Substantiation of New Diagnostic Methods for the Formation of Retention of Upper Permanent Canines in Dental Anomalies

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ABSTRACT

In the case of dental anomalies of the formation of retention of the upper permanent canines, new views on the methods of its diagnosis are presented in the article. Both foreign and domestic a wide review of the literature of scientists was presented by the author, as well as various diagnostic methods were described in detail about this pathology. Various methods of evaluation of X-ray examinations and modern approaches to the diagnosis of retention of the upper permanent canines, which are currently used in practice by an orthodontist to make a final diagnosis, are described.

KEYWORDS: *Dental anomalies, orthopantomography, canine retention, cone-beam computed tomography.*

Worldwide data of Russian and foreign authors, the treatment of patients with this pathology for surgical and orthodontic care is different. In the structure of referrals of patients with dental anomalies in Russia, according to research data, from 4.0 to 18.0% of patients with retention of upper permanent canines. Abroad, the prevalence of retention of upper permanent canines, according to recent data, is significantly lower, ranging from 0.8 to 3.0% [20].

Desorption of the roots of adjacent teeth, the formation of odontogenic tumors, abnormal eruption of adjacent teeth, violation of the capture and biting of food - this is a whole series of morphological problems and structural destruction that entails retention of the upper permanent canines. This in turn leads to a number of aesthetic claims made by patients with retention of the upper permanent canines, including a violation of the smile line, a divergence of the center of the dentition, an anomaly of the position of the teeth, facial asymmetry [6; 17; 21].

Endocrine factors related to the functions of the endocrine glands, which are of great importance for the functioning of the child, significantly affecting the formation of his dental system and the development of the oral mucosa, were examined. They can influence the origin of dental anomalies during both prenatal and postnatal improvement of the child. Hypothyroidism, endemic goiter, idiopathic form of hyperparathyroidism, pseudohypoparathyroidism, cerebral pituitary nanism, Frelich's disease, rickets, according to many domestic and foreign authors, can lead to an abnormal position and violation of the timing of eruption [2;3;4;15].

In addition to the above general factors, the development of the child's dental system is influenced by the unfavorable state of the environment: lack of fluoride in fresh water, insufficient ultraviolet irradiation, and excessive radioactive background [7; 14; 16].

Retention of permanent canines can arise as a result of caries, its complications and related removals of individual temporary teeth, more often in children there is a loss of temporary molars, which leads to displacement of adjacent teeth, eruption abnormalities or medial eruption of the first permanent molars. The result of the medial displacement of the first permanent molars is a shortening of the dentition in the area of the support zone and a lack of space for the canine eruption [5;8].

Chronic apical destructive processes of milk teeth determine anomalies of position and violations of the timing of eruption of permanent teeth as a result of the displacement of their rudiments by granulation tissue, which is confirmed by a number of studies [9].

Since the bone crypt of the rudiment of a permanent tooth is connected by a guide channel with a temporary tooth, the preservation of the temporary predecessor is an important point in the eruption of a permanent tooth. This intraosseous canal contains a fibrous cord with the remains of the epithelium of the dental plate and unites the crypt with the cortical plate and sometimes the wall of the alveoli of the milk tooth. The structural features of the intraosseous canal have a significant impact on the eruption of the tooth, but the diameter of this passage varies depending on the size of the tooth. The diameter of the crown of a permanent canine is much larger than the diameter of its predecessor. Thus, the creation of sufficient space for the eruption of permanent canines depends on the resorption of the bone and the root of the milk tooth. The delay in the loss of the milk canine is a consequence, not the cause of the dystopia of the permanent canine [11; 18].

The roots of the lateral incisors are characterized by another guide for the eruption of permanent upper canines. To resist the pressure from the crowns of erupting canines, the roots of the lateral incisors, in a child of eight to nine years old, should be sufficiently formed. As a result, the final eruption of the canines should lead to the straightening of the position of the incisors and the formation of adequate interdental contacts. The eruption of the canine can deviate either vestibularly or palatally relative to the dental arch, in the absence of contact between the crown of the canine and the root of the lateral incisor. Adentia or microdentia of the lateral incisors leads to the absence of a guide for the eruption of canines [10].

