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# Two-stage orthodontic treatment outcomes of children with dentoalveolar class II malocclusion

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## Abstract

**Background**. During the rehabilitation of children with distal occlusion, it is not always possible to achieve the desired outcomes. In this context, the factors influencing the outcomes of treatment for class II malocclusions in children at different stages of occlusion development.

**Aim**. To study two-stage orthodontic treatment outcomes in children with dentoalveolar class II malocclusion by the clinical case.

**Material and methods**. We analyzed the physical examination results of the patient within the treatment from 6 to 17 years. Facial proportion symmetry, aesthetic, type of face, plaster dental models were determined by using the photographs. Orthopantomography was used to analyze the condition of temporary and permanent teeth, jaw bone tissue and to assess functional disorders. Orthodontic treatment in a mixed dentition period was carried out using removable devices, including those improved by the authors. In the permanent dentition, orthodontic brackets with power elements were used.

**Results**. Untimely contacting the doctor, an insufficient level of motivation to implement recommendations for improving posture and dental care contributed to an increase in treatment duration. Keeping excessive cervical spine flexion and head tilted back, the "bad habit" of placing (pressure) the hand on the chin, and the rejection of a myo-gymnastic exercise (physical therapy) interfered with the synchronous (normal) development of the jaws. Premature loss of a temporary molar on one side led to dentoalveolar asymmetry and disruption of occlusal contacts. Additional orthodontic appliances were used to correct these deformities. Over-retained deciduous teeth led to the delayed eruption of permanent teeth and, presumably, to the curvature of their roots. Violation of the tooth's root shape and asymmetry in permanent teeth crown size prevented the full correction of their position using highly effective modern non-removable orthodontic equipment. The anomalous position of the rudiment of the third molar, the refusal for timely tooth extraction further led to the increasing complexity of the surgical technique.

**Conclusion**. The timing and effectiveness of orthodontic treatment of a patient with dentoalveolar class II malocclusion were influenced by a poor body posture, extraction of a primary molar, the delayed eruption and crown size asymmetry of permanent teeth, the presence of "bad" habits and minimal cooperation of the patient with the orthodontist.

**Keywords**: class II malocclusion, diagnosis, prevention, treatment, children.

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## Background

Distal occlusion (DO) is a common pathology detected in at least 11% of children during preventive examination and in more than 40% of children who seek orthodontic treatment, including children in Krasnodar territory [1–5].

In the period of permanent occlusion, DO often co-occurred with abnormalities in the shape and size of the dental arch, teeth crowding, abnormal position of the incisors, and vestibuloposition of the canines. All these cause aesthetic discomfort in the patient, lead to a deterioration in oral hygiene, and affect the quality of life of the patients [1, 2, 6–9].

Comprehensive rehabilitation of pediatric patients with DO is aimed at achieving facial harmony and normalizing tooth position, shape and size of the dentition and their ratio, and functional state of the masticatory and facial muscles [1, 2, 7, 10–13].

Orthodontic treatment, which starts with the emergence of the first signs of DO, is accompanied by the prolonged use of removable and non-removable orthodontic devices, restructuring of mas-

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ticatory and facial muscles, and normalization of breathing, chewing, swallowing, and speech functions [1, 2, 6, 9–21].

During the rehabilitation of pediatric patients with DO, it is not always possible to achieve the desired result. In this regard, factors influencing the results of DO treatment in children at different periods of occlusion formation are of interest.

**This study aimed** to examine the results of two-stage orthodontic treatment of pediatric patients with dentoalveolar DO by presenting a clinical example.

## Materials and methods of research

Treatment outcomes of a child from age 6–17 years were analyzed in detail. Medical records, facial photographs, diagnostic models of the jaws, and orthopantomograms were also evaluated.

The preliminary diagnosis was formulated based on the data obtained in the main (clinical) research methods, namely, survey, examination, and clinical functional tests. The survey clarified the probable causes of DO and the complaints of the patient and parents. During the examination, deviations of the facial configuration from the generally accepted criteria of the norm and manifestations of dentoalveolar abnormalities were evaluated. The Eschler–Bittner functional test revealed the facial profile during sagittal movements of the lower jaw in comparison with Angle's criteria for normal occlusion.

