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KEY WORDS: Apical foramen, Grossman, Ingle, Root tip, Safety factor.

BISECTING VERSUS PARALLELING CONE TECHNIQUE IN THE ACCURACY OF WORKING LENGTH DETERMINATION-INVITRO STUDY

Dr Shalini Egmore Chennai 600008

Dr Ramaprabha* Professor *Corresponding Author

ABSTRACT

Introduction: The aim of this clinical study is to compare two radiographic techniques for determining working length of root canals namely bisecting and paralleling cone technique and to analyse whether the method of working length determination (Ingle/Grossman) or the technique of radiographic imaging plays a significant role in accurately determining root canal length.

Methods: A total number of 22 extracted teeth with 29 roots was collected and cleaned. Paralleling and bisecting angle techniques were used both preoperatively and postoperatively. Working length was evaluated using both Ingle's and Grossman's methods. The values were compared before and after reducing the saftey factor using the Chi-square test.

Results: Both the techniques and methods were statistically significant. Ingle's method overestimated the length less frequently in bisecting angle technique irrespective of safety factor while Grossman's method overestimated less frequently with paralleling technique when safety factor was not considered.

Conclusion: Bisecting angle technique gave more number of accurate values with Grossman's method when safety factor was considered. Paralleling technique gave more number of accurate values with Ingle's method when safety factor was considered.

INTRODUCTION

According to endodontic glossary, Working length is defined as "the distance from a coronal reference point to the point at which canal preparation and obturation should terminate" (1)

Working length should terminate in the smallest possible dimension of the root canal space (2, 3), thereby producing the smallest possible wound (4, 5). It is one of the critical factors for the success of endodontic treatment. Consistent determination of correct working length during cleaning and shaping and obturation is essential for the success of endodontic therapy (6, 7, 8). It is one of the verifiable steps in root canal treatment. Working length can be determined radiographically and electronically (9) but each has its own limitations. The following are the limitations of radiographic methods. (i) Increasing reliance on tactile sensation(10) (ii)Short measurements leads to under treatment (11), On the other hand (iii) over instrumentation leads to extrusion of infected material apically and trespasses into the periodontal domain (4,5)(iv)Multiple Radiation exposure especially in medical contraindications like pregnancy (12). The following are the drawbacks of electronic working length determination. (i) Moisture in the canal could affect the signal in certain apex locators (13) (ii) The presence of implanted electronic devices contraindicates the use of apex locators(14) (iii) Relationship of canal/root to the anatomical structures are not appreciated .

Thus, Radiographic method is the only universally accepted meaningful method of length adequacy assessment in the clinic (15). Radiographs can be taken by paralleling and bisecting angle techniques. Paralleling technique is also called the long cone/right angle technique. Here, the x-ray film is supported parallel to the long axis of the teeth and the central ray of the x-ray beam is directed at right angles to the teeth and film (16). In bisecting angle technique, the central ray of the x-ray beam is directed at right angles to the plane that bisects the angle between the long axis of the tooth and the film (16). Paralleling technique produces less distortion, increased image clarity, reproducible cone and film placement, but ideal parallel orientation is not feasible in all clinical situations (17). In such conditions bisecting angle technique can be used. Attempts to mimic vertical angulation for the type of the tooth can reduce the discrepancies in this technique of x-ray imaging (18). Radiographic calculation of working length involves many methods namely Ingle's method, Grossman's method, Best's method, Bregman's method, Bramante's method, Everett- Fixot method.

There are many studies reported in the literature comparing radiographic and electronic working length determination (19). However, the effect of radiographic technique, the method of calculation, and the effect of

safety factor have not been reported. Thus, the main aim of this study is (i) to compare two radiographic techniques for determining working length of root canals namely bisecting and paralleling cone technique (ii) Secondary aim is to analyse whether the method of working length determination (Ingle/Grossman) or the technique of radiographic imaging plays a significant role in accurately determining root canal length (iii) the influence of safety factor on the final working length was evaluated.

