

## Treatment of Dentognathic Anomalies and Deformations in Children with Congenital Unilateral Cleft Lip and Palate

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### Abstract

Removable and fixed orthodontic appliances with various active elements are used to eliminate dentognathic anomalies and deformations in children with congenital cleft lip and palate. The subject of the analysis was the design features of orthodontic devices used in the treatment of dentognathic anomalies and deformations in 137 children aged 4.5 to 14.5 years with congenital unilateral cleft lip and palate in the mixed dentition period.

The choice of an orthodontic constructions depends on the period of development of a dentognathic apparatus, age of patients, cleft type, stages, timing and scope of surgical interventions, quality and methods of surgery, severity of deformation in the transverse and sagittal planes and components of the anomalies and deformations symptom complex, which complicate the pathology, psycho-emotional state of a child, factors of communication between the parents and the patient with the doctor, socio-economic components. In the presence of deformations in the sagittal and transverse planes, it is advisable to gradually use orthodontic devices to achieve optimal sagittal and transverse overlap, after which, due to intercuspitation, the upper dental arch is held by the lower one.

In the absence of adequate orthodontic follow-up in children with congenital cleft lip and palate, they develop persistent forms of dentognathic deformations. It is possible to achieve the best treatment results during the period of peak growth of the upper jaw and naso-orbital complex.

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### Introduction

In accordance with the data by the State Institution Public Health Center of the Ministry of Health of Ukraine, the percentage of children with congenital cleft lip and palate (CLP) has remained stable in recent years and ranges from 0.091% to 0.1%.<sup>1</sup> Statistical indicators of the number of people born with this pathology in the world, according to the World Health Organization, are 1:800-2000, including in European countries – 1:500-1000, the USA – 1:600, African countries – 1:2440. The incidence

of birth of children with cleft lip and palate in Japan is approximately 0.146%.<sup>2,3</sup>

The prevalence of dentognathic anomalies and deformations (DAD) in children with CLP reaches about 94%.<sup>4,5</sup> CLP children have physical abnormalities and various oral problems.<sup>6</sup> They are especially pronounced at through clefts. Usually, one child presents with several concomitant anomalies or deformations.<sup>4,5</sup> The leading role in complex and multi-stage rehabilitation of children with CLP is assigned to an orthodontist.<sup>2-5,7-10</sup> Early orthodontic treatment allows to reduce the severity of DAD caused by both a congenital defect and surgical intervention, and should prevent the occurrence of severe deformations of the dentognathic apparatus. Removable and fixed orthodontic appliances with various active elements are used to eliminate DAD in children with CLP in the period of mixed dentition period.<sup>4-13</sup> An important issue is the determination of the area

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of application of orthodontic forces, the frequency of activation of appliances.<sup>14</sup>

The aim: to provide the characteristics of orthodontic devices used in the treatment of the dentognathic anomalies and deformations in children with congenital unilateral cleft lip and palate in the mixed dentition period and determine the areas of application of forces.

### Materials and methods

The subject of the analysis was the design features of removable and fixed orthodontic devices used in the treatment of DAD in 137 children aged 4.5 to 14.5 years (average age  $9.3 \pm 4.2$  years) with congenital unilateral cleft lip and palate (UCLP) in the mixed dentition period. Among them, removable devices was used in 92 cases at the initial stage of orthodontic treatment, fixed in 45. In the course of follow-up, removable orthodontic devices were replaced with fixed ones in 44 patients, removable orthodontic appliances were manufactured again of a similar or different design in 48 patients, fixed orthodontic appliances were remade in 38 patients accordance with the treatment plan and taking into account positive anatomical and functional changes. In total, during the treatment of 137 children, 140 removable and 127 fixed orthodontic appliances were manufactured in the laboratory.

In addition to individual constructions of orthodontic appliances, standard devices were used. In 33 cases, it was an extraoral headgear with chin cup device in combination with removable intraoral appliances. In 47 cases, it was a Dealer mask in combination with removable (n=18) and fixed (n=29) intraoral appliances. For children over 11.5 years of age, braces were used in 32 cases, in 18 of them in combination with a Dealer mask.

The inclusion criteria were as follows: children with UCLP at the stages of surgical interventions, age from 4.5 to 14.5 years without distribution by gender, with an existing residual or secondary defect in the area of the hard palate or alveolar process, parental consent. Exclusion criteria: lack of complete documentation of the case, age older than 15 years, presence of concomitant somatic diseases associated with bone metabolism disorders, mental disorders, and parental refusal.

The procedures, possible discomforts or risks, as well as possible benefits were explained fully to the human subjects involved, and their informed consent was obtained prior to the investigation. Before starting the orthodontic treatment, all patients underwent a comprehensive diagnostic examination that included subjective and objective methods, a treatment plan was drawn up taking into account the phasing of surgical interventions and multidisciplinary support from other specialists.

