ADVANCES IN
BASIC AND CLINICAL ORAL SCIENCES

ADVANCED ENDODONTICS AND PERIODONTOLOGY

· EDITORS RONG SHU JINGPING LIANG ·

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PREFACE

This book is designed to focus on research progress of endodontics and periodontology in recent years and to guide the students to understand the trends of those fields, establishing their scientific attitude to explore the unknown knowledge. The part for Endodontics is divided into 6 chapters, determination of root canal working length,development and application on micro root canal treatment, root canal retreatment, strategies to the problems in the process of root canal treatment, the effect of oval canal on root canal treatment, radiographic aids in root canal treatment. The part of periodontology is divided into 5 chapters, frontiers in periodontal microbiology, research progress of aetiology from systemic disorders, periodontal initial therapy, the progress of periodontal regenerative therapy, and the periodontal medicine outline.

CONTENTS

CHAPTER I

DETERMINATION OF ROOT CANAL WORKING LENGTH

Wenwei Xia, Jingping Liang

PART I GENERAL DESCRIPTION

Root canal treatment (RCT) is the process of infected root canal being shaped, cleaned and obturated. The objectives of shaping and cleaning are to remove pulp tissue, debris, and bacteria, as well as to prepare the canal for obturation. This step plays a key role in successful root canal treatment.

Determination of working length is the first step of preparation. Working length is designated for the distance preparation instruments inserted into the canal attain. Meanwhile, the width and taper of prepared canal are also important factors for successful RCT.

1.1 Significance of Working Length in Root Canal Treatment

Correct working length determination comprises one of the most critical steps in endodontic treatment. Determination of working length is the first step of root canal preparation. When working length is determined longer than it should be, the excessive movement of instruments beyond the apical constriction (AC) will push the bacteria in the root canal into the periapical area, or directly violate the periodontal ligament and alveolar bone. On the other hand, loss of the apical constriction leads to/cause an open apex with an increased likelihood of overfilling, lack of an adequate apical seal, and pain and discomfort for the patient. When working length is determined too short, the root canal will not be prepared deep enough, so that bacteria in the apical portion may survive and multiply. Besides, when working length is not correctly determined, the taper and width of instruments will not fit for the root canal. As a result, somewhere of the canal wall is not prepared enough while somewhere of the canal wall may be overprepared. In consequence, the success rate of RCT drops. The apical 3 mm of the root canal system has been considered to be a critical zone in the treatment of infected canal.

In conclusion, determination of the working length is the main factor leading to success in RCT. Correct working length determination is essential for perfect root canal preparation, and then makes it

cleaning and filling easier.

1.2 Theoretical Basis of Precise Determination

In the process of tooth development, dentin is formed by odontoblast in pulp tissue, and then cementogenesis is initiated by cementoblast after root dentin formation. There is a distinct borderline between the two hard tissues, namely Cementum-dentin junction (CDJ). It is the point where pulp tissue ends and periodontal tissues begin. Therefore, preparation in RCT should stop at CDJ.

Theoretically, CDJ is considered as an ideal termination for RCT. CDJ is a junction of dentin, cementum and periodontium. Periadical blood circulation can reach this point. One third of the apical surface cementum is regenerative, and induced odontoblast from periodontium or residual vital pulp can regenerate dentin tissue. Therefore, a successful RCT is expected to create an environment conducive to the regeneration of cementum even dentin, which will seal the AF so that the root canal can be free from infection. However, CDJ is a histological mark and it is not a fixed point. Its location in the root canal is highly variable. So it is impossible to determine CDJ in clinic.

Clinically, the final working length would be reached by considering both radiographic measurements and the accuracy of electronic apex locators, together with the knowledge of the anatomy of the root apex. It is impossible to get the exact position of CDJ with the three methods alone or together. This is only an estimate.

Therefore, how to decrease the error to the greatest extent with these methods makes sense in working length determination.

