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## VERTICAL ROOT FRACTURE DIAGNOSIS IN ENDODONTICALLY TREATED TEETH

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**Annotation.** *Timely diagnosis of vertical root fractures is a big challenge to dentists, because there are no specific clinical signs, symptoms and X-ray features. The aim of the research is to study clinical cases of vertical root fractures in endodontically treated teeth and to carry out analysis the methods of their diagnosis, clinical features and radiological characteristics. In patients aged 40-65 years, 34 clinical cases of vertical root fracture are considered. The main and additional methods of patients' examination are analyzed. The statistical calculation of the obtained results is performed by the method of variation statistics with the determination of the Student's t-test using computer programs Microsoft® Excel 2017 and "Statistica 6.1". Clinical symptoms and abnormal findings during examination were recorded but not subjected to statistical analysis. Clinical examination revealed periodontal swelling or abscess in 6 patients, isolated narrow and deep periodontal pocket in 24 patients, low localized fistula in 9 patients. Radiological results: only in 6 clinical cases a vertical fracture line was observed on intraoral X-ray images; in 30 cases the destruction of bone tissue in the periapical area, mainly in the halo-type radiolucency was determined; in 4 cases no pathological changes in periapical bone tissue were revealed. Vertical root fracture was confirmed by muco-periosteal flap detachment in all cases. It has been established that a number of signs, namely: isolated deep narrow periodontal pocket; coronally located fistula; characteristic bone destruction (J-shaped or "halo" radiolucency) on the radiograph indicate the likelihood of vertical root fracture. Signs of fenestration of the bone adjacent to the fractured root and visualization of the fracture line after mucoperiosteal flap surgery are pathognomonic.*

**Keywords:** *vertical root fracture, endodontically treated teeth, diagnostics, clinical features, radiographic signs.*

### Introduction

A vertical root fracture is a longitudinal fracture of the tooth root, which usually starts from the inner wall of the root canal and continues to the outer surface of the root [2]. At the same time, one or both root surfaces can be involved in the process. There is an incomplete or complete linear defect, which is directed along the root axis towards the apex and a fracture along the longitudinal tooth axis, oriented from the root canal to the periodontium [9]. According to the American Association of Endodontics, vertical root fracture defined as a longitudinally oriented fracture of the root that originates from the apex and propagates to the coronal part, it occurs from 11 to 20% of cases of endodontically treated teeth [5].

Among the etiological factors are: tooth trauma; traumatic occlusion in pathologic bite (open or cross-bite); the presence of bulky fillings with amalgam or composite, thinning of dentin in endodontic treatment or root canal preparation for post placement, which significantly reduces the strength of the root; excessive pressure applied to the endocanal construction (post, inlay) when their fixing in the root canal, etc. [3, 5, 7, 8].

Vertical root fracture of the endodontically treated tooth is one of the most adverse complications of endodontic treatment [6]. Timely diagnosis of such fractures is extremely difficult, additional methods of examination (X-ray, computed tomography) are not always effective, so the prognosis for the treatment of such teeth may be unfavorable. Due to the similarity of clinical manifestations of vertical root fractures of the tooth with other diseases (apical periodontitis, periodontal disease, etc.), the dentist

often chooses the wrong treatment tactics, which leads to bone loss, time, and, consequently, to worsening further prosthetics after tooth extraction [1].

The aim of the study was to consider the clinical cases of vertical root fractures in endodontically treated teeth and to analyze methods of their diagnosis, clinical features and radiological characteristics.

### Materials and methods

In patients aged 40-65 years, 34 clinical cases of vertical root fracture of the teeth were considered, including 4 incisors, 11 premolars and 19 molars, which resulted in tooth extraction (29 teeth), root amputation in the maxillary molars (3) and hemisection in the mandibular molars (2). On average, 42 months passed after endodontic treatment. During this study the following examination methods were evaluated: patient complaints, examination results, palpation, percussion with a test of biting a rubber cylinder or tooth slooth, the presence of periodontal pocket and its segmental probing, the presence and features of fistula, radiological changes, signs of bone fenestration.

In 5 cases, mucoperiosteal flap detachment was performed with subsequent staining of the root surface with methylene blue and assessment of the alveolar bone and tooth roots using a stereoscopic microscope "MBS-2" at 20-fold magnification. When making the diagnosis, special attention was paid to the 3 most characteristic features: isolated (narrow) periodontal pocket; coronally located fistula; specific destruction of bone tissue (halo-type radiolucency) on X-ray image.

Statistical analysis of the study results was carried out using computer programs "Statistica 6.1" (number BXXR901E246022FA) and Microsoft® Excel 2017 for Mac (corporate license, product ID: 02984-001-000001). Statistical data was performed using the method of the Student parametric criterion according to the principle of variation statistics. Values of  $p < 0.05$  were considered statistically significant. Clinical symptoms and abnormal findings during examination were recorded but not subjected to statistical analysis.