### Results

It was established during the clinical examination that 96.4% of patients (n=132) did not receive full orthodontic presurgical support before the primary surgical interventions. Only 8.8% of the parents (n=12) discussed the possibilities of orthodontic rehabilitation of their child before birth with an orthodontist. Spoons and special nipples were used for artificial feeding due to the inability of the babies to suck. Only 6.1% of the infants (n=8) used obturators. During presurgical orthodontic preparation, the DynaCleft system was used in 11.4% of cases (n=15) alone or together with preoperative nasopalveolar molding (PNAM) or intraoral plates. After cheilorhinoplasty, 6.6% of children (n=9) used functional devices such as removable prostheses with pilots in the frontal area, aimed at leveling the negative impact of the orbicularis oris muscle and preventing the formation of sagittal deformations. After veloplasty, 8.8% of the patients (n=12) used retention devices.

The insufficient level of presurgical orthodontics and orthodontic follow-up after the first primary surgical interventions are among the reasons for the high prevalence of DAD in older age. Use of the clinical and additional research methods allowed to identify deformations in the transverse and sagittal planes in 90.5% and 88.3% of the study subjects, respectively, combined pathologies in the sagittal and transverse planes, complicated with narrowing and/or shortening of tooth rows and maxillary micrognathia – in 79.6% of the children, among all examined patients (n=137). In general, deformations in the transverse and sagittal planes were diagnosed in 99.2%.

Components of the DAD symptom complex were diagnosed in children with congenital UCLP, which complicate the

pathology: defects of the dental arch and alveolar process of the upper jaw at the cleft site (82.5%), eruption of teeth in the area of the defect (78.8%), displacement of the midline (70,8%), tooth anomalies and tooth position anomalies (crowding of teeth – 56.7%, diastema – 40.1%, tortoanomaly – 38.0%), dentoalveolar disproportion (37.3%) and others.

For treatment of deformations, obtaining satisfactory overjet (sagittal overlap), overbite (vertical overlap) and normalization of transversal ratios, in most cases, removable, intraoral, combined principle of action orthodontic appliances by Schwartz with occlusive side plates, one or more orthodontic screws, and protracting springs were used at the initial stage of treatment (n=87) and during re-fabrication (n=39). Their design features were sectoral cuts, which allowed to move individual fragments of the jaw at the dental and alveolar levels.

In order to eliminate deformation in the transverse plane, one-sided orthodontic screws placed in the base of the apparatus perpendicular to the alveolar ridge of a small fragment of the jaw were preferred. In the presence of a deformation in the sagittal plane, they were located perpendicular to the frontal area of the alveolar ridge of the large fragment of the jaw. Two screws, placed at the base of the device perpendicular to the alveolar ridge of the small fragment and the frontal area of the alveolar ridge of the large fragment of the jaw, were used in combined sagittal and transversal pathologies (Figure 1). Activation of the screws was carried out individually, taking into account experimental and theoretical studies of the rigidity of orthodontic devices used in the treatment of DAD in children with congenital UCLP and determining the qualitative indicators of bone tissue in the areas that correspond to the maximum stress under their influence. With round-the-clock use, excluding the time of hygienic procedures, the screw was activated on average once every 3-4 days.



**Figure 1.** Removable orthodontic appliances for the treatment of dentognathic anomalies and deformations in children with congenital unilateral

cleft lip and palate in the sagittal (A), transversal (B) planes, with a combination of sagittal and transversal pathologies (C).

Simultaneously with Schwartz appliances, patients (n=33) used an extraoral headgear with chin cup device during sleep and at home to control the development of the lower jaw at an early age and prevent its disproportionate growth relative to the upper jaw. Orthodontic forces in functional appliances depend on muscular activity and act intermittently. The use of chin cup devices in combination with orthodontic appliances with occlusive side plates contributes to the most effective functional correction, especially in children who sleep with their mouths open.

In order to stimulate the growth of the upper jaw and shift it along the sagittal, hooks were added to the appliances at the canines level for fixing a removable extraoral device – the Dealer mask, in the treatment of children aged 6 years and older (n=18) (Figure 2).



**Figure 2.** Use of an extraoral headgear with chin cup device (A) and Dealer mask (B).

Removable and fixed appliances have their advantages, but disadvantages as well. The main criterion for successful treatment with removable devices is the motivational component. Most children with UCLP and their parents are more motivated to orthodontic treatment than peers without congenital defects. The percentage of those who failed to follow the recommendations is quite low – about 8%.

