safaei. Oral and Dental Sciences Research Laboratory, School of Dentistry, Kermanshah University of Medical Sciences, Kermanshah, Iran. E-mail: mohsen_safaei@yahoo.com

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Abstract

AIM: This study was conducted to investigate the effect of applying Gates-Glidden (GG) drill by pre-clinical dental students on root canal treatment quality.

METHOD: A total of 56 first molars consisting of 168 canals were selected in this study. For this purpose, 56 students who had been formerly trained by two methods of root canal preparation were randomly divided into two groups (n = 28). Group 1: the step-down method by GG and Group 2: step-back technique without GG. The prepared teeth were filled with gutta-percha/ZOE sealer using lateral condensation. Periapical radiographs were taken before and the following treatment to survey occurrence of preparation errors and CBCT images to determine residual dentine at furcation region.

RESULTS: The findings showed that among 10 error types in specimens prepared by students, the occurrence of underfilling, overfilling, inappropriate, ledge formation, and single cone was more common without GG. There were no significant differences in residual dentine amount at furcation region between preparation with and without using GG ($P > 0.05$).

CONCLUSION: Using GG for root canal preparation by dental students resulted in low errors and not an increased dentine removal risk.

Introduction

One of the most important parts in the treatment of root canal is cleaning and shaping it to eliminate the wound and maintain the original shape of the canal [1]. An ideally prepared canal should form a uniform cone between the apical third and cervical third [2].

Technical errors or the problems associated with root canal instrumentation are the factors causing root canal treatment failure [3]. Despite scientific developments and technological advances, the biomechanical instrumentation techniques and new files are still limited regarding performance and efficiency [4], [5]. Among the instruments used for canal preparation, Gates-Glidden (GG) drill is extensively used for the preparation of direct areas of root canal owing to high cutting capability, easy application, and low price [6]. Additionally, GG drills are deliberately designed to separate near the hand-piece to facilitate the removal of a fractured drill piece from the root canal [7]. GG may be necessary for access into the root canal to provide a direct path into orifices without weakening the remaining structure. Applying GG widens the cervical area, making it possible for larger files to penetrate the apical area

[8]. However, there are opposing opinions about GG. Wu et al., [9] reported that the preparation of curved canals by GG drills might reduce the thickness of dentin and increase the risk of perforation. Flores et al., [10] reported no significant differences in the four instruments of GG, Largo, LA-Axxess and Cpdrill about the removal of canal dentin. Also, GG drill was introduced as an acceptable instrument regarding preserving the thickness of root dentin during canal preparation, which did not remarkably reduce the thickness of the remaining dentin [11].

Acquiring enough skills to perform the desired RCT by undergraduate dental students has been the subject of intense research among the scholar and university instructors [12], [13], [14]. For example, at Kermanshah School of Dentistry, Iran, undergraduate students must complete a pre-clinical Endodontics course that includes both theoretical (seminars) and practical training (training of the manual files and GG drills).

This research aims to investigate the effect of using GG drill on the quality of root canal treatment by pre-clinical educational undergraduate students. In the present study, the quality of the performed treatments regarding the incidence of various technical errors was analysed by periapical radiographs, and the remaining dentin was measured by cone beam computed tomography (CBCT).

Material and Methods

In this quasi-experimental study, the samples were selected from among the extracted mandibular and maxillary molars using the simple sampling technique. Students participating in this project include 56 pre-clinical dental students in Kermanshah school of Dentistry, Iran. First, root canal treatment techniques with and without GG drills were instructed to the students theoretically and practically. Then, one tooth was randomly given to each student. The students were divided into two groups each having 28 members (n = 28). One group of students prepared one tooth by GG drills using the step-down method, and another group prepared tooth through the step-back technique without using GG drills.

A total number of 56 extracted maxillary and mandibular first molars were collected. The teeth without cracks, internal or external root resorption and the curvature of each root canal were measured according to Schneider's method [15], and those with < 25° curvature and < 22 mm length were included in the study. The teeth were kept in 0.5% chlorine solution until the initiation of the experiment. Before the treatment, the tissue residues and dental calculus were removed by a scalpel. The blocks of self-curing acrylic immediately were combined with sawdust and plaster with dimensions of 2 x 2 x 2.5 cm and a piece of wax (3 x 3 mm) was mounted at the end of the apex. The samples were placed on a flat surface by two pieces of 3 x 10 mm wax in an arch shape, and the position of the samples was marked on the plate to assimilate the teeth at the time of taking CBCT radiographs (for evaluation of the remaining dentin at the surroundings of furcation). Before treatment, CBCT radiographs were taken from the samples (10 samples in each stage), and volumetric CBCT scan was performed on each tooth with a high resolution [12 x 8] field of view, 5.4 second exposure time, 3.07 mA and 110 kV by VGI New Tom machine (Italy). Cross-sections (0.5 mm thickness and 0.1 mm interval) were prepared from each tooth. Also, a periapical radiograph was taken by an X mind machine (Italy) using the parallel technique (8 mA and 70 kV) from buccolingual direction.

