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## RADIOLOGICAL DENTAL CHARACTERISTICS OF AGENESIS OF PERMANENT UPPER LATERAL INCISORS AND ITS FREQUENCY AMONG ORTHODONTIC PATIENTS

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Agnesis of the upper lateral incisors, in general, is a multifactorial clinical symptomless pathology with impaired aesthetics, function and psychological problems in patients. The aim of the study was to identify dental radiological features in orthodontic Ukrainian patients with agnesis of upper lateral incisors on orthopantomograms and to determine the frequency of occurrence of agnesis among orthodontic Ukrainian patients by an observational cross-sectional study. Orthopantomograms of 30 patients aged 7–25 years who had agnesis of permanent upper lateral incisors were found, analyzed and measured. According to the results of our study, in female patients, the presence of agnesis of the permanent upper lateral incisors has a significant direct relationship with the angles of inclination of central incisors ( $r=0.847$ ,  $p=0.0$ ), with the presence of temporary lateral incisors ( $r=0.972$ ,  $p=0.0$ ) and with the angles of inclination of canines ( $r=0.532$ ,  $p=0.002$ ). In male patients, a direct correlation of the presence of agnesis of the permanent upper lateral incisors was found with the angles of inclination of central incisors ( $r=0.815$ ,  $p=0.000$ ), with the presence of temporary lateral incisors ( $r=0.972$ ,  $p=0.000$ ) and with the angles of inclination of canines ( $r=0.532$ ,  $p=0.002$ ). The frequency of agnesis of upper lateral incisors among Ukrainian orthodontic patients is 1.9 %.

**Key words:** agnesis of upper permanent lateral incisors, radiological diagnosis, angles of inclination of upper central incisors, angles of inclination of upper canines.

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## РЕНТГЕНОЛОГІЧНА СТОМАТОЛОГІЧНА ХАРАКТЕРИСТИКА АГЕНЕЗІЇ ПОСТІЙНИХ ВЕРХНІХ БІЧНИХ РІЗЦІВ ТА ЇЇ ЧАСТОТА СЕРЕД ОРТОДОНТИЧНИХ ПАЦІЄНТІВ

Агенезія верхніх бічних різців, як правило, є багатофакторною клінічною безсимптомною патологією з порушенням естетики, функції та психологічними проблемами у пацієнтів. Метою дослідження було виявлення стоматологічних рентгенологічних особливостей у ортодонтичних пацієнтів України з агенезією верхніх бічних різців на ортопантомограмах та визначення частоти виникнення агенезії серед пацієнтів-ортодонтів України за допомогою обсерваційного перехресного дослідження. Виявлено, проаналізовано та виміряно ортопантомограми 30 пацієнтів віком 7–25 років з агенезією постійних верхніх бічних різців. За результатами нашого дослідження, у пацієнтів жіночої статі наявність агенезії постійних верхніх бічних різців має вірогідний прямий зв'язок з кутами нахилу центральних різців ( $r=0,847$ ,  $p=0,0$ ), з наявністю тимчасових бічних різців ( $r=0,972$ ,  $p=0,0$ ) та з кутами нахилу іклів ( $r=0,532$ ,  $p=0,002$ ). У пацієнтів чоловічої статі встановлено прямий зв'язок наявності агенезії постійних верхніх бічних різців з кутами нахилу центральних різців ( $r=0,815$ ,  $p=0,000$ ), з наявністю тимчасових бічних різців ( $r=0,972$ ,  $p=0,000$ ) та з кутами нахилу іклів ( $r=0,532$ ,  $p=0,002$ ). Частота агенезії верхніх бічних різців серед українських ортодонтичних пацієнтів становить 1,9 %.

**Ключові слова:** агенезія верхніх постійних бічних різців, рентгенологічна діагностика, кути нахилу верхніх центральних різців, кути нахилу верхніх іклів.

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Agnesis of the upper lateral incisors, in general, is a multifactorial clinical symptomless pathology with impaired aesthetics, function and psychological problems in patients. All causes of dental diseases, including gene loci of agnesis of upper lateral incisors, have not yet been determined, which is a scientific strategy for the future.

Children with hypodontia have delayed dental development [5], namely: shorter and narrower roots [7], reduced mesiodistal dimensions of teeth and reduced width of dental arches, reduced ANB angle and maxillary length [15], as well as the architecture changes of bone tissue of the edentulous area of the jaw [8], which should be taken into account when planning orthodontic treatment. Bilateral or symmetrical agnesis of the upper lateral incisors leads to changes in the alveolar process, which requires mandatory bone augmentation during implantation. Inadequate size of the alveolar process, shortening of the upper jaw can prevent the normal development of teeth rudiments [10].