PART Ⅱ COMMON METHODS FOR WORKING LENGTH DETERMINATION

2.1 History of Working Length Determination

Methods for working length determination were developed along with the improvement in knowledge of teeth anatomy, root canal treatment approaches as well as science techniques. Initially, working length was determined by tactile method and paper point method. Then radiography is being used in working length determination. The exact measurement was achieved by using hand instruments and the subsequent translation with the assistance of gauges. Radiography is a traditional method of obtaining information on the anatomy of the root canal and its surrounding tissue, which is still widely used in working length determination. In 1942, Suzuki found that there was a constant resistance of 6.5kΩ at a defined current between the periodontal membrane and oral mucosa in dogs, which did not vary with ages, sex, teeth position and situation of patients. In 1962, Sunada developed the first apex locator, working with direct current based on this assumption. The first-generation (resistance) locators detected the point where the file displaces from within the canal to the periodontal ligament, whereas the second-generation devices were based on the impedance principle. The reliability of these systems was approximately 55% to 75%, although their main inconvenience was the fact that the presence of pus, pulp remains, or irrigating solutions within the canal led to erroneous readings. To improve the measurement procedure, direct current was replaced by alternating current, and the frequencies used were varied and sometimes isolated. In addition, bipolar and oscillating electrodes were used. Integrated resistance adjustment was dropped, as it proved to be untenable. In 1984, a difference method was introduced by Yamashita as a new principle of measurement. This method used two different frequencies for the first time with two matching resistances and impedances. The apical constriction was determined from the difference between the two. Kobayashi and Suda improved this idea of relative impedance measurement and introduced the 'ratio method' in 1991, creating an impedance quotient instead of a difference.

All the types of apex locators are designed on the basis of the constant resistance between the periodontal membrane and oral mucosa. They are different from each other in the types of the outer impressed current. So far, there are five generations of electronic apex locators:

First- and second-generation models (resistance-type) work with direct current by measuring the resistance. This model is susceptible to many interference factors and has been eliminated.

Third-generation (impedance-type) works with two different frequencies current by measuring impedance. This model is assisted by computer process and can provide a relative precise data (Fig. 1-1).

Fig. 1-1 Third-generation (impedance-type) apex locator.

Fourth-generation (impedance-type) works with multiple frequency alternating current by measuring resistance and impedance separately. This type is impressed by more than two frequencies and the resistance and impedance under defined current were detected separately, which can improve the precision (Fig. 1-2).

Fifth-generation (frequency-type) is the newest model which works with variable frequency current by calculating the impedance ratio under different voltage ratios. This method is free from the interference factors in root canal to the maximum extent. Therefore, frequency-type locators can operate in a canal filled with pus and tissue (Fig. 1-3).

2.2 Concept, Operation And Significance of Tactile Method

Tactile method works by feeling the AC with intracanal instruments. Stop advancing the instrument when there is a resistance, and this point is considered the working length termination (Fig. 1-4).

Tactile method requires that the clinician to have a good knowledge of the tooth anatomy and adequate experience. Therefore, the success rate of this method varies among clinicians. There is a study which demonstrating that the success rate of RCT for a professional clinician using tactile method alone in working length determination was about 60%. In cases with periadicular diseases, the suc-

Fig. 1-2 Fourth-generation (impedance-type) apex locator.

Fig. 1-3 Fifth-generation (frequency-type) apex locator.

