CASE STUDY

# FEATURES OF THE VARIATIVE MORPHOLOGY OF THE MANDIBULAR SECOND MOLAR USING CONE-BEAM COMPUTED TOMOGRAPHY IMAGING

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**Viacheslav R. Gurando[1], Petro A. Hasiuk[2], Anna B. Vorobets[2], Volodymyr Ye. Pudiak[2]**
[1]UZHHOROD NATIONAL UNIVERSITY, UZHHOROD, UKRAINE
[2]I. HORBACHEVSKY TERNOPIL NATIONAL MEDICAL UNIVERSITY, TERNOPIL, UKRAINE

## ABSTRACT

**The aim:** To characterize the variations in the anatomical structure of the second lower molar.

**Materials and methods:** In order to determine the topography of the roots and root canals of the mandibular second molar, modern imaging methods were used: orthopantomography and cone-beam computed tomography.

**Case report:** During the analysis of the orthopantomogram of the patient, the three-root morphology of the root system of 37 teeth was revealed. That is, three roots were clearly visualized. After detecting an atypical shape of the root system of the mandibular second molar in the panoramic image, the patient was offered to perform cone-beam computed tomography (CPCT) for diagnostic purposes. Analysis by cone-beam computed tomography showed the presence of four mature roots of normal length, which were arranged in the shape of a diamond.

**Conclusions:** The four-root configuration is considered a rare form for mandibular molars, but it should be considered in endodontic interventions and, if possible, in the planning of such interventions, use cone-beam computed tomography.

**KEY WORDS:** X-ray examination, cone-beam computed tomography, Mandibular second molar, tooth clinical anatomy, root topography

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## INTRODUCTION

Modern reconstructive dentistry requires a high level of knowledge of the anatomical structure of dental crowns. It is especially important to know the morphology of the masticatory surface of the teeth, as pathological lesions of hard tissues often begin in this area, as well as the topography of the roots and root canals [1-3].

Knowledge of the structure of the tooth cavity is a prerequisite for endodontic treatment, as high-quality preparation of root canals determines a positive treatment result. The greatest difficulties arise in endodontic treatment of molars due to their remote location in the dental arch and the presence of several roots, which may have different numbers of root canals of complex configuration [4, 5].

Effective restoration of defects of hard tissues of teeth with modern filling materials, as well as restoration of the integrity of the crown of the teeth with fixed prosthetic devices requires the application of this knowledge in the dentist's daily practice [6-8].

The teeth of the masticatory group are the most complex structures of the entire dental system and have a high degree of surface differentiation. Their main function, which is to grind and grind food, contributed to the emergence of a number of specific anatomical features that distinguish them from other teeth. Molars have a large area of the masticatory surface, on which there are several humps, a massive crown, which rests on two or three roots. During chewing, the teeth of the lateral group are subjected to a very significant load. It is established that the load on the first molar is approximately 77.7 kg, while on the front group of teeth - 20-40 kg. Because such a significant load is distributed over a large area due to the wide and voluminous crown and branched root system, molars are able to withstand a significant force of masticatory pressure [9-12].

The group of molars has a complex structure, significant variability in the shape and size of the crowns, as well as the position in the dental arch. The first molars are key teeth, have a stable shape and are rarely reduced. The function of the first molars is to maintain the central ratio of the jaws and stabilize the masticatory loads, protect the temporomandibular joint from compression. Keeping the first permanent molar intact is extremely important in the process of forming a permanent occlusion, it also fixes the height of the occlusion during the change of teeth, preventing the development of dental and maxillary anomalies [13-16].

The second and third molars are variable teeth, they are often characterized by signs of reduction processes, manifested by changes in the shape of crowns, their size, number of cusps, location of the main fissures, variability in the number of roots and root canals [17, 18].

Anatomical variations can be found in any tooth. Knowledge of the typical morphology and its changes helps to identify these features during endodontic interventions and increase the chance of successful treatment. The most typical anatomy of the second mandibular molar is the presence of two roots and three root canals, but other root configurations have also been described in the literature. As for the configuration with four full roots, it is the rarest, and occurs in 0.2% of cases [19].

In order to conduct a quality diagnostic process in modern dentistry, great importance is attached to the X-ray method of research. The technique of orthopantomogram research has become part of everyday practice as a mandatory stage of quality primary diagnosis. The only technique to date that allows to obtain a three-dimensional image of the study area with minimal irradiation and maximum accuracy of the obtained image is cone-beam computed tomography (CBCT) [20-23].

In today's conditions, the data of experimental study of the structure of dental hard tissues, their morphological and histological structure are significantly expanded. The study of the structural features of the structure of the hard tissues of the teeth will offer new approaches to addressing the prevention, diagnosis and treatment of carious and non-carious lesions.

## THE AIM

The aim of the study is to characterize the variations in the anatomical structure of the mandibular second molar.

