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METHODS FOR DETERMINATION OF ROOT CANAL CURVATURE: A brief review

Dental Science

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ABSTRACT

Successful endodontic therapy involves access cavity preparation, canal preparation, and three-dimensional fluid sealed obturation of the canals. Canal preparation can be very challenging due to the complex morphology of the root canal system. The severity of root canal curvature is essential to select instrument and instrumentation technique. Severe canal curvatures of different degrees within the roots can lead to a variety of problems including ledge formation, separation of instruments, perforation, canal blockage or a teardrop transportation at the apex. The anatomical variations of complex root canal morphology often causes endodontic treatment failure, so it is necessary to have a thorough knowledge about tooth morphology. This paper reviews different methods use to determine the root canal curvature.

KEYWORDS:

Curved canals, root canal curvature , root canal morphology, cone-beam computed tomography

INTRODUCTION

Root canal therapy relies on establishment of an accurate and reproducible working length. The working length establishes the apical extent of the preparation. Accuracy of this length is essential if damage to the root apices and periapical tissues is to be avoided during instrumentation and obturation.[1] The main purpose of endodontic therapy is to treat diseased dental pulp so that the function and appearance of the treated natural tooth can be maintained.[2] The therapy involves the removal of diseased dental pulpal tissue, preparing the root canals along with proper irrigation solutions, and then sealing them subsequently using an inert filling material.[3]

Schilder[4] has emphasized that the root canal should present a flare shape from apical to coronal, preserving the apical foramen and not altering the original canal curvature. The root canal morphology is not always straight and the curved canals restrict the preparation of the curvature or may lead to some procedural errors. Preoperative assessment of the root canal morphology is thus necessary so that the complexity, the degree of curvature, and radius of the root canals are determined to an extent. This will significantly reduce the occurrence of the procedural errors and the excess removal of tooth structure from the inner curvature, resulting in stripping or zip formation. Table1enumerates the classification of root canal curvatures.[5,6] In the past few decades, only the angle of the canal curvature was the focus for categorizing the root canal morphology and the curvature. The canal was classified as either straight (if the angle was 5° or less), moderately curved (if the angle was 10-20°), or severely curved (if the angle was >20°). Later, it was proposed that the degree, position, and severity of the canal curvature also play an important role.[2]

Table1. CLASSIFICATION OF ROOT CURVATURE

According to anatomic location	Schneider's classification	Dobo-Nagy classification	Radius-based curvature	Shape-based curvature
Apical third curvature	Straight (if angle <5)	I shape (straight)	Severely curved (r<4 mm)	Apical gradual curve
Middle third curvature	Moderately curve (if angle is 10-20)	J shape (apical curve)	Moderately curved (r>4 mm; <8 mm)	Sickle-shaped curve
Coronal third curvature	Severely curved (if angle is >20)	C shape (entirely curve)	mild curvature (r>8 mm)[2]	Bayonet curve
		S shape (multicurve)		Dilacerated curve

DETERMINATION OF ROOT CANAL CURVATURE

Curvature of the root canal system should be determined preoperatively to avoid procedural errors and subsequent treatment failure. The following methods can be used for root canal curvature determination:

Periapical radiographs

These can be used to assess the root curvature but may lead to misinterpretation since the radiographs produce a two-dimensional image of a three-dimensional Object[6] and thus, curvatures that are present buccolingually may not be visible. The majority of the canals do have some curvature on the different planes and thus, it is not possible to demonstrate them solely on the basis of radiographs.[5]

Cone beam computed tomography

The accuracy of CBCT images to identify anatomic and pathologic alterations compared to panoramic and periapical radiographs has been shown to reduce the incidence of false-negative results.[7]

The propose method to determine the curvature radius of curved root canal uses two 6-mm semistraight lines superimposed to the root canal (Figure 1A to C), the primary line (light gray) being the one that represents the longer continuity of the apical region and the secondary line (dark gray) being the one that represents the middle and cervical thirds. Regardless of the length of the secondary line, only the 6 mm closest to the primary line is used to measure. The midpoint of each semistraight line is determined. From this spot, two lines perpendicular to the semistraight lines are drawn until they meet at a central point, which is named circumcenter. The distance between the circumcenter and the center of each semistraight line is the radius of the Circumference[8],which determines the magnitude of the curve (Figure 1 Ato C).[3] The smaller the radius, the greater the curvature and thus more complex the root canal structure.[9]

In high-resolution images, such as CBCT scans, the measurement of root curvature radius can be obtained by the circumcenter. Based on 3 mathematical points determined using a software named Planimp (CDT Informatics, Cuiaba, MT, Brazil), root curvature radius can be calculated in both apical and coronal directions. This method aided by CBCT images can benefit the endodontic treatment planning and preparation of curved root canals.