Differences in the prevalence of agnesis depend on race and ethnic group [4]. In the Middle East, in a region with a high level of consanguineous marriages, agnesis of upper lateral incisors and upper canines is most common. Agnesis of upper canines is almost never found in Ukraine.

All researchers, without exception, insist on complex treatment of agnesis of upper lateral incisors by a team of specialists: an orthodontist, an implant surgeon and an orthopedist, consider the necessary role of a pediatric dentist, insist on drawing up a diagnostic protocol, on the need for radiological research methods and analysis of control and diagnostic models.

In the USA, among all conservative methods of treatment of agenesis of permanent upper incisors, the most effective is to change the shape of canines to lateral incisors, moved to central incisors, emphasize the important role of the restorative dentist and offer 3 treatment options: canine replacement, tooth-supported restoration or single-tooth implant. Implantation is supported in India [9] and UAE [12]. In Switzerland, 5 treatment methods of agenesis of upper lateral incisors are offered: a crown on an implant of one tooth, a fixed partial prosthesis on resin, a cantilever removable prosthesis, a complete removable prosthesis, but autotransplantation is considered the most cost-effective.

**The purpose** of the study was to identify dental radiological features in orthodontic Ukrainian patients with agenesis of upper lateral incisors on orthopantomograms and to determine the frequency of occurrence of agenesis of lateral incisors of the upper jaw among orthodontic Ukrainian patients by an observational cross-sectional study.

**Materials and methods.** The studies were approved by the biomedical ethics commission of the Poltava State Medical University No. 221 by 22.11.2023 and were conducted in accordance with the written consent of the participants.

From October 2018 to September 2023 a total of 1.545 OPTGs of orthodontic patients were analyzed. Inclusion criteria were men and women with occlusal pathology of Angle I, II and III class and agenesis of upper permanent lateral incisors. Persons with congenital facial defects and previously treated orthodontically were excluded.

Based on the results of analysis OPTGs of 30 patients aged 7–25 years who had agenesis of permanent upper lateral incisors were found, analyzed and measured. The following factors influencing the choice of treatment strategy were taken into account during the analysis of OPTG: gender, age, inclination angles of central incisors, inclination angles of canines, presence of temporary lateral incisors and degree of resorption of their roots, presence of temporary canines and degree of resorption of their roots.

OPTGs were made on the ORTHOPHOS XG DS/Ceph (“Sirona Dental Systems GmbH”). The angles of inclination of the central incisors and canines were measured relative to the vertical midline. Teeth angles were measured using CoreIDRAW® Graphics X6, Windows 10.

The studies were approved by the biomedical ethics commission of the Poltava State Medical University № 221 by 22.11.2023 and were conducted in accordance with the written consent of the participants. The materials of the scientific work comply with the Rules of Humane Treatment of Patients in accordance with the requirements of the Tokyo Declaration of the World Medical Association, the international recommendations of the Helsinki Declaration on Human Rights, the Council of Europe Convention on Human Rights and Biomedicine, the Laws of Ukraine, the orders of the Health Ministry of Ukraine and the requirements of the Ethics Code of the Doctor of Ukraine.

Statistical data processing was carried out in the license package "IBM SPSS Statistics v. 23". The study of the sample for the normality of the data distribution was carried out using exploratory analysis according to the Shapiro-Wilk test. Correlations license package using Spearman's non-parametric statistics.

**Results of the study and their discussion.** Agenesis of the permanent upper lateral incisors among orthodontic patients was complicated by various types of malocclusion, namely: Angle's class I – in 46.7 % (14) of patients, Angle's class II – in 43.3 % (13) cases and Angle's class III – in 10 % (3) of patients. We consider it important to choose a treatment strategy for agenesis of the upper lateral incisors to assess the angle of inclination of the central incisors and canines of the upper jaw.

According to the results of our study, inclinations of the central incisors relative to the midline are observed in the majority of the examined – 93.3 % (28), including 53.6 % (15) of women and 46.4 % (13) of men. At the same time, the inclination of both central incisors was detected in the majority of 60.7 % (17) cases, and the inclination of one of the central incisors – in 39.3 % (11).

The mean value of the angle of inclination of the right upper central incisor was  $7.34 \pm 10.48^\circ$  and of the left upper central incisor was  $5.58 \pm 8.12^\circ$ , regardless of the type of malocclusion.