Standard access cavities were prepared using diamond burs connected to a high-speed handpiece under constant water spray. The length of the canal was determined by k-files, sizes 10 and 15. To this end, the file was placed within the root canal, and a radiograph was taken to determine the length. The working length was considered to be 1 mm from the apex. Then, the instrumentation of one tooth was performed with GG drills using step-down technique and instrumentation of another tooth was carried out without GG using step-back technique. In the step-back technique, the working length was determined by file 15. Then, the files 20, 25 and 30 were used until the master apical file (MAF) was determined. After determining MAF, canal preparation was done with a working length of 1 mm short of the canal's length for each larger file, 1 mm shorter than the length of operation to file 45. In the step-down technique, the working length was determined using file 15. Next, the coronal third of the root canal was prepared by GG drills 1, 2 and 3, and files 20, 25 and 30 were applied for apical instrumentation. Continued instrumentation of the apical area was similar to the step back technique. During all the stages, the canals were rinsed with 0.5% sodium hypochlorite solution. Afterwards, they were dried with paper points. The prepared canals were filled with gutta-percha (Arya dent, Iran) and ZOE sealer (Golchay, Iran) according to the manufacturer's instructions using the lateral condensation technique.

Two calibrated and blinded endodontists evaluated the radiographs to detect different types of errors. Apical evaluation of radiographs was performed by view box. Ten possible errors detected by endodontists in periapical radiographs were recorded in separate forms, which included vertical root fracture, fractured file, zipping, and ledge underfilling, overfilling, single cone, inappropriate shaping, strip perforation and canal transportation [16]. Evaluation of CBCT radiographs was done before and after obturation by NMT Free viewer to find out the amount of initial dentin and remaining dentin in

the surroundings of furcation.

Before and after preparation of samples, the thickness of dentin at the surrounding of furcation was measured in the depths of 5 mm from the canal opening on CBCT radiographs (at axial section) using NMT Free viewer software. To determine the thickness of primary dentin, one section in a specific depth of CBCT radiograph was selected for each sample, and the thickness of primary dentin at the adjacent area of furcation in the depths of 5 mm from the opening of the canal was measured by the ruler of the software. After preparing and filling the canals, the thickness of the remaining dentin for each sample in the same section of CBCT radiograph was measured by the same method. The amount of removed dentin was calculated by subtracting the thickness of the initial dentin from the thickness of the remaining dentin.

Data were analysed by SPSS18 software using inferential statistics, including Kappa coefficient for diagnostic agreement between two endodontists and multivariate logistic regression by moderating the effect of the views of both endodontists. Independent samples t-test was applied to specify the difference between primary, removed and remaining dentin with and without application of GG drills. A p-value of less than 0.05 was considered as statistically significant.

Results

A total of 1540 errors were diagnosed through periapical evaluation, from which both endodontists agreed upon 1345 cases and disagreed on 195 cases. The diagnostic agreement between both endodontists was statistically significant about all errors in all canals of mandibular molars by periapical evaluation (Kappa coefficient: 0.6). In this section, only statistically significant difference errors between application and non-application of GG are presented (Table 1).

Table 1: Main errors observed between application and non-application of Gates Glidden drill

			With GG[5]	Without GG	
Underfilling	DB[1] (maxillary molar)	A	8.3%	40.0%	0.002
		B	8.3%	60.0%	
Overfilling	MB[2] (maxillary molar)	A	16.7%	83.3%	0.007
		B	16.7%	83.3%	
Inappropriate shaping	P[3] (maxillary molar)	A	42.9%	83.3%	0.014
		B	28.6%	100.0%	
	D[4] (mandibular molar)	A	14.3%	71.4%	0.010
		B	14.3%	57.1%	
Ledge	DB (maxillary molar)	A	8.3%	80.0%	0.001
		B	8.3%	80.0%	
Single cone	D (mandibular molar)	A	21.4%	45.0%	
		B	14.3%	28.6%	0.019

1. Distobuccal canal (DB); 2. Mesiobuccal canal (MB); 3. Palatal canal (P); 4. Distal canal (D); 5. Gates Glidden (GG).

In the distobuccal canal of maxillary molars, there was a significant difference between two groups regarding the incidence of underfilling (P = 0.002), in which the incidence of error was 7 times greater in cases where GG drill was not used. In the mesiobuccal canal of maxillary molars, there was a significant difference between two groups regarding the incidence of overfilling (P = 0.007), the incidence of error was 6 times greater in cases where GG drill was not used.

In the palatal canal of the maxillary molars, there was a significant difference between the application of GG and non-application of GG in terms of the incidence of inappropriate shaping (P = 0.014), the chance of error was 4 times greater in cases where GG was not used.