Overcomplicated teeth located in the direction of permanent complete teeth often cause their retention. This phenomenon is called hyperdentia. More than 80% of supercomplete teeth are found on the upper jaw and 90% of them are located in its anterior part [12].

Pressure on the rudiments of the corresponding permanent teeth from cysts or tumor foci can also cause retention. Odontoma is the most common odontogenic neoplasm, consists of abnormal or incorrectly differentiated odontogenic tissues. Clinically, an odontoma practically does not differ from an overcomplicated tooth and can also counteract the development and eruption of permanent canines [6; 14].

Odontogenic cysts are most often associated with a violation of the eruption of permanent teeth. The upper canines are affected more often than the rest of the teeth. Sometimes the cause of the cyst is pulpitis of the milk tooth. After excision of the neoplasm, the tooth can erupt independently, provided there is sufficient space in the dental arch [13].

Shortening and narrowing of the upper dentition, which is also associated with the upper micrognathia, leads to a shortage of space for all complete teeth, which may be one of the reasons for the retention of canines [16].

It is not always possible to divide the factors leading to retention of permanent canines of the upper jaw into general and local, endogenous and exogenous, therefore, this division, according to many authors, is conditional [17].

The etiological factors leading to retention of teeth were systematized in Volgograd residents into groups. With retention of canines, the author identified the following as the main reasons: atypical laying of the rudiments of canines or adjacent teeth, over-complete teeth, odontomas and cysts in the course of eruption, premature mineralization of the tip of the erupting canine. Another compatriot, based on the results of her own research, proposed a clinical and morphological classification of anomalies in the timing of eruption of permanent teeth, which takes into account the following

etiological factors: a lack of space in the dentition, an anomaly in the position of an uncut tooth, an anomaly in the size and shape of an uncut tooth, overcomplicated teeth, congenital pathology of the maxillofacial region [9].

It is proved that it is possible to establish the retention of teeth only on the basis of an X-ray examination of the alveolar parts of the jaws. Intraoral X-ray techniques, orthopantomography, telerentgenography, multispiral computed tomography, cone-beam computed tomography are currently used to diagnose retentive and dystopian teeth [5].

Intraoral radiography is performed on dental X-ray diagnostic devices. It includes the following types of studies: contact, occlusal and interproximal radiography. Intraoral radiography is of limited use in the diagnosis of retentive and dystopian teeth, since it does not give a complete picture of the state of the dental system. However, with its help, it is possible to identify the presence of the rudiment of the tooth and its condition, determine the stage of formation and development of the root of the tooth, assess the condition of the periapical tissues, detect overcomplete teeth, determine the prospects of tooth eruption, identify a pathological focus of a limited nature [2].

Since 1987, radiovisiography has been developed in dentistry. Computer processing of information increases the diagnostic informativeness of the study by manipulating contrast, brightness, clarity, dimensions by eliminating technical errors, highlighting areas of interest. The advantages of radiovisiography are also a significant reduction in radiation exposure, the ability to archive information [3].

The method of orthopantomography (OPTG) was proposed in 1939 by Blackman, then mathematically justified and prepared for wide practical application by Finnish specialists Soila and Paatero (1956). During OPTG, the doctor gets the opportunity to evaluate both jaws, teeth, temporomandibular joints, paranasal sinuses, which allows to establish the degree of mineralization of crowns and roots of teeth, their formation, stage and type of resorption of the roots of temporary teeth, which is important for diagnosing possible pathology of structures of hard tissues of teeth. According to the OPTG, it is possible to identify the rudiments of uncut teeth, determine their position in the jaw and the prospects of eruption. In addition, orthopantomography is performed to determine the inclination of erupted teeth and retented teeth in relation to neighboring ones [12].

In order to determine the position of the crown of the retented canine of the upper jaw in the vestibulo-oral direction, in his research, he proposed using principles based on the laws of optics: 1) the X-ray shadow of the retented tooth located palatally on the orthopantomogram will always be larger than the symmetrical tooth; 2) the X-ray shadow of the retented tooth located in the thickness of the alveolar process, on the orthopantomogram will approximate in size to the shadow of a symmetrical tooth; 3) the X-ray shadow of the retented tooth located vestibularly on the orthopantomogram will always be smaller in size than the symmetrical tooth; 4) the edge sharpness of the tooth more distant from the plane of the film will always be lower than the shadow of the tooth located closer to the plane of the film [14].