To clarify the information obtained, additional (instrumental) methods were employed, namely, face photometry, measurement of diagnostic models of the jaws, and orthopantomography. Symmetry and proportionality on photographs of the face in direct projection were studied, and the facial type was determined according to Izard. In the lateral projection, the profile and aesthetics of the face were evaluated using the Ricketts method. On diagnostic models of the jaws, the height and width of the crowns of the permanent teeth were measured compared with the norm according to Ustimenko. The proportionality of the segments of the dentition was examined according to the methods of Tonn and Gerlach. The width, length, and symmetry of the dentition were assessed using the methods of Pont, Korkhaus, and Khoroshilkina [1–3, 6, 20].

Orthopantomography was used to evaluate the dentoalveolar regions, temporary and permanent teeth, bone tissue of the upper and lower jaws, and temporomandibular joints [22–24].

The study complied with the standards of the Declaration of Helsinki. The medical record of an orthodontic patient (Registration Form No. 043-1/y) was approved by the order of the Ministry of Health of Russia dated December 15, 2014, No. 834n. It included an informed consent to orthodontic treatment and the use of depersonalized photographs of the teeth and oral cavity ("I allow the use of photographs of my teeth and oral cavity without indicating my name and surname").

## Results and discussion

The medical record indicates that Patient L first applied for orthodontic care at age 5 years with complaints about the incorrect position of the lower incisors, which occurred during their eruption according to the parents.

*Medical history data*. The child was born at term, grew, and developed in accordance with age. Somatic diseases were not detected at the time of treatment. The hereditary nature of dentoalveolar abnormalities has not been established. The patient did not visit the dentist for treatment of dental caries. Tooth 8.4 was removed because of complicated caries at age 6 years.

The configuration of the patient's face was slightly changed. However, excessive curvature of the cervical spine and posterior head tilt were identified, which was considered a risk factor for the formation of inferior micro-/retrognathia and worsening of the facial profile [25].

*Examination* of the oral cavity revealed the absence of tooth 8.4 in the dentition, which we assessed as a risk factor for the deformity with shortening of the lower dentition on the side of extraction [26–28]. The mutual position of the distal surfaces of the crowns of the upper and lower second temporary molars in the same plane suggested the eruption of the first permanent molars according to Angle's class II.

According to the results of the examination, the diagnoses of neutral occlusion, narrowing of the dentition, close position of the incisors, and secondary adentia of tooth 8.4 were established.

Exercise therapy was recommended to the patient to normalize posture. Removable plate devices were made to expand the dentition. The defect of the lower dentition on the right was restored to prevent unwanted migration of teeth toward the defect, reduction of the lateral segment, and impairment of the contacts of antagonist teeth.

The proposed measures were intended to eliminate the existing deviations from the norm, prevent the negative effect of the identified risk factors, and create conditions suitable for the formation of physiological occlusion. However, the patient refused to use orthodontic devices and did not visit the orthodontist for 1.5 years.

At age 8 years, the patient returned to the orthodontist with complaints about the tight position of the lower incisors. Excessive curvature of the cer-

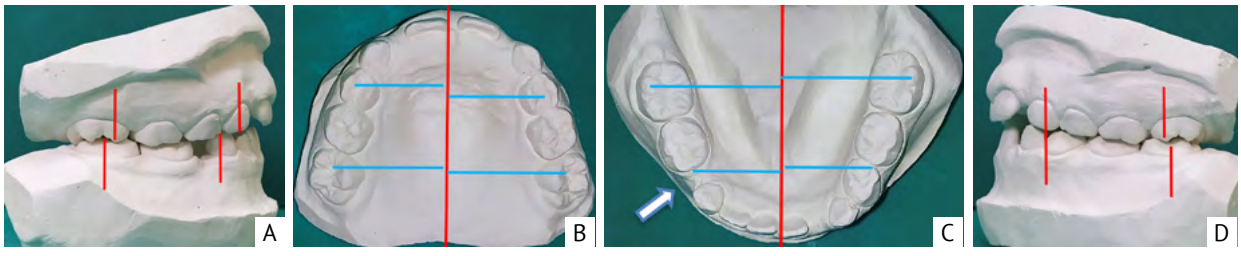


**Fig. 1**. Diagnostic models of the jaws of Patient L (aged 8 years and 6 months): A, right side view; B, model of the upper jaw; C, model of the lower jaw; D, left side view.