The studies were carried out in compliance with the main provisions of the "Rules of ethical principles of scientific medical researches with human participation", approved by the Helsinki Declaration, ICH GCP, EEC Directive № 609, orders of the Ministry of Health of Ukraine № 690 dated 23.09.2009 y., № 944 dated 14.12.2009 y., № 616 dated 03.08.2012 y. The research protocol was approved by the Biomedical Ethics Committee of National Pirogov Memorial Medical University, Vinnytsya.

### Results. Discussion

Patients with vertical root fracture of the teeth complained of discomfort and pain when chewing, sometimes on constant dull pain, swelling, presence of fistula, and slight tooth mobility. The details of the complaints

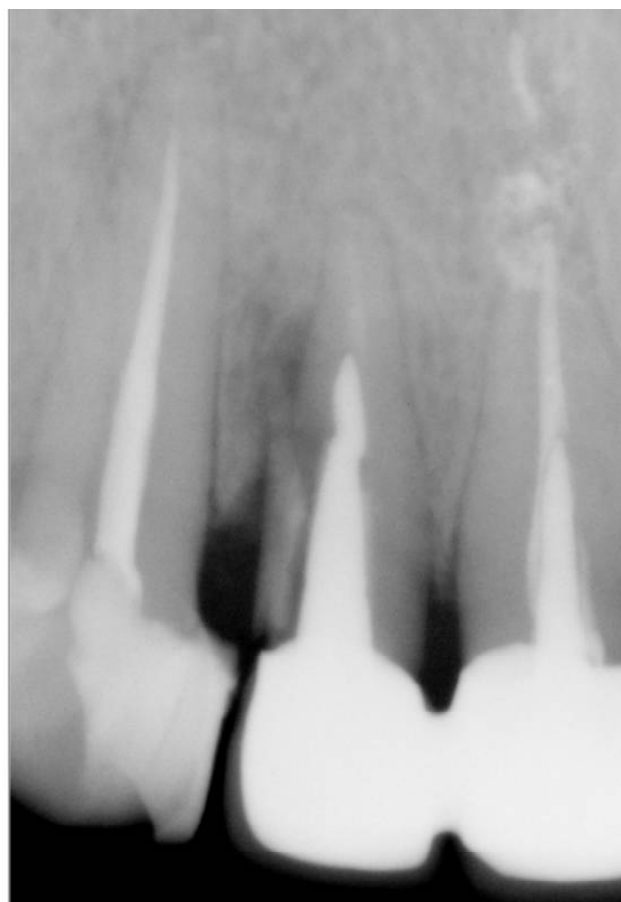


Fig. 1. Oblique root fracture of 1.2 tooth with displacement.



Fig. 2. J-shaped or halo-type of bone destruction in periapical zone and along the lateral root surface of 1.5 fractured tooth (oblique fracture).

were as follows: 19 patients (55.9±8.52%) had tooth discomfort; 15 patients (44.1±8.52%) complained of swollen gums in the treated tooth, the appearance of fistula and an unpleasant taste in the oral cavity. Among them 2 patients (5.9±4.04%) had insignificant tooth mobility, 5 patients (14.7±6.07%) noted unpleasant sensations or insignificant pain when chewing, which occurred only when the jaws were unclenched.

During examination localized swelling or gingival abscess were revealed in 6 patients (17.6±6.53%). Low-localized fistula was diagnosed in 9 patients (26.5±7.57%); in 3 clinical cases it was on the palatal side, in 5 cases was on the vestibular side, in 1 case there were two fistulas (palatal and vestibular). Fistula in vertical root fractures, in contrast to apical periodontitis was located closer to the gingival margin (coronally).

In 24 patients (70.6±7.81%) the periodontal defect by type of the periodontal pocket near the tooth with vertical root fracture were revealed, which in 17 clinical cases was located on vestibular surface, in 5 cases - on the lingual surface, in 2 cases - on the vestibular and lingual surfaces, according to the location of the fracture line. Periodontal defect in all

clinical cases was narrow (1-2 mm) and deep (5 mm and more). When probing the gingival sulcus slightly distally or mesially the pathology was not determined, which distinguished periodontal defect in vertical root fracture from periodontal pocket in periodontal disease. Tooth percussion in 7 patients (20.6±6.94%) was slightly painful. After the test with a bite of a rubber cylinder or tooth slooth stick, pain occurs when the jaws are clenched that distinguishes the vertical root fracture from apical periodontitis.

Radiological results. Only in 6 clinical cases (17.6±6.53%) on the intraoral radiograph a vertical fracture line was revealed (Fig. 1). In 4 cases (12.5±5.67%) no pathological changes of bone tissue in the tooth area with a vertical root fracture were observed, but in two of them the radiograph diagnosed a shadow oriented parallel to the filling material and atypical exit of the sealer to the lateral root surface. Such changes, according to most authors [5, 7, 8, 10] occur in vertical root fracture, which appeared directly during root canal obturation.

