

Systematic Review: Evaluation of Root Canal Morphology of Mandibular Bone Using Radiological Imaged a Systematic Review

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ABSTRACT

The present study investigated the evaluation of the root canal morphology of the mandibular bone using radiological images. One of the reasons for failure in root canal treatment is lack of knowledge about root canal morphology. The complexity in the anatomy of the root canal system is definitely one of the main limitations during endo treatment. One of the causes of failure in endodontic treatment is insufficient knowledge of dental anatomy, which causes errors in diagnosis and treatment process. Regarding the effect of ethnicity and race on the shape and number of root canals. During the last few decades, various clinical (In Vivo) and laboratory (In Vitro) studies have been carried out in the field of morphology, number of roots and canals of teeth and different results have been obtained. Posterior teeth are considered the most difficult teeth in endodontic treatment due to their very complex and varied morphology in the canal system. The internal anatomy of mandibular molar teeth has been studied in different ways, and the results of this research largely depend on the method used to examine the root anatomy. Ingle and Bakland believe that the reason for the difference in results depends on things like race, age, gender, tooth position and the type of (In Vitro) or (In Vivo) study. Shakeri et al reported the prevalence of midmesial canals to be 3%. Akbarzadeh et al. in the state of Ohio reported the prevalence of mid-mesial canal as 14.7%.

Introduction

In several studies, it has been mentioned that the range of movements of the lower jaw decreases after orthognathic surgeries [1-3]. The molars of the mandible have a wide variety in terms of the number of roots and sub-canal [4-6], the location of the longitudinal concavity of the root and the outer limits of the pulp chamber

[7-9]. The mandibular first molar is the first posterior permanent tooth to erupt. For this reason [10-12], it seems to need root canal treatment the most. These teeth often have extensive fillings and bear a lot of occlusal force [13-15].

Therefore, the pulp chamber space is limited and even calcified in most cases. These teeth often have two buccal cusps [16-18], two

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lingual cusps and one distal cusp, they have two mesial and distal roots, with two canals in the mesial root and one canal in the distal root.

In the Iranian population, about 97% of lower first molars have two roots and about 3% have three roots [19-21]. (RE) radix entomomlaris is found in the first, second and third molars of the mandible, but it is the least common in the second molar. Studies have shown that this extra root can be separate or part of other roots [22-25]. It is usually smaller than the mesiobuccal and distobuccal roots and is usually curved and needs special attention in endodontic treatments.

Various studies on root canal anatomy have reported the presence of mid mesial canal in mandibular first molar [26-28].

The third mesial canal, which is called mesio-central or middle mesial, is a third mesial canal with a separate apical foramen, which was first described in the study of Vertucci and Williams and then in the study of Barker et al. Later [29-31], Pomeranz et al reported the prevalence rate (12%) and its clinical treatment in a comprehensive study [32-35].

The prevalence of mid mesial canal varies between 0.26-53.8% in studies. Since the goal of endodontic treatment is to prevent periapical infection or to treat it if it occurs and maintain periapical tissue rupture and non-vital tooth function [36-38], success in endodontic treatment is directly related to the correct diagnosis and neutralization of microorganism and it depends on the use of efficient tools and the full aperture of the affiliate channel [39-41]. If these measures are done correctly, the success of endo treatment increases up to 94%. In addition, obtaining coronal and apical flood is one of the effective factors in the success of the treatment [42-45]. Deciding to start a successful treatment requires sufficient knowledge as well as available technology.

In order to detect errors during or after root canal treatment, the use of various radiographic methods can be effective [46-48]. Two-dimensional periapical radiography is one of the common diagnostic imaging methods used to determine the root structure and the presence of any apical lesion [49-51].

However, conventional periapical radiography has several limitations that can lead to the failure to detect a periapical pathological lesion or incorrect treatment [52-55].

This radiograph summarizes the image in the mesio-distal dimension, the same compression of the third dimension in the image may hide significant anatomy or pathological changes. Another limitation of two-dimensional radiography is the possibility of image distortion, and this is due to the inevitable separation between the receiver of the object and the image [56-58].

To prepare a more ideal image, a parallel technique should be used in periapical radiography, which is rarely possible due to the conditions of the oral cavity [59-61].

In addition, the possibility of superimposition of anatomical structures on the image is another disadvantage of two-dimensional imaging. Another disadvantage is the difficulty of reproducibility of these graphs, which means that sometimes certain areas of the jaw or teeth need to be re-examined to detect the progress or regression of the disease over time [62-65]. Different factors are effective in creating a completely similar image, and if they are not observed, the probability of inappropriate interpretation in two-dimensional radiographs is higher than in three-dimensional ones. Huang et al in Taiwan [66-68], by examining molars with advanced periodontitis, found that molars with radix roots showed more advanced periodontal disease in the distolingual region [69-71].