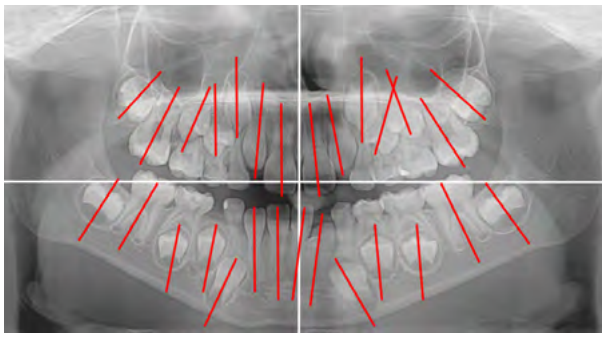

**Fig. 2**. Orthopantomogram of Patient L (aged 8 years and 6 months).

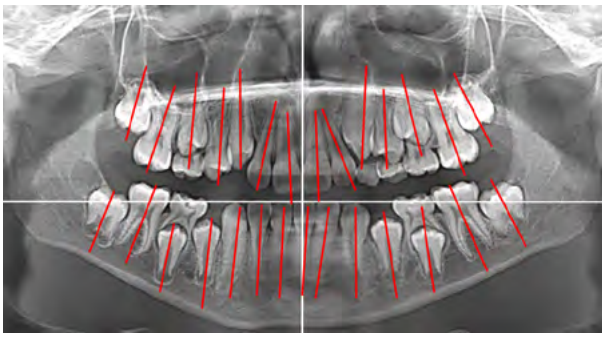

**Fig. 3**. Orthopantomogram of Patient L (aged 12 years).

vical spine and backward tilt of the head persisted. A decrease in the height of the lower third of the face by 2.0 mm, in comparison with the height of the middle third of the face, was accompanied by minor changes in facial configuration.

The Izar facial morphological index was 87.5%, which did not contradict the data on the disproportion in the middle and lower parts of the face and the decrease in the height of the lower part of the face (oph-sn) > (sn-gn). The proportionality of the parts of the lower third of the face was also impaired (sn-st):(st-gn) = 1:2.2.

In the photographs of the face in the lateral projection, the contours of the lips and soft tissues of the chin remained in the Dreyfus profile field. The facial profile was convex (angle n-sn-pg = 164°). The protruding points of the lips were not adjacent to the Ricketts aesthetic line (pn-pg).

Examination of the oral cavity revealed the close position of the lower incisors, secondary adentia of tooth 8.4, shortening of the right lateral segment, and asymmetry of the lower dentition. The diastema between teeth 1.1 and 2.1 had no space left for the eruption of the lateral incisors of the upper jaw. The median lines of the dentition did not match. The ratio of the dentition in the area of the first permanent molars on the right and on the left was class II, and it was physiological in the area of temporary canines on the left and tubercular on the right, which, in our opinion, was a consequence of the displacement of tooth 8.3 toward the defect of the lower dentition.

On the diagnostic models of the jaws (Fig. 1), the width and length of the anterior sections of the dentition were evaluated using the methods of Pont and Korkhaus. Given the absence of teeth 1.2 and 2.2, the sum of the widths of the crowns of the maxillary incisors was calculated by the equation using the Tonn index (SI' = si × 4/3). Narrowing of the dentition, shortening of the right lateral segment, and asymmetry of the lower dentition were noted.

The orthopantomogram shows the abnormal direction of the eruption of permanent teeth germs and the lack of space in the arch for the eruption of lateral incisors (Fig. 2).

The diagnoses of DO (dentoalveolar form), narrowing of the teeth, asymmetry of the lower dentition, shortening of the lateral segment on the right, crowding and tortoposition of the lower incisors, and diastema in the area of teeth 1.1 and 2.1 were established.