In 2009, a study was conducted at Manchester Medical University, where, according to a questionnaire survey of dentists, 22 dental centers with an X-ray department analyzed the popularity of this technique in dental practice. It was revealed that 73.3% of the surveyed doctors consider orthopantomography to be the most informative technique compared to intraoral X-ray examinations of teeth and periodical tissues for dental therapists during endodontic treatment, for dental surgeons when planning surgery, as well as for orthodontists in the diagnosis and treatment of dental retention. Thus, orthopantomography has long served as the main method of radiation examination of patients with retentive teeth [17].

The orthopantomography method, despite its great informative value, has a number of disadvantages.

The spatially selected layer of the image is a plane located strictly vertically, but U-shaped curved horizontally with a thickness of 1-2 cm. The largest percentage of distortions, overlays and non-coincidences falls on the frontal section. The shadow of the spine and the lumen from the uncompressed tongue can be superimposed on the image of the frontal part of the jaws in the picture. The magnification of objects in the image can be from 1:1.2 to 1:1.75, depending on the design of the device and the area of the image [18].

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Telerentgenography was proposed by the Italian anthropologist Paccini in 1922. In orthodontics, it was first used in 1931 by Hofrath in Germany and Broadbent in the USA, and in 1934, a cephalometric analysis was proposed using a telerentgenogram. The method is used in orthodontics to diagnose the consequences of improper development of the jaws (according to Andresen), incorrect position of the teeth, occlusion disorders, jaw shape, joint pathology. Despite certain disadvantages, the method is part of the examination, with the help of which numerous variants of dysgnathies can be technically classified depending on skeletal and dentoalveolar ratios. In the orthodontic clinic, telerentgenograms are produced both in direct and lateral projections. To correctly assess the retention of teeth, it is impractical to use it without orthopantomography [4].

Localization of the upper permanent canines can be established using standard radiological methods, while there is image distortion, overlapping of three-dimensional structures, artifacts, projection errors, sometimes poor image quality [9].

Computed tomography is by far the most informative method of radiation diagnostics in dentistry

and maxillofacial surgery. Many domestic and foreign authors consider computed tomography as a priority method of studying patients with dystopia and retention of teeth [6].

The first CT scanner was tested in 1974. Subsequently, its creators, engineers Cormack and Housefield, received the Nobel Prize for this invention. Despite the widest diagnostic possibilities, to date, computed tomography, as a method of examining patients with dental anomalies, has rarely been used in dentistry. This was due to the high radiation load from the study and the fact that in most cases the computed tomogram had an image quality insufficient for the needs of dentists [4].

Until recently, there were three types of CT scanners: spiral, sequential, magnetic resonance. One of the first comparative radiological studies was conducted at the Vienna Medical University in 1995. Orthopantomography and computed tomography were used to study 29 patients with 36 permanent retentive teeth. 2 programs (conventional and dental) were used in the analysis. The authors summarized the following: 1) both CT programs are visually more informative than orthopantomography; 2) the dental CT scanner program is more effective than the usual program in the diagnosis of retention, because it allows more accurately diagnosing the resorption of the roots of neighboring teeth [11].

At the Institute of Radiology of Pavia, a research work was carried out on spiral computed tomography to determine the localization of retentive maxillary canines and further treatment planning. For this purpose, 19 patients with 29 retentive permanent canines variously located in the thickness of the alveolar process (palatine and vestibular) were examined. Patients were sequentially examined using orthopantomography, telerentgenography in lateral projection and spiral computed tomography. As a result of the conducted research, the authors found that it is impossible to detect desorption of the root of the adjacent incisor on the orthopantomogram, especially on its palatine and buckle surfaces. Computed tomography in 26 clinical cases easily diagnosed the space between the resented canine and the adjacent incisor and in 8 clinical cases resorption of the root of the adjacent incisor. The authors concluded that computed tomography facilitates the diagnosis of retentive canines, especially when it is inclined to the top of the alveolar ridge of the upper jaw, reduces the time of radiological examination, reduces the risk of possible movement of the patient's head [12].