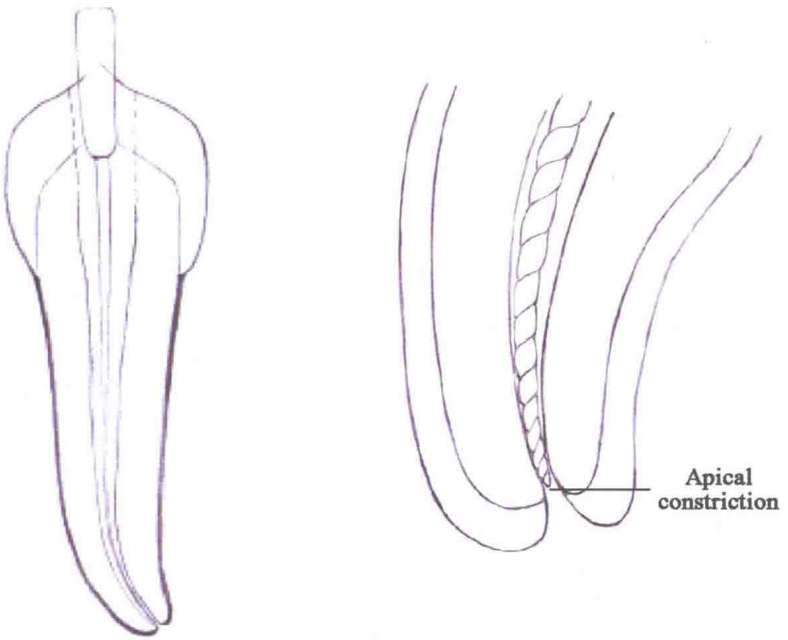

Fig. 1-4 Tactile method for working length determination.

cess rate drops. Because when there is a periadicular lesion, both the apex cementum and the periapical alveolar bone can be resorped, so that the position of AC is altered or even disappears. In cases with intra-canal calculus, the canal was blocked and hard to get through. Obviously, tactile method is not enough for clinical practice and it is scarcely performed alone to determine working length in clinic recently. However, tactile method still plays an important role in dredging the root canal with instruments. The ideal use of tactile method would be to minimize the number of radiographic exposures by making an accurate estimate of the working length before any radiographic measurement. For example, tactile method can be used to insert the file to a relative correct position before taking a radiograph. If the file is not located correctly in advance, we will not get the useful information from the radiograph. Besides, the exited file may destroy the periadicular tissue and cause discomfort. The manual technique obviously depends on the sensitivity of the operator. Therefore, as a dentist, it is essential to master the apical anatomy and the mean working length of every tooth (Table 1-1).

Table 1–1 Means of the Teeth Length for Chinese People

	Teeth Length (mm)	Corona Root Tatio	Teeth Lengh (Wang) (mm)
Maxillary			
Central incisor	22.5	1:1.25	22.5
Lateral incisor	2.2	1:1.47	21.5
Canine	26.5	1:1.71	25.2
First premolar	20.6	1:1.51	20.5
Second premolar	21.5	1:1.86	20.5
First molar	20.8	1:1.71	19.7
Second molar	20.2	1:1.80	19.3
Mandibular			
Central incisor	20.5	1:1.34	19.9
Lateral incisor	21	1:1.32	21
Canine	25.5	1:1.48	24.6
First premolar	21.6	1:1.79	20.9
Secind premolar	22.3	1:1.83	20.5
First molar	21	1:1.72	20.5
Second molar	19.8	1:1.86	19.1

Cited from Means of the teeth length for Chinese people, Huiyuun Wang.

2.2 Concept, Operation And Significance of Radiographic Method

Calculation of the working length by radiographic method is made with respect to the position of the radiographic apex. Radiography is the traditional method of obtaining information on the anatomy of the root canal and its surrounding tissue.

However, the radiographic method is unreliable in determining the position of the AC or AF. When the radiographic apex does not coincide with AC or even with the AF, the measurement will be incorrect. Besides, radiography is sensitive both in its exposure and interpretation. It depends on a series of factors: tooth inclination, film position, length of the beam cone, vertical and horizontal cone angulation, and so forth. Moreover, the main inconvenience is that this approach is entirely subjective and therefore scantly reproducible. Data shows that 82% AF are found to be located by the radiographic method alone. However, AF of 50% maxillary canines, 25% maxillary molars and 23% maxillary central incisors are hardly located by radiographic method alone.

AF can be located at any position of the apex, labial/buccal side, lingual/palatal side, mesial side or distal side (Fig. 1-5 to Fig. 1-9).

2.3 Concept, Operation And Significance of Electronic Method

Electronic method is an approach to measure root canal working length by detecting the position of periodontal ligament with electronic devices. Different generations of electronic apex locators were