The values of root curvature radius considering the two 6-mm semistraight lines are classified as follows: small radius (r<4 mm): severe curvature; intermediary radius (r>4 and r<8 mm): moderate curvature; and large radius (r>8 mm): mild curvature.[3]

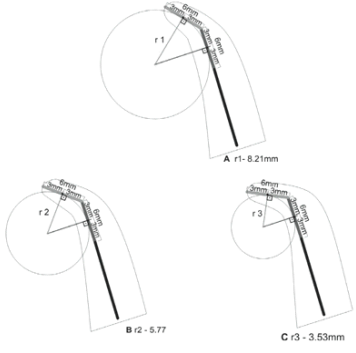


Figure 1. The root curvature radius based on 3 mathematical points can be determined in both apical and coronal directions. Curvature radius considering the two 6-mm semistraight lines are classified as small radius (r≤4 mm): severe curvature; intermediary radius (r>4 and r≤8 mm): moderate curvature; and large radius (r>8 mm): mild curvature.

Schneider's method

Using this method, a mid-point is marked on the file at the level of the canal orifice. A straight line is drawn parallel to the image and that point is labeled as point A. Another second point is marked where the flare starts to deviate that is labeled point B. A third point is marked at the apical foramen and is termed point C and the angle formed by the intersection of these lines is measured (Figure 2). If the angle is less than 5°, the canal is straight; if the angle is 5-20°, the canal is moderately curved; and if the angle is greater than 20°, the canal is classified as a severely curved canal.[10,11]

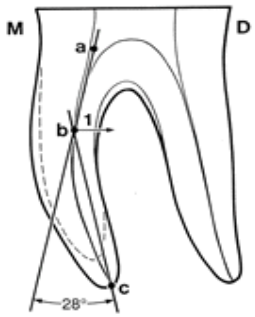


Figure 2. Schneider's method

Weine's method

Weine[12] described another method for the determination of root canal curvature similar to Schneider's method (Figure 3) but showed the differences in the angles according to curvature of the canal. In this method, a straight line is drawn from the canal orifices to the point of curvature and a second line is drawn from the apex for the apical curvature and the angle is measured at the point of intersection between the two lines. [11]

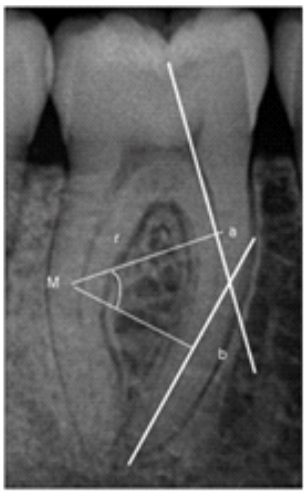


Figure 3. Weine's method

Luiten method

Luiten *et al*[13] modified Schneider's method by using two lines drawn by the identification of four geometric points. Point A is first marked at the center of the canal orifices and then point B is marked 2 mm below the orifices in the long axis of the canal. A first primary line is drawn joining point A and point B and then point C is marked 1 mm coronal to the apical foramen. Point D is marked at the apical foramen then a second primary line is drawn joining these two lines (Figure 4). The angle formed by intersection of the two lines is measured as in the Schneider method.[14]

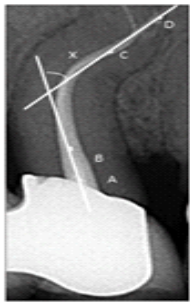


Figure 4. Luiten method

Cunningham's and Senia's method

This approach is different as it focuses on multiple root curvatures, that is, S-shaped canals, and the angle is measured separately at the coronal and apical ends. Point A is first drawn at the center of the orifices and then Point B is marked where the deviation or curve of the canal starts and a line is drawn joining these two lines. Point C is then marked where the canal again changes its direction or the deviation starts and point C is joined with point B. Point D is finally marked at the apical area and joined with point C (Figure 5). The angle formed by the intersection of lines through points A and B and then points B and C is named angle X while the angle formed by the intersection of lines through points B and C and points C and D is named angle Y.[14]

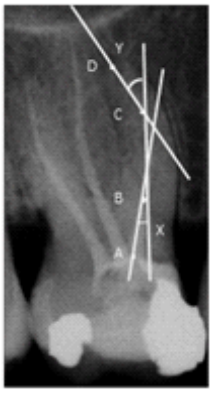


Figure 5. Cunningham's and Senia's method

CONCLUSION

Successful endodontic therapy can be very challenging due to complex anatomy and the presence of severe root curvatures. The curvature may vary from gradual curvature of the entire canal, sharp curvature of the canal near the apex, or a gradual curvature of the canal with a straight apical ending. S-shaped canals may also occur and success in negotiating these canals depends on the size, degree of curvature, size and flexibility of the instrument, along with the skills of the operator. To avoid procedural errors in severely curved canals like ledge formation, transportation, and instrument breakage, the use of rotary NiTi is recommended. Schneider's and Weine's method are simple and practicable. Schneider's method has already been widely adopted by the endodontists. Traditionally the diagnosis and planning of root canal treatment is made based on periapical radiography. However, the higher accuracy of CBCT images compared to panoramic and periapical radiographs has been shown to reduce the incidence of false-negative results.

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