

Knowledge and Understanding of Endodontic Concepts, Working Width vs Working Length and Variable Taper vs Constant Taper among Endodontic Practitioners

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ABSTRACT

Aim: The present study aims to assess the knowledge of some endodontic concepts, working width (WW) vs working length (WL) and variable taper vs constant taper among endodontic practitioners.

Materials and methods: A descriptive study design was employed to assess the knowledge and understanding of endodontics practitioners. The questionnaire was distributed among 400 participants, which was composed of different items and was measured using different rating scales.

Results: Descriptive statistics were presented in tables based on the frequency and percentages of responses from participants. Out of 400 participants, 363 responses were obtained. The results showed that the radiographic method and the electronic method were both useful for determining the WL during root canal treatment. Moreover, a majority of the participants preferred to use WL with 0.5 mm shorter than apex, while a few of them preferred 1 mm shorter than the apex. The significant factors that help in determining the WW and length included canal taper, canal morphology, and canal curvature.

Conclusion: The study results have concluded that both the radiographic method and the electronic method are useful in determining the WL. Canal geometry and morphology were among the factors that influence the WL detection method.

Keywords: Constant taper, Endodontic concepts, Variable taper, Working length, Working width.

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INTRODUCTION

One of the major components of root canal treatment is canal preparation. It is directly related to subsequent disinfection and obturation of the root canal. To allow effective chemo-mechanical preparation and obturation of the root canal, instrumentation must result in a continuously tapered shape with the smallest diameter at the apical foramen and the largest at the orifice.¹ Despite the manufacturing of so many rotary Ni–Ti instruments, only a few matched the level of these primary objectives of root canal preparation consistently.² Root canal shaping is one of the most important steps for successful root canal therapy. Therefore, understanding the complexity of the root canal system has led to the development of newer techniques, instruments, and materials. It is important to accurately understand concepts such as endodontic WL and WW of each canal. Failure to accurately determine the WL may result in apical perforation and subsequent extrusion of irrigation solutions and obturation material into the periapical tissues.^{3–6} It was found out that the palatal and the mesiobuccal roots of maxillary molars present inaccurate radiographic WL readings.⁷

Root canal preparation with rotary nickel–titanium (Ni–Ti) instruments became popular in the last decade as it facilitates the difficult and time-consuming process of shaping and improves the final quality of root canal preparation. Even in severely curved canals, as demonstrated, Ni–Ti instruments are able to maintain canal shape.^{8,9} After getting these positive results, new Ni–Ti systems are being introduced with new blade designs and tapers, claiming increased safety and easiness to use. Currently, available Ni–Ti instruments vary in their designs. Various blade designs, different tapers, additional grooves, and different tip geometries

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have been suggested. According to the taper, the shaft design can be categorized into two categories: progressive taper and constant taper. Instruments with progressive taper can shape canals more quickly than instruments with constant taper.¹⁰ It is claimed that instruments with a progressive taper that increases coronally have enhanced flexibility at the apical and middle parts of the instrument.

Dentists who have incorporated rotary instrumentation into their routine practice seek a simple system of files and look for an easier technique to be used in daily operations. Many dentists are attracted by the techniques which involve only a few instruments. With their initial choices, some of them rapidly find a practical comfort level. They add their own modifications per acquired experience, propound to use other instruments and techniques. The new design and usage of this modality for canal preparation required close understanding toward the physics of rotary instrumentation.

The present study aims to assess the knowledge of some endodontic concepts, WW vs WL and variable taper vs constant taper among endodontic practitioners.

MATERIALS AND METHODS

This study was based on a descriptive design to assess the knowledge and understanding of endodontics practitioners. The study was conducted at the Faculty of Dentistry, King Abdulaziz University, Jeddah, Kingdom of Saudi Arabia. An informed consent form has been signed by all the participants based on their willingness by ensuring their confidentiality and anonymity throughout the study period.

The study data were collected using a primary data collection approach (survey questionnaire), which included WW, WL, variable taper, and constant taper. The questionnaire was based on two sections: demographics and questions comprising a total of 21 questions. The questionnaire has been distributed to the potential participants through an online survey. A total of 400 dental practitioners from different dental sectors in Saudi Arabia were approached, out of which only 363 answered the questionnaire completely. The variables listed in the questionnaire were composed of different items and were measured using different rating scales.