MATERIALS AND METHODS

Extracted human teeth were used in this study. Teeth with calcified pulp chambers or root canals were excluded from the study .A total number of 22 extracted human teeth which included incisors, canines and molars were collected and cleaned. Then the teeth were mounted in wax moulds covering from the root tip to cementoenamel junction.

Two preoperative radiographs were taken for each tooth using paralleling cone and bisecting angle technique. In bisecting angle technique, film was kept as close to the tooth as possible. Radiation source was kept at specific angulations (20) for each tooth that is, for

Maxillary central incisors : +40degrees
Maxillary molars : +20 degrees
Mandibular central incisors: -15 degrees
Mandibular molars: -5 degrees

In paralleling technique, the film – tooth and the tooth- source distance was kept as far apart as possible. Film and tooth was kept 1 inch apart, Tooth and the source was kept 12 inches apart. These measurements and angulations were standardized for each tooth. The length was measured preoperatively for each tooth and recorded in both the techniques.

Following which, access cavity was made in each tooth. Working length radiographs were taken after inserting 15 size k file in each canal. The radiographs were taken in both paralleling cone and bisecting angle technique as done earlier. By using these radiographs working length was calculated by both Grossman's and Ingle's methods as follows

Grossman's method (21)

Length of the tooth is initially measured from the radiograph (radiographic length of the tooth). The file measured to this length (actual length of the instrument) is inserted in the canal and another radiograph is taken. Radiographic length of the instrument is measured from this radiograph. The actual length of the tooth was calculated using this formula. Safety factor was also considered.

ALT = RLT X ALI
RLI
ALT= Actual length of the tooth
RLT=Radiographic length of the tooth
ALI= Actual length of the instrument
RLI= Radiographic length of the instrument
Ingle's method (22)

From the preoperative radiograph, the length of the tooth is measured. From this length 1mm is subtracted to overcome the errors due radiographic distortion. This is safety allowance. This length is measured in the instrument and inserted in the canal and another radiograph is taken. The difference between the instrument tip and the radiographic root tip is added or subtracted to instrument length depending on whether the instrument is

shorter or longer respectively. This is the tentative working length. 1mm safety factor was subtracted from this and the final working length was recorded. Safety factor is the average distance between the minor constrictor and the anatomic root tip.

Two reference landmarks in the root apex (standard I and II) were obtained for each tooth to compare the final working length calculated by each method or technique. The actual length of the teeth till apical foramen (Standard I) was determined by inserting a 15 size k file into the root canal after the removal of the wax moulds. The length was calculated till the file tip was barely visible at the apical foramen. A second set of measurements of the tooth length was taken to coincide with the root tip (Standard II).

STATISTICAL ANALYSIS:

Paralleling and bisecting angle techniques were compared using Ingle's and Grossman's method before and after reducing the saftey factor using the Chi-square test. All the comparison resulted the p-value less than 0.05 (level of significance).

RESULTS

All the combinations of techniques and methods were significantly different from each other ($p<0.05$) before and after subtracting the safety factor.

Bisecting angle technique gave more number of accurate values with Grossman's method (standard I) (post safety factor).

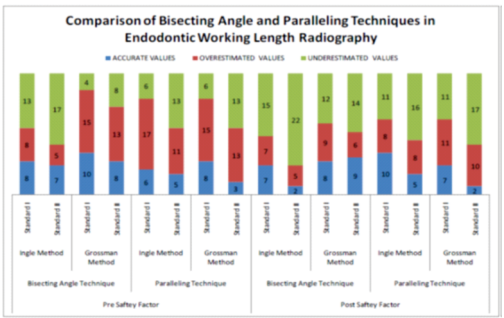
Paralleling technique gave more number of accurate values with Ingle's method (standard I) (post safety factor).

Bisecting angle technique overestimated less often with Ingle's method (standard II) (pre and post safety factor).