Although the exact cause is unknown, the unique characteristics of the radix root may

lead to increased pocket depth and serious periodontal destruction [72-75].

The presence of the radix root in the first molar of the lower jaw is related to ethnic characteristics. In African populations, the maximum prevalence was 3%, and in Eurasian and Indian populations, the prevalence was less than 5%.

In Mongoloid populations (Malaysians, Chinese, Eskimos and American Indians), the incidence is 5-40%. According to the results of this study, the prevalence of Radix root was 0.63% [76-78]. The occurrence of radix root has no significant relationship with sex [79-81]. Also, the examination of molars on both sides did not show a significant difference in the occurrence of this type of root based on the side [82-85].

Regarding the factor of gender and tooth side, the study of Rahimi et al. in Tabriz and Chandra et al. in South India were in line with the present study [86-88]. Some studies have reported that this anatomical change occurred more on the right side, while others stated that it was more common on the left side [89-91]. Several studies have reported the incidence of three-rooted mandibular molars bilaterally from 50% to 69%.

However, Schäfer et al did not report any bilateral occurrence in a study of 1024 mandibular first molars in a German population [92-95].

The ability of CBCT to show lesions in several dimensions can overcome the main disadvantage of periapical radiographs. Its medium field of view can provide clear apical images of the oral cavity [96-98], which is sufficient for measuring and identifying apical lesions [99-101].

This ability can also detect endodontic errors, such as obscuration heterogeneity that exists in the buccolingual dimension, especially in oval and ribbon canals. In addition, the data are

presented with a higher resolution in the axial axis compared to conventional CT [102-105].

By reconstructing the multi-plane image in sagittal, axial, coronal and also diagonal view, CBCT shows all aspects of anatomy and pathology of the image [106-108]. It is certain that providing clinical information about the morphology of dental canals in different populations will help in the treatment of patients.

Therefore, the present study was conducted with the aim of morphological evaluation of the root canal in the mandibular first molar using CBCT images [109-111]. Radix root, according to the standard definition, an additional root is considered on the lingual side of the distal root of the lower molar [112-115], and a distolingual root is considered to be calculated and is usually separated at an angle to the pulp chamber [116-118].

The presence of a distinct third canal with a distinct apical foramen in the mesial root of the mandibular molar indicates the presence of the mid-mesial canal and its difference with the isthmus is that in the isthmus no path can be recognized even within 3 to 4 mm and only 2 orifices [119-121]. Mesio buccal and mesio lingual are clearly connected by a developmental groove; But in mid-mesial, between these two paths, there is a specific path with at least 3 mm penetration depth.

What is oral radiography and what is its purpose?

Radiography is a valuable diagnostic tool that is used as a supplement to clinical examination in the diagnosis of dental diseases. Two-dimensional periapical and panoramic radiographs are commonly used in dentistry [122-125]. These methods provide the doctor with a complete view of the condition of the mouth and jaw, so that he can more accurately check his hypothesis and suggest a suitable way for treatment [126-128].

In general, radiography is considered a type of specialized tests that provides valuable information to the doctor in all stages of treatment, including initial diagnostic evaluation, treatment and monitoring during treatment [129-131].

However, there are certain limitations in 2D radiography that can be overcome with 3D imaging techniques such as cone beam computed tomography imaging. The purpose of these radiographic methods is to help early diagnosis and proper and timely treatment of various dental and oral pathologies. In general, oral radiographs are divided into 3 parts;

1. Intra oral radiography [132];
2. Extra oral radiography [133];
3. CBCT CT scan [134].

Types of intra oral radiography methods

As mentioned, radiography in a complete and comprehensive category is divided into 3 categories, one of which is related to intra oral radiography [135-137].

Occlusal radiography

One of the types of intra oral radiography is related to occlusal radiography. In this process, by using a series of X-rays, photographs are taken of the tooth that reflect complementary information about its condition. It is interesting to know that this method is used to complete two other methods and is not recommended by the doctor alone [138-140].

However, to compare oral radiography methods, you must have information in this field. The best method used to diagnose intra oral problems is this method. Occlusal can well reflect the position of all upper and lower teeth of the child. This allows the doctor to examine the child's teeth and the causes of their non-growth. Occlusal radiography equipment is not found in every center.

Therefore, if the doctor asks you to prepare an occlusal radiograph, you should look for an

equipped radiography center that supports this method [141-143].