Descriptive statistics were used to present the frequencies and percentages of the demographic variables, while cross-tabulation was performed to show the knowledge and understanding of endodontic concepts among practitioners.

RESULTS

A total of 400 participants were approached initially from which only 363 participants had completely returned the questionnaire and, therefore, were considered as the final sample for the study.

Table 1 presents the descriptive statistics based on the demographic variables, including gender, age, years in practice, and academic degrees. Gender distribution of the participants was of the following: 70% of females and 30% of males. Most of the participants had experience of less than 1 year (51.51%), followed by 2–5 years (31.6%), and more than 10 years (9.09%). Most of the participants possess a bachelor's degree (87.05%).

WL AND WW

This section presents the definition, determination, significance, measurement, and factors affecting WL and WW. Table 2 shows the definition and determination of WL and reveals the definition of WL as "The distance between the reference point coronally and the anatomical apex" (37.19%). Most of the participants stated that both the radiographic method and the electronic method are used to determine the WL (78.23%).

Table 3 presents the significance of WL by listing the most important factors. These factors include "Determine the instrument length in the canal" (14.6%), "Limits the depth to which the canal filling may be placed" (11.29%), and "Determination of the success of treatment" (3.3%). Most of the participants stated that "0.5 mm shorter than the apex" is the accurate measurement of WL. However, a few of the participants preferred to use WL with 1 mm shorter than the apex (Table 4).

The determination of WL and WW is affected by several factors (Table 5). In this regard, canal morphology, canal taper, and canal curvature were the most important factors to determine the WW and the WW (57%).

Table 1: Demographic distribution of the participants

Variables	Descriptive statistics	
	n	%
Gender		
Male	109	30
Female	254	70
Age		
21–30	282	77.7
31–40	55	15.15
41–50	24	6.61
51–60	2	0.55
Years in practice		
Less than 1 year	187	51.51
2–5 years	115	31.6
6–10 years	28	7.71
More than 10 years	33	9.09
Academic degrees		
Bachelors	316	87.05
Masters	12	3.3
PhD	4	1.1
Doctorate	3	0.8
International board certificate	6	1.65
Saudi board certificate	20	5.50
Diploma	2	0.55

Table 2: Frequency and percentage of responses to the definition and the method of determination of WL

	n	%
Definition of working length		
The distance between the reference point coronally and the anatomical apex	135	37.19
The distance between the reference point coronally and the radiographic apex	126	34.71
Both are true	95	26.17
None of the above are true	6	1.65
I do not know the right answer	1	0.2
Determination of working length		
Radiographic method	17	4.68
Electronic apex locator	61	16.8
Both	284	78.23
I do not know the right answer	1	0.2

Table 3: Factors that test significance of WL

Significance of working length	n	%
Determine the instrument length in the canal	53	14.6
Limits the depth to which the canal filling may be placed	41	11.29
Limits the postoperative pain and discomfort	4	1.1
Determination of the success of treatment	12	3.3
All of the above	243	67
I do not know the right answer	10	2.75

Table 4: A question to verify the preferred WL extension among participants

Measurement of working length	n	%
0.5 mm shorter than the apex	200	55
1 mm shorter than the apex	88	25
None of the above	75	20.66

Table 5: Factors that affect the determination of WW and WL

Factors	n	%
Canal morphology	52	8.25
Canal taper	33	9
Canal curvature	16	4
All of the above	207	57
I do not know the right answer	55	15

VARIABLE AND CONSTANT TAPER

This section presents the knowledge and understanding of variable and constant tapers in the form of meaning, and types of files according to the taper. Table 6 presents the meaning of variable and constant taper. Most of the participants understand variable taper as “a series of rotary files that have the same common apical tip size but vary in their tapers” (29.7%), whereas participants reveal the meaning of constant taper as “a series of files with a constant taper with varying apical tip sizes” (46.8%).

Table 7 presents the features of variable and constant taper files and shows the following result: “conservative in the coronal third of the radicular dentin” as the most important feature of the variable taper (23.96%) and constant taper, respectively (33.3%).

Table 8 presents the different types of files, weather variable taper, or constant taper. The findings showed the preference of protaper next as the most important type of variable taper file (66.39%), whereas K-Flexofiles were the most important type of the constant taper file (74.38%).