## MATERIALS AND METHODS

This study was conducted at the orthopedic dentistry department I. Horbachevsky Ternopil National Medical University, Ukraine, and was approved by the ethics committee of the I. Horbachevsky Ternopil National Medical University, which determined that the general ethical rules of humane treatment of patients were observed when working with patients in accordance with the requirements of the Tokyo Declaration of the World Medical Association and the International Recommendations of the Helsinki Declaration of Human Rights.

In order to determine the topography of the roots and root canals, orthopantomography and cone-beam computed tomography were performed using a PICASSO Imaging system (Vatech, South Korea).

The patient was scanned in a sitting position using a special face support and centering with light rays. The frame with the sensor and the X-ray tube rotated around the patient's head by 194 degrees. For one cycle of shooting 3000 separate pictures were received, scanning time was 15-20 s. The total radiation time is 6 s.

The physical and technical parameters and the area of X-ray examination were selected on the display of the device, the final adjustment was performed using a joystick, the shooting parameters were set automatically, depending on the patient's build.

To scan the object used a plane sensor with a diameter of 24/19 cm, the generating beam was collimated in the form of a cone.

For analysis, a conical beam scan of the mandible with a slice thickness of 0.01 mm was performed. The next step was to identify areas of interest for which retrospective image reconstruction was performed in order to build the most accurate and detailed three-dimensional model. 4-6 examination zones were identified on each of the examined tomograms.

The information was processed on a computer with the operating system «Windows XP & 7» in the program «EzD2009».

After that, the three-dimensional virtual object was «cut» in layers, the appropriate thickness (0.01 mm), each slice was stored in computer memory as files in DICOM format (Digital Imaging Common Medicine).

In the process of working with the program «EzD2009» used the basic interface to work in the main option MPR (multiplanar reformation).

## CASE REPORT

A 55-year-old woman of Slavic nationality was referred for a panoramic examination for the planning of dental treatment.

Orthopantomography can be considered one of the most effective additional methods of examination of patients. It gives a broad overview of the entire dental system, allows you to simultaneously see both dentitions and alveolar processes, as well as to establish the nature of interdental contacts. The technique provides high speed and ease of the procedure itself, significantly reduces the radiation dose on patients [24].

The analysis of the obtained orthopantomogram revealed an unusual morphology of the root system of 37 teeth, which looked like a three-root. That is, three roots were clearly visualized (Fig. 1).

But, as we see, even this highly informative method of examination of dental patients does not always allow to obtain all the necessary amount of diagnostic information. Therefore, after detecting an atypical shape of the root system of the second molar of the mandible on a panoramic image, the patient was offered to perform cone-beam computed tomography (CBCT) for diagnostic purposes.

Thanks to the 3D image on the CPCT, the presence of not three, as seen in the panoramic image, but four roots for tooth 37 was established. All four roots - distal, mesial, buccal and lingual - were mature, with relatively the same size and length. Moreover, both buccal and lingual roots were equivalent in size and fully developed (Fig. 2).

To determine the presence of a variation in the anatomical structure of the mandibular second molar on the opposite side, its CBCT image is considered (Fig. 3).

It is established that in this tooth there are no fully formed four roots. But the tendency to split the mesial root into three roots and canals is clearly visible.

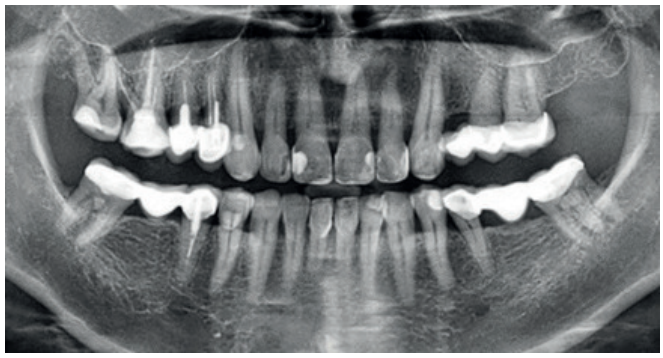

**Fig. 1.** Initial panoramic radiograph. Visualization of atypical anatomy of the root system of 37 tooth. 2D panoramic image shows three roots

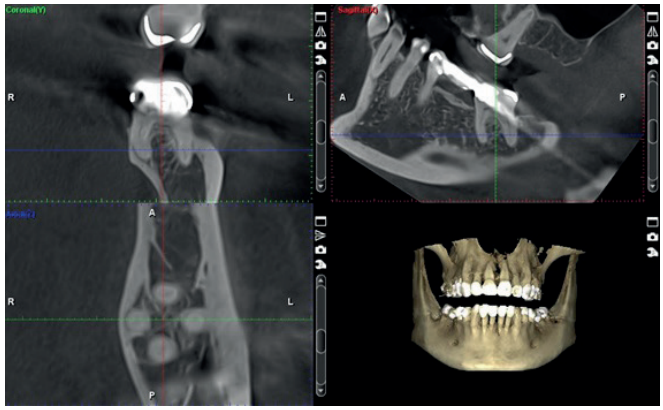

**Fig. 2.** Cone-beam computed tomography:
a) coronal projection performed on the buccal and lingual roots;
b) sagittal projection performed on the mesial and distal roots of 37 teeth.
c) axial projection showing the formed root system 37 of the tooth in the form of a regular rhombus.