In the distobuccal canal of maxillary molars, the ledge was 10 times greater in cases where GG was not used that was statistically significant (P = 0.001). In the distal canal of mandibular molars, the incidence of the single cone was more prevalent in which the chance of error was 2.6 (P = 0.019) time greater in cases where GG drill was not used.

The evaluation of the amount of remaining dentin in the middle third of all canals by CBCT radiographs showed no significant difference between using and not using a GG drill (Independent t-test, P > 0.05) (Table 2).

Table 2: Mean and standard deviation of the volume of removed dentin

Type of Canal	The volume of remaining dentin				P-value
	With GG[6]		Without GG		
	Mean	SD	Mean	SD	
MB[1] (maxillary molar)	0.9043	0.27972	1.0067	0.30768	0.198
DB[2] (maxillary molar)	1.1000	0.38612	1.1400	0.39115	0.702
P[3] (maxillary molar)	1.1214	0.37453	1.0833	0.26394	0.662
MB (mandibular molar)	0.9133	0.31366	0.9476	0.21591	0.636
ML[4] (mandibular molar)	0.9917	0.27122	0.9500	0.29212	0.582
D[5] (mandibular molar)	0.9500	0.32046	0.9900	0.21250	0.584

1. Mesiobuccal canal (MB); 2. Distobuccal canal (DB); 3. Palatal canal (P); 4. Mesiolingual canal (ML); 5. Distal canal (D); 6. Gates Glidden (GG).

Discussion

In this study, periapical radiographs were used to evaluate the effect of applying GG by preclinical students on procedural errors [13], [16]. The results of the present research show that utilisation of the GG drills by pre-clinic students during root canal preparation significantly decreased underfilling, overfilling, inappropriate shaping, ledge and single cones (P < 0.05).

The incidences of underfilling and in the distobuccal and over filling in the mesiobuccal canal of maxillary molars were greater while GG drill was not used. Reduction of underfilling and overfilling errors in cases where GG was used might be due to a direct access to the apical area of the canal and a better control over the working length. It has been found that preparing the coronal portion of the root canal provides different benefits in irrigation efficacy, apical

control, cone fit, and compaction procedures. In this regard, apical blockage, lodging, zipping, and perforations are less likely to occur [17], [18], [19]. Mollashahi et al., [20] reported adverse effects, especially in the curved canals declined while using GG, which can be attributed to the direct access of this instrument into canals. Kfir et al., [21] showed that various techniques could differently lead to the incidence of errors. They reported the incidence rates of 5% and 2% for transportation and perforation in the 8-step technique, respectively, and frequency rates of 17%, 7% and 6% for transportation, perforation and canal obstruction in the step-back technique, respectively. To verify the effect of canal shape on the incidence of error, Yin et al., [22] demonstrated that in the curved canals, the rotary and manual systems manifested different performance regarding the incidence of error and cleaning the surface of the canal.

The results of the present research showed no significant difference between application and non-application of GG about the remaining dentin in the furcation surroundings and danger zones of the prepared canals. This result can be because in this study students were instructed how to use GG drill through anticurvature technique, as a result of which the removal rate of dentin in the area adjacent to furcation was lower. GG drill was introduced as an acceptable instrument regarding preserving the thickness of root dentin during canal preparation. This technique does not remarkably reduce the thickness of the remaining dentin and may be suitable and safe for pre-flaring [11], [23], [24], [25]. Some researchers stated that the remaining dentin during preparation with GG drills depends on the type of technique and application of GG in both step-back and crown-down techniques can yield favourable results [23]. Mahran and Abo-El-Fotouh [26] reported a different performance for three different instruments, including Pro Taper, Hero Shaper and GG about the amount of removed dentin in the root canal. Based on the contradictions reported in various studies, it seems that the amount of the remaining dentin after canal preparation depends on the shape of the canal in addition to the type and clinicians' handling of the instrument.

The results of this study also showed no significant difference between the two techniques of canal preparation with and without using GG drill about the amount of removed dentin in maxillary and mandibular molars. Akhlaghi et al., [27] reported no statistically significant difference between GG drills and rotary files regarding the amount of removed dentin in the canals of mandibular first molars with curvatures of 20-35°. Maxillary first premolars with two roots and furcation area in the middle part are sensitive to canal preparation; therefore, it is necessary to remove a limited amount of dentin in these teeth due to the little amount of dentin left after canal preparation [28]. In addition to these factors, the primary thickness of dentin is an important factor in determining the amount of dentin to be removed during canal preparation [29]. One of the noticeable limitations of this study is that the root canals morphology was not the same in the specimens. Also, the procedure was done without using head phantom during the pre-clinical endodontic course.

In conclusion, within the possible reduction of underfilling, overfilling, inappropriate shaping, ledge and single cone errors in some canals, the practical GG drill technique was found suitable by the dentistry students. Moreover, no difference was observed between the two techniques of canal preparation with and without the use of GG drill regarding the amount of remaining dentin adjacent to the furcation area.

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