As a result, it can be investigated in the comparison of oral radiography methods. If you are one of the people that the doctor detects, there is a possibility of the presence of extra and hidden teeth in the upper and lower jaw, he will definitely send you to radiology to get an occlusal photo [144-146].

In addition, if you are concerned about whether your child's teeth are developing normally, occlusal can help with the development of baby teeth. In addition, your children will not be disturbed during the imaging process; Because it is used for people who cannot open their mouth for any reason.

Bite wing radiography

When it comes to oral radiography methods, the first thing that is considered is the knowledge of different methods and their application [147-149]. In this context, it is necessary to know that bitewing radiography is one of the types of oral radiography methods. In this type of photography, with the help of X-rays, the upper and lower back teeth are displayed in a general view [150-152].

The main application of this method is in examining tooth decay, analyzing the size and condition of the bones around the target tooth, and identifying infection and serious gum diseases, which can be of great help to the doctor. Bitewing X-rays not only provide clear images of the upper and lower crowns of the teeth, but also show the depth of the tooth's root and allow the dentist to measure the height of the bone between your teeth within the gums and jaw [153-155].

Most dentists use this method to help diagnose periodontal disease and eradicate cavities. In general, if you have been careful, during the annual dental visit, they will ask you to prepare and deliver this photo; Because it gives the

doctor useful information about the condition of the mouth and teeth [156-158].

Periapical radiograph

One of the most common types of intra oral radiography is periapical. In the first place of dental examinations, you should get a periapical radiograph [159-161].

This method allows you to examine a specific range of teeth and mouth. Periapical has an interesting application in the examination of a specific tooth for which treatment method should be chosen [162-164].

By presenting an image of the entire tooth from the crown to the apex, this method allows the doctor to examine the adjacent teeth, the bone around that tooth, and the anatomical structures. In addition, periapical radiography can provide important information in the field of detecting new or recurrent caries, the presence of mass, the status of restorations, the presence and degree of periodontal bone loss, and also provide a clear view of the periapical structures. The techniques of this method are divided into 2 general categories;

- Split angle technique [165];
- Long cone parallel technique [166].

Introduction of extra oral radiography methods

Now that you have familiarized yourself with intra oral radiography methods to compare oral radiography methods [167-169], it is time to get information about extra oral methods. In the following, we have introduced these methods to you and mentioned the uses of each [170].

Cephalometric method

Cephalometric radiography is one of those unique tools that enable the dentist to have a complete radiographic image of the side of the face [171]. This method generally provides the dentist with a way to see the teeth, jawbone

and soft tissues beyond what is seen with the naked eye [172].

As you know, cephalometric X-ray is an extra-oral radiograph. This means that no screen or film will be placed inside the mouth and vice versa. That is, cephalometric and panoramic X-rays show the nasal and sinus passages, which are destroyed by intra oral biting X-rays. Compared to oral radiography methods, cephalometric provides interesting and complete information about the teeth to the doctor [173].

For this reason, this method is often used for common dental and oral problems. In total, this information includes:

- ❖ Diagnosing signs of caries and dental surgery [174];
- ❖ Assisting in orthodontic planning [175];
- ❖ Observing fractures and injuries of the mouth and teeth [175];
- ❖ Presenting a view of the teeth in relation to the cheek bone [176].

Waters method

One of the main methods of extra oral radiography that can help you compare oral radiography methods is Waters radiography. This method was first discovered and used by the famous American radiologist named Charles Alexander Waters [177]. As a result, the Waters view, or dorsal view, is an example of imaging that is used to better visualize the sinuses [178].

Therefore, the method will not be useful in diagnosing oral and dental diseases. In this method, the rays pass through the back of the head and provide a complete image of the skull and the position of the teeth and mouth [179-181]. This method has a special role in the diagnosis of jaw and face diseases that cannot be denied.

Reverse Town method

Reverse Town is another example of extra oral radiographs that examines the jaw and mouth from another angle and thus helps dentists. In general [182-185], this method depicts an angled anterior-posterior image of the skull position, which is suitable for detecting jaw displacements and fractures in the jaw and oral region. In general, this method has helped advance the goals of treating physician in the field of early diagnosis of complications related to the jaw and mouth and leaves its effects for effective treatment [186-188].

What is CBCT radiography method and what is its use?

One of the issues that can help you compare oral radiography methods; Knowing the radiographic method of CT scan is CBCT. The methods that you have come across so far were some of the special methods that were used for many years. One of the newest methods in the field of extra oral radiography is CBCT. This radiograph provides 3D photos of the condition of the skull and jaw [189-191], which has had obvious effects in the diagnosis of serious jaw and face diseases.