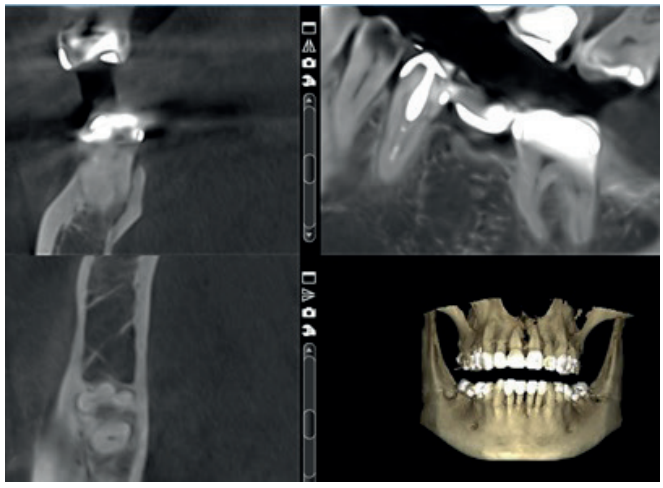

**Fig. 3.** Cone-beam computed tomography: axial projection. The splitting of the mesial root of 37 teeth into three parts is visualized

## DISCUSSION

It should be noted that in modern dentistry the importance of the Imaging methods of research is steadily growing, which has contributed to progress in the development of computer technology.

Orthopantomography can be considered the most effective method for the primary diagnosis of the condition of the tissues of the dental-maxillary system [25, 26].

As the results of our work show in a panoramic image, the patient was found to have an atypical structure of the root system of 37 teeth. However, even this highly informative method of examination of dental patients does not always allow to obtain all the necessary amount of diagnostic information.

Unlike orthopantomography, which is characterized by image distortion of 4-7 mm, the CBCT method, with a maximum image distortion of 0.1-0.01 mm gives a more accurate detail of the clinical picture, carried out using the size of the voxel, as orthopantomography is a summation image [27, 28].

Therefore, only CBCT in this patient was visualized four-rooted system of 37 teeth.

It should be noted that the second molars of the mandible are characterized by significant variability of anatomical structure, manifested by different numbers and lengths of roots, with different direction of their curvature, as well as the presence of numerous root canal configuration options [29, 30].

According to the results of research by a large number of scientists, the mandibular second molar is characterized by significant variability in the structure of the root system. Teeth with two separate roots are common: medial and distal (73.4%). There are also forms with three roots: mainly two distal and one medial (3.8%), as well as single-rooted forms (12.6%). Regarding the number of root canals, according to scientific sources, the most common are three-channel forms (60.87%), teeth with four root canals are found in 32.3%, with five root canals - 5.7% of cases [19, 20].

As reported by the literature that root formation occurs at the embryological stages of tooth development. In multi-rooted teeth, the epithelial cells of the horizontal shell of the Hertwig's epithelial root sheath develop extensions that grow toward the center until they meet each other, dividing the original single cell into several cells, one for each root. It is known that the deposition of secondary dentin during tooth development can also lead to abnormal types of the root system of the tooth [17-20].

Therefore, it can be argued that the appearance of a four-rooted tooth means that four cells were formed as a result of intussusception of epithelial cells during root formation.

In this case, the 37th tooth has four roots: mesial, distal, buccal and lingual, which is noted as an unusual feature for the second molar of the mandible.

Thus, we can assume that the unique root system of the tooth 37 was formed by splitting the rudiment of the mesial root into three separate full-fledged roots. According to our hypothesis, during this splitting, respectively, the mesial, buccal and lingual roots of this, 37 teeth were formed, and the distal root remained unchanged. This set of factors has led to the emergence of a unique configuration in the form of a regular diamond.

## CONCLUSIONS

Thus, as a result of our work, we found an extremely rare variation in the anatomical shape of the roots in the mandibular second molar of the, namely the four-root configuration. In this case, the roots are located in the shape of a regular rhombus: mesial - distal, buccal - lingual.

Therefore, when planning endodontic interventions, in order to increase their effectiveness, it is necessary to consider the above unique features of the anatomical structure of the mandibular second molar.

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**ORCID and contributionship:**
*Viacheslav R. Gurando: 0000-0001-6303-3799* [B,C]
*Petro A. Hasiuk: 0000-0002-2915-0526*[A,F]
*Anna B. Vorobets: 0000-0002-4119-7896*[D]
*Volodymyr Ye. Pudiak: 0000-0002-8741-9407* [E]

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*The Authors declare no conflict of interest.*

## CORRESPONDING AUTHOR
**Petro A. Hasiuk**
I. Horbachevsky Ternopil National Medical University
1 Maidan Voli, 46001 Ternopil, Ukraine
tel: +380961445444
e-mail: gasiukpa@tdmu.edu.ua

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