The comparison of the diagnosis formulation with the previous one indicated a worsening of the clinical situation, and patient L and his parents were informed about it. Their attention was drawn to the presence of risk factors for the formation of dentition abnormalities, namely, delayed eruption of permanent incisors, asymmetry of the lower dentition, and shortening of the right segment of the lower dentition.

The treatment plan included expanding the dentition with the use of removable plate devices of mechanical action, lengthening the lower dentition on the right, correcting the direction of eruption of

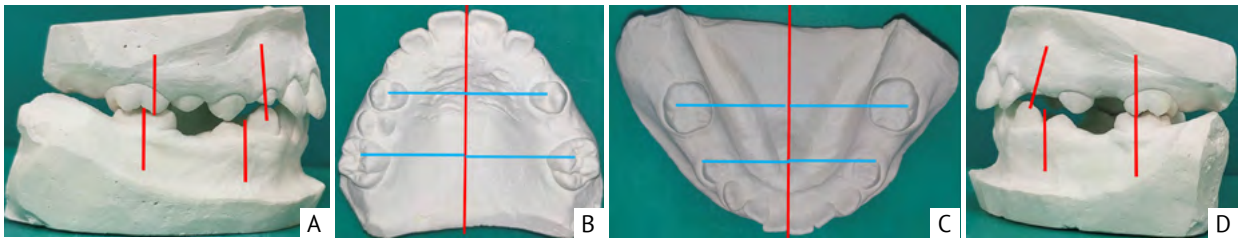


**Fig. 4**. Diagnostic models of the jaws of Patient L (aged 13 years): A, right side view; B, model of the upper jaw; C, model of the lower jaw; D, left side view.

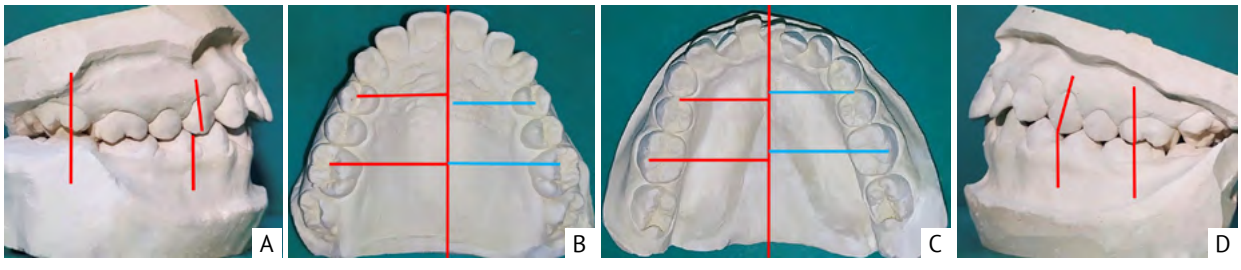


**Fig. 5**. Diagnostic models of the jaws of Patient L (15 years old): A, right side view; B, model of the upper jaw; C, model of the lower jaw; D, left side view.

the incisors and their position in the dentition, controlling the ratio of the first permanent molars and temporary canines, and eliminating functional disorders and unhealthy habits.

The absence of impairment in facial harmony and patient's growth potential at this age enabled the prediction of the positive results of treatment.

At age 12 years, due to the delayed eruption of permanent teeth and uneven resorption of the roots of temporary molars [28], the patient was referred for orthopantomography and extraction of temporary teeth (Fig. 3).

The treatment plan included expanding the dentition using removable orthodontic devices with screws, distalizing the first permanent molars to their Angle class I ratio, controlling the eruption of canines and premolars, and eliminating functional disorders. A satisfactory result of treatment was obtained (Fig. 4).

Neutral occlusion was achieved. Deep incisal overlap was eliminated. The position of the incisors improved, and their close position remained. A space was created for the eruption of canines and premolars. Attention was drawn to the delay in the eruption of permanent canines, second premolars, and second molars. The patient was advised to avoid functional disorders and unhealthy habits and visit the orthodontist two times a year to control the formation of a permanent occlusion. However, the patient did not visit an orthodontist.

At age 15 years, the patient returned to the orthodontist with complaints about the tight position of the lower incisors.