Among its applications, we can mention the evaluation of tooth morphology, including the location and number of canals, the size of the pulp chamber and the degree of calcification, root structure, direction and curvature, fractures, iatrogenic defects and the extent of tooth decay. These images also allow measurements without magnification, which gives more clarity to the radiograph [192].

Comparison of oral radiography methods

Now that you know intra oral and extra oral radiography methods, it's time to have an overview of comparing oral radiography methods to understand the differences and similarities in the effectiveness of each of them.

In the following, you can see this comparison in the form of important factors [193].

Comparison of the history of oral radiography methods

Methods such as cephalometric and periapical radiography were discovered and used in the past years related to 1931, but the CBCT CT scan method is one of the modern technologies of the world, which complements the old methods [194].

Comparison of covering angles of radiographic methods

Covering angles in extra oral radiography are definitely wider than extra oral radiography methods. If we want to express this issue more clearly, we should liken it to a photograph. When you want to take a group photo, you adjust the camera angle and placement so that all the members in the photo are visible, but it is different if it is a single photo. You can even zoom the camera to get a better view of the individual view.

The angle of radiographs such as periapical or bite wing is also like this. Nevertheless, cephalometric or Waters methods show a general and complete picture. The arrow is related to the CBCT method, which gives both the general view and the possibility of zooming on a section without reducing the quality.

Comparison of oral radiography methods in the process of doing them

Generally, old methods such as occlusal or cephalometric are more laborious than new methods such as CBCT. Even people are less exposed to radiation in this method and the imaging process is done faster. This increases the comfort of the patient and improves the imaging process and increases its accuracy.

Comparison of oral radiography methods in disease diagnosis

Intraoral radiography methods can show complications that are less widespread and so-called more minor. For example, tooth decay or root examination can be done with these methods, but if you want a more general view of the condition of the mouth and teeth, extra oral and CBCT methods will definitely be more useful. In addition, these methods are used more in dental and jaw surgeries; Because the examination of the general view and the structure of the surrounding bones are extremely effective.

Use of cone beam computed tomography (CBCT) in endodontics cases

Although a map is useful for getting you where you want to go, it is less important than a globe for determining the relative location of different places or destinations.

A map may be better than nothing, but when it comes down to it, a 2D representation of a 3D structure cannot provide an accurate picture. This geometric configuration, as well as the use of our mental perception of latitude and longitude, can distort our perception of complex anatomical images.

For a long time, endodontic radiographic evaluations were limited to panoramic or intra oral X-rays, which often make it difficult to accurately visualize the tooth due to the lack of three-dimensional accuracy. For example, a periapical radiograph can be distorted by superimposed anatomical structures (including the zygomatic arch, maxillary sinus, and roots), making it difficult to obtain a clear view of the root canal anatomy and for precise procedures such as treatment [192].

According to the joint statement of the American Association of Endodontists (AAE) and the American Academy of Oral and Maxillofacial Radiology (AAOMR) in 2015, cone beam computed tomography (CBCT) has

presented an outstanding progress for tooth roots. This is due to its ability to visualize the tooth and the relationship of the anatomical structures. "CBCT is very useful for endodontics," says Dr. Richard Munns, an endodontist in Pacific City, Oregon. And "Much guess work regarding canal location, numbers, curvature, optimal access site, bone surface, pathology, unmediated lesions, etc. is eliminated or aided by the use of CBCT." AAE-AAOMR statement re It emphasizes that small field-of-view (FOV) CBCT images are the image of choice if abnormal canal morphology is suspected. These images can be invaluable for diagnosis as they allow clinicians to assess the relationship of teeth to other vital structures, to assess traumatic dental injuries such as fractures or erosive lesions and pathology, and to plan treatment for treatment.

Non-surgical or root canal surgery can help. CBCT is especially ideal in areas where there is anatomical noise or where the source of symptoms is difficult to locate, as it can better pinpoint the true location of the root problem. "CBCT imaging has become an essential part of the endodontic world," says endodontist Dr. Rebekah Lucier-Pryles, founder of Pulp Nonfiction Endodontics. "2D images, such as periapical radiographs, are limited in their diagnostic ability due to structural overlap (referred to as anatomical noise).

3D imaging removes this overlap and allows clinicians to see all See areas of the tooth independently." These CBCT images are also valuable in retreatment cases, and the AAE and AAOMR believe that denervated teeth warrant a CBCT scan.

According to these organizations, in the investigation of non-improvement in cases of previous denervation's or in the evaluation of complications of denervation, CBCT with limited field of view is the imaging modality of choice that can determine what follow-up treatment should be performed. CBCT has

numerous advantages, but like any technology, it also has limitations. This allows doctors to understand when it is appropriate to use it. "Opinions vary," explains Dr. Mons. "Some endodontists take CBCT from every patient, others use this method for complex anatomical cases, surgery, retreatment, etc.