PREPARATIONS USING VARIABLE AND CONSTANT TAPER

This section shows the effectiveness of variable and constant tapers in canal preparation (Table 9). The findings showed that variable

Table 6: Definitions of variable and constant taper

	n	%
Meaning of variable taper		
A series of rotary files that have the same common apical tip size but vary in their tapers	108	29.7
A series of files with a constant taper and with varying apical tip sizes	97	26.7
Using single Ni Ti file with variable taper	54	14.8
I do not know the right answer	104	28.65
Meaning of constant taper		
A series of rotary files that have the same common apical tip size but vary in their tapers	95	26
A series of files with a constant taper and with varying apical tip sizes	170	46.8
Using single Ni Ti file with constant taper	98	27

Table 7: Features of variable and constant taper

	n	%
Features of variable taper		
Decrease the possibility of fracture	41	11
Conservative in the coronal third of the root canal	87	23.96
Facilitates the cone fit	35	9
Faster preparation of the coronal third of the canal	65	17.9
I do not know the right answer	135	37.19
Features of constant taper		
Decrease the possibility of fracture	44	12
Conservative in the coronal third of the root canal	121	33.3
Associated with thermoplastic obturation	20	5.5
Faster preparation of the coronal third of the canal	53	14.6
I do not know the right answer	125	34.4

Table 8: A question to test the knowledge of taper characteristics of different rotary files

	n	%
Variable taper		
Protaper next	241	66.39
Protaper universal	85	23.4
Protaper gold	37	10
Constant taper		
Revo-S	74	20.3
K-Flexofiles	270	74.38
I-Race	19	5.2

Table 9: A question to test preparations features of variable taper and constant taper rotary files

	Variable taper	Constant taper	All of the above	I do not know the right answer
High efficiency of cleaning and debridement	91	56	122	94
Resistance and retention form	106	62	94	101
Better prognosis	144	65	154	-

taper is used for better prognosis (n = 144), whereas constant taper is used for maintaining resistance and retention form (n = 62).

DISCUSSION

The results of the present study showed that the radiographic method and the electronic method were useful in determining the WL as narrated by the majority of the participants. The success of root canal treatment depends on the apical termination of obturation, for which, the WL is an important element. A study conducted by Rambabu et al. evaluated the preoperative WL in radiograph and grid radiograph.¹¹ This approach was concerned with the electronic apex locator within the single-rooted teeth. As compared with the conventional WL and apex locator WL, grid WL and apex locator WL showed a high correlation. Therefore,

radiographic grid along with the apex locator is considered as an effective measuring tool for a single-rooted tooth.

Another similar study conducted by Carneiro et al. focused on the accuracy of electronic apex locator for determining the real WL in comparison to the radiographic method.¹² The study results showed that there was a no significant difference between the electronic and radiographic methods. Therefore, it can be concluded that the WL of root canals can be easily determined through electronic apex locator as it is a reliable and accurate method, which optimizes the endodontic procedure in clinical practice. According to the results of the present study, a majority of the study participants reported that the accurate measurement of WL is 0.5 mm shorter than the radiographic apex. At present, apex locators are extensively used in the endodontic therapy and these devices have become indispensable in the clinical practice.

The field of endodontics has gained attention to a new level with the advent of new inventions that enter this field each day. This has resulted in the shift in direction for a root canal from biomechanical preparation to chemo-biomechanical preparation. The access of endodontic irrigants to the WL during treatment is significant, although root canal treatment should not only depend on proper cleaning and shaping procedures.¹³ The endodontic treatment provides predictable clinical results when instrumentation and obturation reach the apical foramen. The results of the present study have demonstrated that there were some participants who were in favor of using WL that is 1 mm shorter than the apex. It was shown that working at 1 mm shorter than the apex resulted in the reduction of cracks in the apical region.¹⁴

Using radiographs alone to determine the WL presents some difficulty when the needed adjustment is more than 1 mm.¹⁵ Different radiographic conditions affect the accuracy of WL determination.¹⁶ A study conducted by Gutmann showed that establishment of WL close to the canal exit or slightly short to the apical foramen is required for cleaning the entire length of the canal.¹⁷ The same study has also revealed that the files placed to the apical extent of the root will likely be outside the confines of the canal, because the root apex may present with several morphological variations in the presence of apical resorption.¹⁷ A ledge is likely to be created through modification of instrumentation that is associated with re-determination of WL.¹⁸ The use of the Root ZX apex locator combined with radiographs is recommended for WL determination.¹⁹ In another study, it was found out that the location of the apical foramen can be determined using radiographs.²⁰