As a result of sports activities, posture and head tilt improved. The tension of the muscles during facial expression and slight limitation of mouth opening were monitored. At rest, the facial configuration was harmonious. At the time of occlusion, the height of the lower third of the face was 2.0 mm less than the lower third of the face.

The patient was found to have an unhealthy habit of resting the chin on the hand. The parents and the patient were instructed to observe correct posture and avoid unhealthy habits and functional disorders [29]. On the diagnostic models of the jaws (Fig. 5), the correct fissure–tubercular contacts of the lateral teeth were determined. The overlap of the lower incisors was more than 1/2 of the height of the crowns, accompanied by their tight location and tortoposition.

In the measurement of the width and height of the crowns of the permanent teeth on diagnostic models of the jaws, the parameters of the teeth of the same name are asymmetric. The width of the crowns of individual teeth, particularly teeth 1.7, 1.1, 2.1, 2.3, 2.7, 3.1, and 4.1, exceeded the average statistical norm (Table 1).

Deviations of the width of the crowns of individual teeth from the average statistical norm contributed to the disproportion of dentition segments.

The proportionality of the width of the crowns of the permanent teeth and the length of dentition segments according to Tonn and Korkhaus are presented in Table 2.

Orthodontic care in the mixed dentition period helped expand the lower dentition and eliminate its asymmetry of the lower dentition, thereby reducing the crowding of the incisors and providing conditions for the eruption of canines and premolars. After years of rehabilitation, the deformities of the

**Table 1**. Width and height of the crowns of the permanent teeth and their differences from the individual norm.

| Width and height of tooth crowns (norm according to V.L. Ustimenko) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Normal width | 8,7–10 | 8,7–10 | 6,0–7,0 | 6,2–7,2 | 7,1–8,1 | 6,0–7,1 | 8,0–9,0 | 8,0–9,0 | 6,0–7,1 | 7,1–8,1 | 6,2–7,2 | 6,0–7,0 | 8,7–10 | 8,7–10 |
| Width | 12,0 | 9,9 | 6,3 | 6,4 | 7,7 | 7,0 | 8,7 | 8,6 | 6,6 | 7,9 | 6,4 | 6,6 | 9,7 | 10,8 |
| Normal height | 4,5–5,9 | 4,5–5,9 | 5,3–6,9 | 6,6–8,0 | 8,0–9,6 | 7,1–8,5 | 8,2–9,7 | 8,2–9,7 | 7,1–8,5 | 8,0–9,6 | 6,6–8,0 | 5,3–6,9 | 4,5–5,9 | 4,5–5,9 |
| Height | 5,6 | 5,4 | 5,9 | 7,8 | 8,4 | 8,1 | 10,6 | 10,6 | 8,5 | 10,0 | 8,0 | 6,1 | 5,5 | 5,4 |
| UJ teeth | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| LJ teeth | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 31 | 32 | 33 | 34 | 35 | 36 | 37 |
| Height | 5,1 | 5,2 | 6,2 | 7,4 | 8,5 | 8,3 | 9,0 | 8,8 | 8,3 | 8,7 | 7,8 | 6,4 | 6,0 | 5,9 |
| Normal height | 4,5–5,9 | 4,4–6,1 | 6,0–7,3 | 7,2–8,5 | 8,5–10,2 | 7,2–8,7 | 7,0–8,6 | 7,0–8,6 | 7,2–8,7 | 8,5–10,2 | 7,2–8,5 | 6,0–7,3 | 4,4–6,1 | 4,5–5,9 |
| Width | 10,0 | 10,4 | 7,3 | 7,3 | 6,6 | 5,7 | 5,4 | 5,4 | 5,6 | 6,8 | 7,1 | 7,4 | 11,2 | 10,1 |
| Normal width | 9,6–10,8 | 10,3–11,7 | 6,5–7,4 | 6,4–7,3 | 6,3–7,2 | 5,6–6,4 | 4,9–5,6 | 4,9–5,6 | 5,6–6,4 | 6,3–7,2 | 6,4–7,3 | 6,5–7,4 | 10,3–11,7 | 9,6–10,8 |

Note: UJ, upper jaw; LJ, lower jaw.