Bone resorption were revealed in 30 clinical cases (88.2±5.53%): most often in 24 clinical cases (80.0±6.16%) a J-shaped area of destruction (halo-type) was observed in the periapical bone and along lateral root surface of fractured tooth (Fig. 2), in 4 clinical cases (13.3±6.2%) the bone resorption was observed in the area of bi- and trifurcation of



**Fig. 3.** Vertical root fracture of 1.2 tooth with the existing destruction of a "pear / hanging drop" shape.



**Fig. 4.** Bone loss in root fracture of 1.4 tooth is similar to periodontal disease.

molar roots; in 2 cases (6.7±4.56%) the periapical lesions were found in the shape of "hanging drop" around the apex. It is known that if a long time passes from the moment of the vertical root fracture, the area of destruction resembles the shape of a "pear / hanging drop" (Fig. 3). Involvement in the pathological process of the coronal part of the root leads to the bone loss similar to periodontal disease with its typical radiological signs (Fig. 4).

Five patients (14.7 ± 6.07%) underwent mucosal flap surgery with subsequent assessment of alveolar bone and tooth roots using a microscope. In all 5 cases, the fracture was confirmed after staining the root surface with methylene blue.

Thus, when making a diagnosis and planning a restoration, the above-mentioned clinical and radiological features should be taken into account and alertness should be exercised. After all, when the vertical root fracture propagates to the outer surface of the tooth root, there is a communication with the periodontal ligament, which leads to appearance of an inflammation. Microorganisms obtain access to the fracture area, and soft tissues can grow into the fracture space, which increases the separation of root segments [4]. In the adjacent periodontium, an inflammatory process occurs, which leads to the destruction of the periodontal ligament and granulation tissue formation and, consequently, the loss of alveolar bone due to its resorption

with typical clinical signs [1]. The bone defect usually propagates rapidly apically [10].

### Conclusions and prospects for further development

1. Early diagnosis of vertical root fracture can often be challenging. In most cases, patients complain of discomfort, pain and abscess, ie when there is already significant resorption of bone tissue. There are no characteristic pathognomonic non-invasive subjective, clinical and

radiological features that would clearly identify vertical root fractures, especially before the appearance of alveolar bone loss. A number of signs, namely: localized edema, coronally located fistula, deep periodontal defects and radiographic halo radiolucencies indicate the likelihood of this complication. Flap surgery is the most informative and reliable method of diagnosis. Signs of fenestration of the bone adjacent to the fractured root, filled with granulation tissue and visualization of the fracture line are pathognomonic signs for vertical root fracture.

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### ДІАГНОСТИКА ВЕРТИКАЛЬНОГО ПЕРЕЛОМУ КОРЕНЯ В ЕНДОДОНТИЧНО ЛІКОВАНИХ ЗУБАХ

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**Анотація.** Своєчасна діагностика вертикального перелому кореня зуба надзвичайно складна, оскільки немає специфічних клінічних ознак, симптомів і рентгенологічних особливостей. Метою дослідження стало вивчення клінічних випадків вертикального перелому кореня зуба в ендодонтично лікованих зубах та проведення аналізу методів їх діагностики, клінічних особливостей і рентгенологічних змін. У пацієнтів 40-65 років розглянуто 34 випадки вертикального перелому кореня зубів, проаналізовано основні та додаткові методи обстеження. Статистичне обчислення отриманих результатів здійснювали методом варіаційної статистики з визначенням критерію достовірності Стьюдента за допомогою комп'ютерних програм Microsoft® Excel 2017 і "Statistica 6.1". Клінічні симптоми та відхилення від норми під час динамічного спостереження були зафіксовані, але не піддавалися статистичному аналізу. В результаті дослідження виявлено локальний набряк та абсцедування ясен у 6 пацієнтів, ізольовану вузьку та глибоку пародонтальну кишеню в 24 пацієнтів, діагностовано низько локалізовану норицю у 9 пацієнтів. Рентгенологічні результати: тільки в 6 клінічних випадках на приціпній внутрішньоротовій рентгенограмі виявлено вертикальну лінію перелому; в 30 випадках мала місце деструкція кісткової тканини в періапікальній ділянці переважно у вигляді ореолу, в 4 випадках жодних патологічних змін кісткової тканини в ділянці зуба з вертикальним переломом кореня не спостерігали. Після відшарування слизово-окісного клаптя підтверджено вертикальний перелом кореня зуба. Встановлено, що ряд ознак, а саме: ізольована (вузька) пародонтальна кишеня; коронково розташований норицевий хід; характерна деструкція кісткової тканини (у вигляді ореолу) на рентгенограмі вказують на ймовірність вертикального перелому кореня зуба. Ознаки фенестрації кістки, прилеглої до кореня з переломом та візуалізація лінії перелому при відшаруванні слизово-окісного клаптя є патогномонічними.

**Ключові слова:** вертикальний перелом кореня, ендодонтично ліковані зуби, діагностика, клінічні прояви, рентгенологічні зміни.