The inclination of permanent canines was observed in 66.7 % (20) of patients with agenesis of lateral incisors, the gender distribution between the sexes was equal. In total, 65 % (13) of cases with tilting of both canines and 35 % (7) with tilting of one of the canines were found. It was found that 25 % (5) of patients with a complication such as tilting of canines were in the period of variable occlusion and 75 % (15) were in the period of permanent occlusion. That is, with the growth of the jaws, the number of complications in the form of inclination of the canines increases by three times.

The mean value of the angle of inclination of the upper canines was almost the same – the right one was  $13.36 \pm 8.27^\circ$  and the left upper canine was  $13.98 \pm 7.81^\circ$ . In individual cases with preserved temporary lateral incisors, the average value of the inclination angle of the right upper canine was  $7.41 \pm 8.52^\circ$  and the left upper canine was  $7.93 \pm 8.76^\circ$ , which is almost 2 times less than the overall average value. Thus, the presence of preserved temporary incisors significantly reduces the angles of such a complication as the inclination of permanent canines. The type of malocclusion did not affect the inclination of the canines.

The presence of preserved temporary lateral incisors was found in 53.3 % (16) of patients, 75 % (12) of which were female and 25 % (4) were male. Cases of paired preserved incisors were observed in 31.3 % (5) of cases, single – in 68.7 % (11). Regarding the age aspect, among the examined patients with preserved temporary lateral incisors, 43.8 % (7) were in the period of variable occlusion, and 56.2 % (9) were in the period of permanent occlusion. In 100 % of cases with preserved lateral temporary incisors, resorption of its root was found; in 81.3 % (13) the degree of root resorption was found to be 1/3, and in 18.7 % (3) – to 2/3.

In 40 % (12) of patients, the presence of preserved temporary canines was observed, 66.7 % (8) of which were female and 33.3 % (4) were male, i.e., preserved temporary canines were twice as common in women. Cases of paired preserved temporary canines on the right and left were found in 66.7 % (8), single – in 33.3 % (4) of patients. Regarding the age aspect, among the examined patients with preserved temporary canines, 41.7 % (5) were in the period of variable occlusion, and 58.3 % (7) were in the period of permanent occlusion. In 100 % of preserved temporary canines, root resorption was detected: 1/3 – in 50 % and 2/3 – in 50 %, therefore, in the strategy of treatment of agenesis of upper lateral incisors, temporary canines are not considered in the long term.

In female patients, the presence of agenesis of the permanent upper lateral incisors has a significant direct relationship with the angles of inclination of central incisors ( $r=0.847$ ,  $p=0.0$ ), with the presence of temporary lateral incisors ( $r=0.972$ ,  $p=0.0$ ) and with the angles of inclination of canines ( $r=0.532$ ,  $p=0.002$ ), as well as a reliable feedback relationship with the resorption of the roots of temporary incisors ( $r=-0.391$ ,  $p=0.033$ ).

In male patients, a direct correlation of the presence of agenesis of the permanent upper lateral incisors was found with the angles of inclination of central incisors ( $r=0.815$ ,  $p=0.0$ ), with the presence of temporary lateral incisors ( $r=0.972$ ,  $p=0.0$ ) and with the angles of inclination of canines ( $r=0.532$ ,  $p=0.002$ ), as well as a reliable feedback relationship with the resorption of the roots of temporary incisors ( $r=-0.401$ ,  $p=0.028$ ).

In both women and men, no correlations were established between the presence of agenesis of the permanent upper lateral incisors and the types of malocclusion and the presence of temporary canines [6].

According to our data, the frequency of occurrence of agenesis of upper lateral incisors among all orthodontic patients was 1.9 %, while in another western region of Ukraine, the prevalence of congenitally missing upper lateral incisors in the orthodontic population of adolescents aged from 12 to 18 years was 3.9 % [8]. In the USA, the number of agenesis is 8.2 % [12], in Brazil their number reaches 13.2 % [14], and in Malaysia, according to the authors, it is 1.7 %. In Nepal, among all orthodontic patients, agenesis was 7.48 %, among all, agenesis of upper lateral incisor was as much as 48.61 % [6], and in Qatar – 36.2 % [3]. In Norway, among all agenesis, agenesis of upper lateral incisors accounted for 20 % Nordgarden et al., in the UAE – 8.3 % [12], in Israel, agenesis among orthodontic patients accounted for 11 % [13]. The fact that agenesis of the upper lateral incisors is the most frequent among all types of agenesis has been emphasized by many researchers in different years Kavadia et al. In 2015, in China, scientists compared the frequency of occurrence of agenesis among the population and among orthodontic patients and came to the conclusion: 5.8 % – agenesis among the population, 7.48 % – among orthodontic patients. The authors note that agenesis of the upper lateral incisors has become more frequent, which may be a reflection of human evolutionary changes, a consequence of reduction of the maxillofacial area, as a complication of underload of the masticatory function due to the consumption of insufficiently hard food.