The present study aimed to understand some endodontic concepts, WW vs WL and variable taper vs constant taper among participants. The factors that help in determining the WW and WL include canal taper, canal morphology, and canal curvature. The study results have preferred protaper next as the most important type of variable taper file, whereas K-Flexfiles were the most important type of the constant taper file.

CONCLUSION

The study results have concluded that variable and constant tapers both play an effective role in canal preparation. It also showed that both the radiographic method and the electronic method are both useful in the determination of WL. One limitation of the study was that it did not assess factors that may increase the difficulty of root canal preparation or instrumentation.

CLINICAL SIGNIFICANCE

The study tests the importance of the understanding of endodontic concepts in the success of root canal treatment.

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QUESTIONNAIRE

What is your age?

- 21–30
- 31–40
- 41–50
- 51–60
- 61–70
- 71–80

What is your gender?

- Male
- Female

What is your specialty?

- Student
- General Dentist
- Endodontist
- Oral surgery
- Periodontist
- Prosthodontist
- Orthodontist
- Saudi board resident, specify
- Other

Years in practice

- Less than one year
- 2–5 years
- 6–10 years
- More than 10 years

What is your highest academic degree?

- Bachelor
- Master
- Ph.D
- Doctorate
- International board certificate
- Saudi board certificate
- Diploma

Working length is defined as

- The distance between the reference point coronally and the anatomical apex
- The distance between the reference point coronally and the radiographic apex
- Both are true
- None of the above are true
- I do not know the right answer

The working length is determined by

- Radiographic method
- Electronic apex locator
- Both
- I do not know the right answer

Significance of working length determination is/are to

- Determine the instrument length in the canal
- Limits the depth to which the canal filling may be placed
- Limits the postoperative pain and discomfort
- Determination of the success of treatment
- All of the above
- I do not know the right answer

Working width is defined as

- The largest diameter of the original canal size in the apical third
- The horizontal dimension of a root canal
- Both are true
- I do not know the right answer

Working length should be

- 0.5 mm shorter than the apex
- 1 mm shorter than the apex
- 2 mm shorter than the apex
- None of the above

Which factor/s affect the determination of working width and working length

- Canal morphology
- Canal taper
- Canal curvature
- All of the above
- I do not know the right answer

Root canal morphology is a critically important part for both conventional and surgical root canal therapy (RTC)

- True
- False

What is the meaning of the variable taper concept?

- A series of rotary files that have the same common apical tip size but vary in their tapers
- A series of files with a constant taper such and with varying apical tip sizes
- Using single Ni Ti file with variable taper
- I do not know the right answer

What is the characteristic feature of variable taper?

- Promote disengagement of the instruments
- Conservative in the coronal third of the radicular dentin
- Facilitates the primary cone fit
- Preparation of the coronal third of the canal and for eliminating interferences.
- I do not know the right answer

Which type of variable taper files do you use?

- Protaper next
- Protaper Universal
- Protaper Gold

What is the meaning of the constant taper concept?

- A series of rotary files that have the same common apical tip size but vary in their tapers
- A series of files with a constant taper such and with varying apical tip sizes
- Using single NiTi file with constant taper

What is the characteristic feature of constant taper files?

- Promote disengagement of the instruments
- Conservative in the coronal third of the radicular dentin
- Associated with thermoplastic obturation
- Preparation of the coronal third of the canal and for eliminating interferences
- I do not know the right answer

Which type of constant taper files do you use?

- Revo-S
- K-Flexofiles
- I-Race.

Which of these preparations has high efficiency of cleaning and debridement?

- Variable taper prep
- Constant taper prep
- All of the above
- I do not know the right answer

Which preparation achieves and keeps the resistance and retention form accurately?

- Variable taper prep
- Constant taper prep
- All of the above
- I do not know the right answer

In your opinion, which preparation gives better prognosis?

- Variable taper prep
 - Constant taper prep
 - All of the above
-