At the Hokkaido Medical University, a radiological study was conducted on the issue of three-dimensional assessment of retentive incisors, canines, premolars, molars of the upper jaw at the stage of planning surgical intervention. The authors compared images of the root shapes of resented teeth from intraoral images, orthopantomograms and computed tomograms in 27 patients. With statistical reliability (P " 0.01), the authors proved the difference in the reliability of the X-ray information obtained and allowed us to conclude that only computed tomography makes it possible to make an accurate diagnosis of retention, with a clear definition of the shape of the root of the resented tooth in three-dimensional space [13].

The study of the use of spiral computed tomography in patients with retention of the upper permanent canines was also carried out by domestic authors. In 2007, based on a comparison of X-ray examination methods, it was revealed that spiral computed tomography is the most optimal additional method that allows to assess the location of the resented canine in three planes, determine its location relative to neighboring teeth, evaluate the morphology of the surface of the canine roots and adjacent teeth on the upper jaw, identify the desorption of the roots of neighboring teeth on the retention side. Based on the observations made, the researcher developed a protocol for X-ray examination of patients with retention of canines on the upper jaw, which allows planning orthodontic treatment based on OPTG data, occlusive radiographs, and spiral computed tomography (CT), TRG in lateral projection. The advantages of the presented protocol are that it systematizes the diagnostic process when planning the treatment of patients with retention of the upper permanent

canines and clearly defines the indications for CT. The disadvantages include the need to conduct a large number of X-ray examinations, including the SCT technique, in addition, this method has a high radiation load. The protocol is used only for the purpose of diagnostic examination of patients with retention of the upper permanent canines and cannot be applied when their eruption is delayed.

Another domestic author, based on the data of spiral computed tomograms, proposed a mathematical model created by means of a personal electronic computer (PC), which allows for the final editing of the entered data at the output and to implement the calculated amount of free space by computer method, to predict the result of treatment of patients with retention of the upper permanent canines [10].

Multispiral computed tomography with 3D reconstruction was used in 2013 on the basis of the Moscow State Medical and Dental University (MGMSU) to develop a computer program for calculating the trajectory of the retraction of a retentive tooth. This method allows the doctor to simulate the position in a real situation, change the trajectory of movement taking into account the applied force vector and visually predict the results of treatment [5, 13].

The most innovative direction of radiation diagnostics of the XXI century in dentistry was the creation and active introduction into practice of cone-beam computed tomography. There are various names of this research method in the literature, however, according to the version of the European Academy of Dental Radiology (European Academy of Dento Maxillo Facial Radiology) and the American International Institute of Cone Beam Tomography (International Cone Beam Institute), the method is called cone beam computed tomography (CBCT) [19].

CBCT allows obtaining high-quality X-ray images of the maxillary system and the maxillofacial region in three mutually perpendicular planes. The fundamental difference between specialized dental tomographs and sequential and spiral CT is that, firstly, in this case, a single planar sensor is used for scanning, and, secondly, that the generated beam is collimated in the form of a cone. During shooting, the emitter works continuously, and information is read from the sensor several times per second. Then the information is processed in a computer and a virtual three-dimensional model of the scanned area is restored [13].

Having all the advantages of multispiral computed tomography, cone-beam computed tomography allows you to perform a similar study with a lower radiation load, which is extremely important in children who make up the largest group of patients with retention of the upper permanent canines. A lower radiation load during CBCT is achieved due to the fact that the value of the current and anode voltage (voltage) in the installations is many times less — 70-90 kV and 3-8 mA, for MSCT these values are 120-140 kV and 100 mA, respectively. Thus, the radiation load from one study varies from 0.04 to 0.08 mSv, depending on the type of tomograph. According to SanPiN 2.6.1.802-99, for practically healthy individuals, the annual effective dose during preventive medical radiological procedures should not exceed 1 mSv. Based on these data, the method of cone-beam computed tomography can be attributed to low-dose studies [1].