**Table. 2**. Segmental analysis of dentition.

| Segmental analysis of dentition according to the Gerlach method in the period of permanent occlusion | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Lor | | Lur | | Lol | | Lul | | SI | si |
| Total | Measur. | Total | Measur. | Total | Measur. | Total | Measur. | | |
| 30,3 | 33,2 | 31,6 | 35,0 | 30,6 | 34,1 | 32,5 | 34,2 | 30,9 | 22,1 |

Note: measur., measurement. The ratio of dentition segments is as follows: Si/si = 1.398; Lor<Lur by 1.3 mm; Lor<Lur by 1.9 mm.

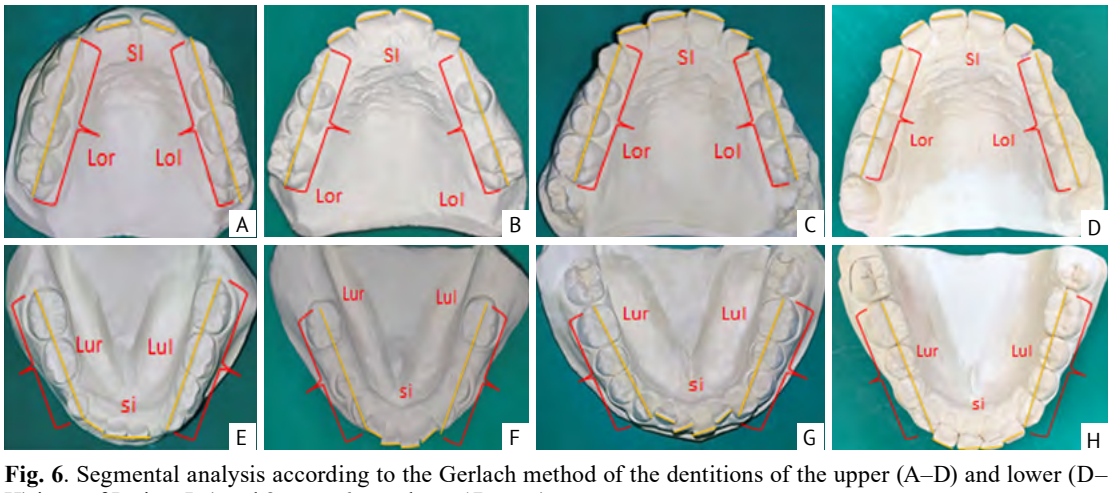


**Fig. 6**. Segmental analysis according to the Gerlach method of the dentitions of the upper (A–D) and lower (D–H) jaws of Patient L (aged 8 years 6 months to 17 years).