"The main concern with CBCT imaging is the possible higher radiation dose to the patient. The AAE and AAOMR recommend that CBCT not be routinely used for endodontic diagnosis or screening purposes in the absence of clinical symptoms. Likewise, the agencies state that CBCT imaging should only be used when imaging needs are not met by lower-dose radiography. Associations say: "According to the history and clinical examinations, CBCT should only be used when the benefits outweigh the possible risks to the patient."

In addition to the risk of higher radiation doses, CBCT has other limitations. A high level of noise and scattering and the potential to produce artifacts can cause the clinician not to pay attention to CBCT images. For doctors who are not comfortable using CBCT, Dr. Munns recommends substituting the surgical microscope. He believes that the lack of use of CBCT and microscope can be a great loss for the specialist doctor. Although CBCT presents some challenges that may influence a physician's decision to forego this technology, its increased availability and wide applications make this tool even more valuable, despite its current drawbacks. Recent research findings show that many doctors often change their previously suggested treatment plan after reviewing CBCT images.

If used correctly, this 3D imaging can provide doctors with vital information allowing them to treat conditions that were previously considered untreatable. "CBCT imaging has changed the face of therapy, both in terms of its ability to detect obscure pathology and in terms of its ability to treat cases," says Dr.

Lucier-Perils. "Physicians' ability to diagnose and evaluate dental diseases using CBCT technology has improved significantly, and as a result, their treatment strategies have become more appropriate."

Conclusion

Root canal treatment is performed in order to chemically and mechanically clean all the pulp space and fill it with a neutral substance. During these steps, not finding a channel or its incomplete cleaning will lead to treatment failure.

Therefore, the dentist must have full knowledge of the morphology of the root canal to perform a successful treatment. Studying dental images can be considered as the main method for disease diagnosis, treatment plan and evaluation of the treatment process by dentists. These images are prepared by dental radiology devices and the basis of their work is the self-aligning tube.

The tube is mounted in such a way that it has the most maneuverability and the size of the focal point of the tube is small. Dental radiography units are used for imaging teeth, anatomy of a single tooth (i.e. crown, neck and root) and dental problems (such as caries) in adult and pediatric patients as well as for orthodontic planning and evaluation. In this regard, three types of imaging can be performed: Intra oral radiography, panoramic and cephalometric. In intra oral radiography for bite wing, periapical and occlusal imaging, the film is placed inside the patient's mouth and the bite wing radiograph images show the crown and the upper third of the roots of the upper and lower teeth.

In periapical radiography, the entire structure of the tooth, including the root, is imaged on one film, and the mandibular and maxillary jaws are imaged on separate films. Occlusal radiographs show the surface of small and large molars. In panoramic radiography,

images of the maxillofacial region are obtained using a beam guide and an external film cassette.

The dental arch is then displayed as an ellipse in a single image. Digital radiography systems, which are also called digital dental imaging systems, are used to prepare computerized images for intra oral radiography as an alternative to conventional dental X-ray films. Direct digital imaging and image processing provide the possibility of displaying multiple images, reducing exposure times, and eliminating the time required for developing and proofing the film. Digital imaging can be used for endodontic planning and evaluation of implants and other dental procedures that require multiple images.

The present project was proposed to solve the problems in periapical imaging caused by the inconsistency in the angle of the camera, teeth and radiology film, and a new method based on the marking of the radiographic image through a marked external frame to correct the deterioration of the image and remove the distortion of the case.

The test is taken. If this plan is successful, the dentist will be able to have a more accurate image of the tooth, which is very efficient especially in applications such as endo, which require very precise measurements. Medical images are one of the most important diagnostic tools for doctors, as they show the state of the body in two-dimensional and even three-dimensional form, which have always devoted a huge part of research to themselves. Dentistry is no exception to the rule.

There are various imaging methods such as radiographic techniques, visible light, laser light, electric current (ECM) to image the tooth or teeth. Among the above methods, radiographic techniques are more important due to their non-destructive nature, providing the possibility of examining the three-dimensional structure of the tooth, providing

the possibility of quantitative analysis of damage and caries of various anatomical structures of the tooth, and availability compared to some similar methods.

By examining two different populations (a population from Brazil and a population from Turkey), Versiani et al suggested that race is an effective factor in the prevalence of mid mesial canal.

This issue shows the importance of further investigation of race in root canal treatment and the interpretation of their results in clinical treatments.

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