Unlike conventional radiography, cone-beam computed tomography is the most informative, since it allows you to obtain images of any anatomical formations in three planes, to isolate a layer of the object of interest and a number of organocomplexes with a thickness of 1 to 10 mm [53]. Alqerban (2011) determined that CBCT is significantly better than panoramic radiography for determining the level of root resorption of lateral incisors in the categories of small and heavy resorption [60]. The largest comparative study was a prospective study in which the data of radiation research methods were analyzed by seven independent doctors. At the same time, patients underwent traditional (intraoral and panoramic) and high-tech (cone-beam computed tomography) radiological methods. Experts independently compiled a treatment plan for each patient (having data from either traditional

research methods or high-tech ones). Discussing the results of the X-ray examination, calculating statistically the accuracy of the diagnosis and the correctness of the chosen treatment, it was concluded that for the diagnosis of dental anomalies and the choice of treatment tactics, it is more expedient to use cone-beam computed tomography. However, according to a number of authors, such a diagnostic method has not found wide application due to the lack of a clear systematized methodology that allows for exhaustive diagnostic studies [20.22.24].

A group of Russian researchers proposed an informative and systematized method for diagnosing retarded teeth using cone-beam computed tomography (Sirona "GALILEOS", Morita "3DX"). The technique included: 1) determining the location of the retented teeth in the anterior and lateral sections of the jaws, as well as the angle of inclination of the longitudinal axes of the retented teeth to the coordinate axes; 2) determining the distance from the retented tooth to the compact jaw plate; 3) determination of bone density in the area of retented teeth and comparison with the density of bone tissue in the area of the same teeth on the opposite side. The technique offers an algorithm for studying the CBCT data, but does not give a summary assessment of the severity of tooth retention. Another researcher described the relationship between the remoteness of the retentive canines of the upper jaw from the occlusal plane and the probability of their removal. This pattern is called the "rule of vertical thirds" and can be used to predict treatment [3].

In 2009, a group of foreign researchers proposed a method for assessing CBCT, taking into account a number of parameters of the position of the retented canines: the angle of inclination, vertical position relative to the occlusal plane, antero-posterior position of the root tip and the degree of overlap of the adjacent incisor. Based on the evaluation of these parameters, the author determines the prognosis of eruption of the upper permanent canines [5].

Foreign researchers in 2015 publications point to the fact that there is no single agreement in orthodontic practice, according to which criteria would be allocated to determine the possibility of orthodontic treatment of retentive canines. As a result of a literary review of 237 articles devoted to the retention of upper permanent canines, the authors identified 10 parameters for determining the difficulty of treating retentive canines using CBCT data. Thus, according to the authors, the complexity of orthodontic treatment of patients with retention of the upper permanent canines is influenced by such factors as: the age of the patient; the position of the retented tooth in three planes; the presence of transposition of the retented tooth with a lateral incisor or the first premolar, the presence of dilaceration of the root of the retented tooth, the presence of resorption of the roots of neighboring teeth. In conclusion, the authors indicate that the most important parameters for assessing the difficulty of treating retentive canines using CBCT data are the patient's age, inclination relative to the occlusal plane, dilaceration, the imposition of the shadow of the retentive canine on adjacent teeth, the distance to the occlusal plane [4].

Based on the variety of etiological factors leading to retention of the upper permanent canines, it can be concluded that it is necessary to dynamically monitor and conduct regular preventive examinations for the eruption of these teeth in children, starting from the period of replacement bite [23.24.25].Thus, summing up the literary review of the articles, it is possible to use various X-ray research methods to diagnose the retention of the upper permanent canines. The most modern of the currently available is CBCT, which combines the acquisition of a large volume of diagnostic data with low radiation exposure to the patient. The literature describes various methods of evaluating X-ray studies in order to diagnose and plan the treatment of retention of the upper permanent canines, however, there are no works concerning the X-ray evaluation of the dental system of children during the period of replacement bite in order to prevent the formation of retention of canines. And still we have no right to judge and insist on using this or that technique for X-ray studies, because a lot depends on the economic development of a particular region. It also depends not a little on the

orthodontist, namely in the ability to read the information received by one or another resource.

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