Paralleling technique overestimated less often with Grossman's method (standard II) (pre safety factor). Paralleling technique overestimated less often with Ingle's method (both standard I and II) (post safety factor). Bisecting angle technique underestimated less often in Grossman's method (standard I) (pre and post safety factor).

Paralleling technique underestimated less often in both Ingle's and Grossman's method (standard I) (pre and post safety factor).

The chart below shows the frequency distribution of accurate values, over estimated values and under estimated values across the combination of technique, method and saftey factor consideration.



*standard I= Apical foramen
*standard II= Root tip

DISCUSSION

Working length determination plays an indispensable role in root canal treatment. Accurate determination of working length is the most important step for the success of the treatment (6). Several studies concluded that overestimated working length had resulted in poor success rate. Swartz et al had found a significant decline in the success rate of overfilled canals. Underfilled canals also had a significant fall in the success rate of endodontic therapy (23,24)

There are various methods of determination of working length and often more than one is used in accurate determination. Plain films and conventional processing is the gold standard method. Tidmarsh et al proved conventional films to be superior to digital radiographs and electronic apex locators in length determination (25).

Forsberg compared paralleling, modified paralleling, and bisecting angle technique in length determination in which he concluded paralleling technique to be the most accurate (26). Our study also found that paralleling technique gave more number of accurate values with Ingle's method (standard I) (post safety factor). This technique overestimated less often with Grossman's method (standard II) (pre safety factor) and overestimated less often with Ingle's method (standard I and II) (post safety factor). It also underestimated less often in both Ingle's and Grossman's method (standard I) (pre and post safety factor). In a study, it was found that bisecting angle technique was accurate when the vertical angulation was minimal (26). In our study, Bisecting angle technique had given more number of accurate values with Grossman's method (standard I) (post safety factor). This technique overestimated less often with Ingle's method (standard II) (pre and post safety factor) and underestimated less often in Grossman's method (standard I) (pre and post safety factor).

Consistent reference point in the apex was considered to be the most coronal aspect of the major foramen. This reference point is located by an average of 0.5mm from the minor constriction in younger individuals and 0.7mm for older individuals (27). In our study both apical foramen (standard I) and the root tip (standard II) was considered as the reference points with and without the safety factors. Thus, the influence of the variation in this distance can be better balanced.

However, the clinical judgement of working length becomes more difficult when the distance between the apical foramen and the anatomic apex increases. This fact becomes more significant in premolars and molars where there is higher probability of inconsistency in foramen position (27).

Usually in Grossman's method safety factor is not considered but in our study when we considered it, accurate values were

obtained with bisecting angle technique (standard I).Ingle's method usually includes safety factor, but in our study Ingle's method gave better results with paralleling and bisecting technique with or without safety factors.

Bramante and Berbert (7) determined Ingle's method to be the most accurate method for measuring canal length. Fitzgerald (28, 29) and Bhakdinaronk et al (30) studied paralleling technique to be the most accurate. But in clinical situation this technique is not consistently possible. Price (31) outlined bisecting angle technique which was the dominant one in the 1970s.

Many studies in the literature had compared the efficacy of paralleling and bisectingangle techniques in working length determination (32). But, in our study we had compared the accuracy of both paralleling and bisecting angle technique in both Ingle's and Grossman's method with and without including the safety factors. We have found that there are significant differences between the two angulation techniques in the two different methods and safety factor played a key role in affecting the values.

Thus it is evident that paralleling technique gave more number of accurate values with Ingle's method (standardI)

(post safety factor). Bisecting angle technique gave more number of accurate values with Grossman's method

(standard I) (post safety factor). Paralleling technique overestimated less often with Grossman's method (standard II) (pre safety factor). Paralleling technique overestimated less often with Ingle's method (both standard I and II) (post safety factor).

CONCLUSION

Within the limitations of this in-vitro study, it may be concluded that it is prudent to use Grossman's method and consider safety factor of 1mm when bisecting angle technique is used for taking radiograph. In the contrary, Ingle's method can be used when paralleling technique is used for taking radiography.

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