Among the 30 cases with agenesis of the upper lateral incisors studied by us, 30 % of patients (9) were in the period of variable occlusion and 70 % of patients (21) – with permanent occlusion. That is, according to our data, patients with a permanent occlusion seek help from an orthodontist 2.3 times more often, which confirms a study of Nunn et al. from Malaysia.

Scientists from the Netherlands Polder et al., as early as 19 years ago, emphasized the dependence of agenesis on gender, namely: it is 1.37 higher in women than in men. In our study, agenesis of lateral incisors on the upper jaw was found in 53.3 % (women): 46.7 % (men) 1.1 times more often in women, while the Larmour et al. even derived the pattern: women to men, as 3/2 respectively. Ukrainian researchers from the city of Uzhhorod (Ukraine) also found a higher percentage of agenesis of the upper lateral incisors in women (2.8 %) compared to men (1.1 %) [8].

In our study, symmetric or bilateral forms of agenesis of the upper lateral incisors were 6.5 times more frequent than unilateral forms and accounted for a total of 86.7 % (26), and unilateral forms in 13.3 % (4) of the total number of patients coincides with literary sources and confirms the data of scientists from the Netherlands Polder et al. According to the 2022 data of Ukrainian researchers [8], 50 % of the examined had bilateral agenesis of the upper lateral incisors, 21.4 % had left unilateral agenesis, and 28.6 % had right unilateral agenesis.

We determined that women had bilateral forms in 100 % of cases. In men, cases of bilateral adentia of upper lateral incisors were 72.4 %, which is 2.5 times more frequent than unilateral (28.6 %). In the period of variable occlusion, agenesis with bilateral forms were found in 88.9 % (8) of patients, and in the period of permanent occlusion in 85.7 % (18) of patients.

Among the examined, 32.1 % (9) of the patients had incisor inclination during the period of variable occlusion, and 67.9 % (19) of patients during the period of permanent occlusion, i.e., with age, morphological complications increase by 2 times, which is the opposite to the conclusions of Portuguese scientists, who claim that with age the angle of inclination of the incisors is corrected.

In our case, agenesis of the upper lateral incisors among orthodontic patients was complicated by malocclusion, namely: 46.7 % (14) of patients had a diagnosis of Angle's class I, 43.3% (13) – Angle's class II, and 10 % (3) – Class III according to Angle. Although researchers from Nepal did not find a connection between agenesis of the upper lateral incisors and malocclusion [6].

Choosing a treatment method for agenesis of upper lateral incisors requires a decision by a team of specialists based on a diagnostic protocol: whether to open a space for prosthetics by implantation [9, 12] or use the most cost-effective method of autotransplantation. The movement of teeth is accompanied by complex biochemical processes in bone tissue [1, 2]. Without a correct radiological assessment of position and morphology of the central upper incisors, there can be no success in the interdisciplinary treatment of agenesis of the upper lateral incisors [11].

As a result of the study, we proved that for choosing a treatment strategy for this pathology, a radiological assessment of position of the upper incisors and canines on OPTGs of the jaws is sufficient.

### Conclusions

The frequency of agenesis of the upper lateral incisors among Ukrainian orthodontic patients is 1.9 %. Bilateral forms of agenesis of lateral incisors occur 6.5 times more often, in 100 % of women.

Agenesis of the upper lateral incisors has the greatest number of correlations with dental parameters: the angles of inclination of the central incisors, the angles of inclination of canines and with the preservation of temporary lateral incisors, the presence of which significantly reduces the inclinations of permanent teeth.

Most patients (93.3 %) with agenesis of the upper lateral incisors have inclinations of the central incisors. With age, the complication of the pathology increases: the inclinations of the central incisors in a permanent occlusion are doubled, and the inclinations of the canines are tripled.

Ukrainian patients with the problem of agenesis of lateral teeth on the upper jaw seek help of an orthodontist 2.3 times more often after the age of 14, but the treatment of agenesis of the upper lateral incisors should be started as early as possible, in a period of variable occlusion.

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