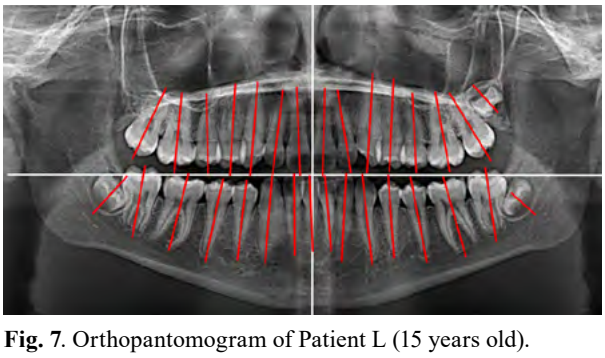

**Fig. 7**. Orthopantomogram of Patient L (15 years old).

**Table 3**. Tilt of the axes of the permanent teeth on orthopantomograms of Patient L during follow-up.

| Age | Axial tilts in degrees (°) of the permanent teeth of the upper jaw | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 8,5 years | | 47,4 | 63,1 | 66,6 | 105 | 93 | 85 | 85 | 96 | 101,9 | 93 | 78,8 | 108,9 | 119,2 | 140,9 | |
| 12,5 years | | 77,7 | 75 | 90,7 | 91,6 | 90,6 | 77,3 | 93,6 | 93,3 | 108,8 | 86,8 | 92,2 | 98,4 | 110 | 117,8 | |
| 15 years | | 65 | 84,9 | 91,2 | 86,7 | 85,5 | 82,8 | 92,2 | 88,5 | 99 | 86,8 | 87,4 | 93,1 | 100,5 | 121,4 | 132,7 |
| 17 years | | 70,9 | 71,3 | 82,9 | 85,7 | 86,3 | 81,9 | 87,1 | 87,7 | 101,4 | 91,8 | 87,7 | 97,7 | 97,2 | 113 | 155 |
| Age | Axis tilts in degrees (°) of the permanent teeth of the lower jaw | | | | | | | | | | | | | | | |
| | 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 |
| 8,5 years | | 123,4 | 120,6 | 105,3 | 100,2 | 117,3 | 92 | 91 | 98,7 | 95,8 | 58,2 | 83,7 | 84,8 | 64,3 | 53,5 | |
| 12 years | | 115,5 | 111,5 | 103,5 | 93,8 | 96,6 | 91,6 | 91,6 | 93,1 | 98,3 | 89,3 | 81,4 | 81,4 | 66,3 | 62,6 | |
| 15 years | 132,4 | 100,2 | 104,3 | 102 | 96,6 | 94,3 | 89,4 | 87,8 | 85,4 | 92,7 | 83,7 | 85,8 | 78,8 | 74,2 | 81,4 | 130,8 |
| 17 years | 141,4 | 112,8 | 111,6 | 113,6 | 97,1 | 104,3 | 83,3 | 90,9 | 85,5 | 86,3 | 77 | 80 | 76,2 | 111,5 | 64,2 | 140,8 |

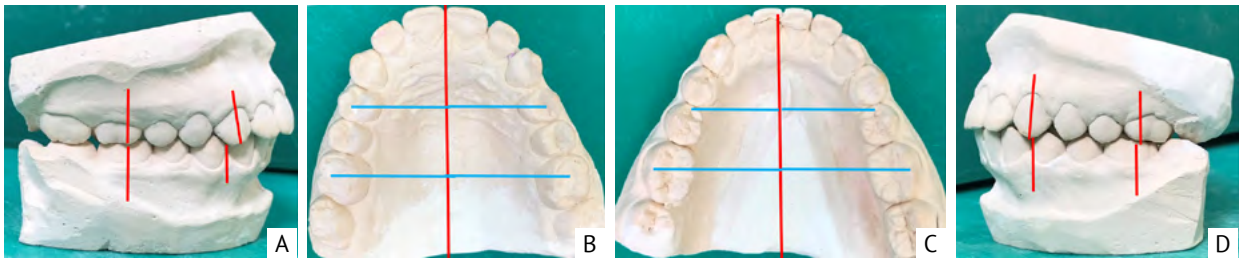


**Fig. 8**. Diagnostic models of the jaws of Patient L (17 years old): A, right side view; B, model of the upper jaw; C, model of the lower jaw; D, left side view.

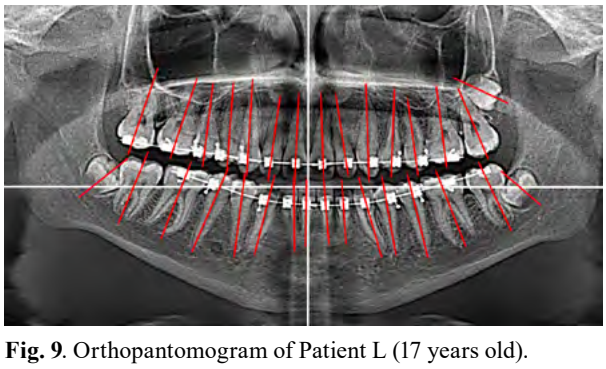

**Fig. 9**. Orthopantomogram of Patient L (17 years old).

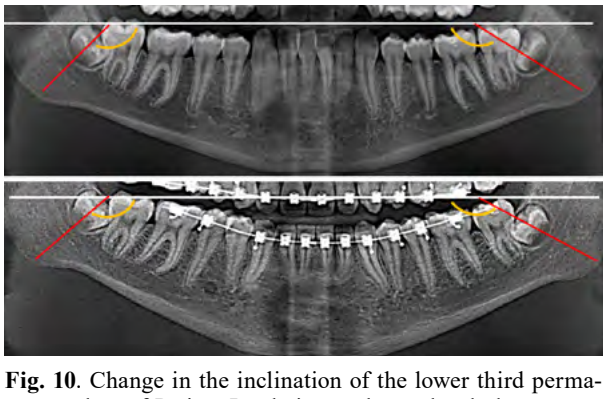

**Fig. 10**. Change in the inclination of the lower third permanent molars of Patient L relative to the occlusal plane on orthopantomograms at age 15–17 years.

patient's dentition were eliminated as much as possible; however, it was not possible to obtain ideal results (Fig. 6).

Deviations of the width of the crowns of the teeth from the norm and disproportion of the dentition segments complicated with occlusion in accordance with Andrews' "six keys."

In addition, the orthopantomogram revealed a curvature of the roots of permanent teeth (Fig. 7), which complicated their replacement, and normalization of inclination of the roots was not possible.

The patient and the parents were informed about the possibility of some problems during teeth movement and formation of occlusion. They agreed with the treatment plan. However, they asked to remove the germs of the third molars later because of family matters.

As a result of orthodontic treatment with the Damon Q bracket system with elements of appropriate strength, a satisfactory result was obtained (Fig. 8).

On the orthopantomogram after the orthodontic correction of occlusion, a slight asymmetry in the position of the teeth and curvature of the roots of individual teeth were observed (Fig. 9).

The position of the germs of teeth 2.8, 3.8, and 4.8 deteriorated during follow-up from age 15–17 years (Fig. 10).

This was confirmed by changes in the tilts of the axes of the permanent teeth and the germs of

the third permanent molars relative to the occlusal plane (Table 3).

The germs of teeth 2.8, 3.8, and 4.8 were removed at age 18 years. Thus, the results of our study showed that certain factors that influenced the development of dentoalveolar abnormalities and the efficiency of treatment in a patient with DO.

Untimely search for specialized dental care and preterm loss of a temporary molar led to the asymmetry of the lower dentition and an increase in the severity of dentoalveolar abnormalities.

The motivation [30] to discontinue unhealthy habits turned out insufficient. Regularly pressing the chin on the palm of the hand contributed to an increase in the degree of overlap of the incisors.

Non-compliance with recommendations to improve posture and persistence of excessive curvature of the cervical spine and tilting of the head back also affected the formation of occlusion.

Untimely removal of the germs of the third permanent molars [31] and developmental disorders of individual permanent teeth prevented the full correction of the position of the teeth with the use of effective modern non-removable orthodontic equipment (Damon Q bracket system).

**Conclusions**

1. In the sagittal direction, the face with the dentoalveolar form of DO demonstrated a harmonious configuration. With a combination of DO with deep incisal occlusion, a decrease in the height of the lower face is possible.

2. Preterm loss of a temporary molar (tooth 84), impaired development of individual teeth and delayed eruption, functional, and unhealthy habits contributed to the occurrence of deformities of the lower dental arch, increased severity of dentoalveolar abnormalities, and decreased efficiency of secondary prevention and orthodontic treatment of a patient with dentoalveolar form of DO.

3. Preterm loss of a temporary molar on one side led to a reduction in the length of the lateral segment and asymmetry of the dentoalveolar arch and disruption of occlusal contacts. Additional orthodontic devices are necessary to eliminate these deformities.

4. The delay in the change of temporary teeth can presumably cause the curvature of the roots of erupting permanent teeth, which is an indication for the removal of these temporary teeth.

5. The asymmetrical size of the tooth crowns and curvature of the roots of individual permanent teeth made it difficult to achieve an orthodontic result in accordance with the generally accepted "six keys of occlusion" according to Andrews.

6. The formation of dentoalveolar abnormalities and results of orthodontic treatment were influenced by insufficient motivation for the active cooperation of the patient and his relatives with dental specialists.

7. The anomalous direction of eruption of the germs of the third molars remained during follow-up in the period of permanent occlusion formation.

**Author contributions**. F.S.A. was the work supervisor and analyzed the literature data and research results. R.A.H. conducted the research and analyzed the literature data and research results.

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**Conflict of interest.** The authors declare no conflict of interest.

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