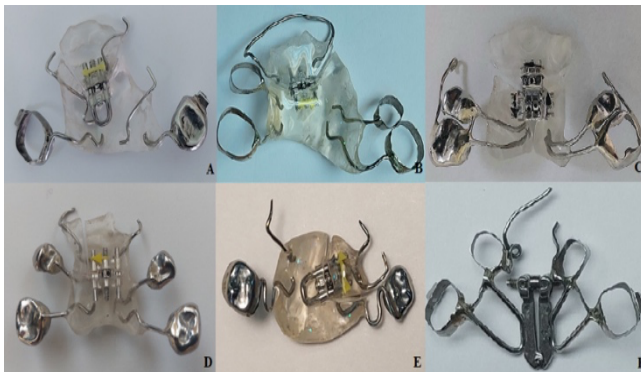
The use of fixed appliances has certain limitations associated with the peculiarities of the conditions for fixation, the impossibility of supporting elements on temporary teeth with the existing resorption of their roots



and during physiological change of teeth, the difficulties of high-quality oral hygiene.

Among the fixed orthodontic appliances, modifications of Derichsweiler, Nord, Haas / Marco Rosa, McNamara maxillary mechanical devices were used for the treatment of patients at the initial stage (n=45) and during re-fabrication after 5-9 months (n=38), as well as at the second treatment stage when replacing removable appliances with fixed ones (n=44) (Fig. 3).

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**Figure 3.** Fixed orthodontic appliances for the treatment of dentognathic anomalies and deformations in children with congenital unilateral cleft lip and palate (A-F).

The main disadvantages of these designs, proven by clinical experience and research, include the lack of versatility, because they were developed for the expansion of the upper jaw in patients without congenital malformations and provide for uniform expansion of the upper jaw. In the presence of large and small fragments of the jaw in UCLP, their displacement is noted. The large one, placed on the healthy side, does not change its position or shifts distally. The small one is usually displaced to the middle. A narrowing and shortening of the jaw is observed while maintaining multiple occlusal contacts on the part of the large fragment, in contrast to the small one. This requires correction by asymmetric extension and protraction of the jaw.

The complexity of orthodontic treatment is due to the fact that there is no bone base capable of holding the expanded fragments of the upper jaw in the area of the palatal suture in children with clefts. Moreover, the scar tissue that forms after primary surgical interventions prevents the growth and development of the upper jaw and its expansion. An important factor when using fixed appliances is to dose the action of their forces to prevent resorption of teeth roots and an adverse effect on the periodontium. The recommended period of their use is after the end of formation of the roots of the supporting teeth. Activation of the screws was also carried out individually, taking into account experimental and theoretical studies of the rigidity of orthodontic devices used in the treatment of DAD in children with UCLP and determining the qualitative indicators of bone tissue in the areas that correspond to the maximum stress under their influence, on average once every 2-4 days (Figure 4).



**Figure 4.** Fixed orthodontic appliances for the treatment of dentognathic anomalies and deformations in children with congenital unilateral cleft lip and palate during treatment without (A-C) and in combination with braces (D-F).

In order to shift the upper jaw in the sagittal direction, a Dealer mask was used in combination with maxillary fixed devices in the treatment of children aged 6 years and older (n=11) and braces in children aged 11.5 years and older (n=32).

The choice of an orthodontic constructions in the treatment of children with DAD in UCLP depends on the period of development of a dentognathic apparatus, age of patients, cleft type, stages, timing and scope of surgical interventions, quality and methods of surgery, severity of deformation in the transverse and sagittal planes and components of the

anomalies and deformations symptom complex, which complicate the pathology, psycho-emotional state of a child, factors of communication between the parents and the patient with the doctor, socio-economic components. Growth disorder is the basis for the formation of pathological bites and other orthodontic problems.

In the presence of deformations in the sagittal and transverse planes, it is advisable to gradually use orthodontic devices to achieve optimal sagittal and transverse overlap, after which, due to intercuspitation, the upper dental arch is held by the lower one.

Displacement of cleft fragments of the jaw while maintaining occlusal contacts prevents its free growth, and when the deformation in the transverse plane is primarily eliminated by expansion, the frontal site is displaced distally. Thus, the deformation in the sagittal plane increases, there is an increase in the reverse sagittal gap and a shortening of the dental arch (Figure 5). In adulthood, it is extremely difficult to eliminate such a deformation without orthognathosurgical interventions.



**Figure 5.** The result of primary expansion of the upper jaw in the transverse direction without affecting the sagittal component of the dentognathic deformations symptom complex (A-C).

## Discussion

It is extremely difficult to determine the optimal ways for treatment of children with UCLP. This is due to the great variability of deformations and the biased assessment of the proposed therapy by the patients<sup>4</sup>, but in order to reduce the number and severity of DAD in older age, early orthodontic treatment is extremely important. In addition, it is important for the parents and patients to be motivated for comprehensive and long-term orthodontic treatment and maintenance of a high level of dental health during all its stages.<sup>3, 4, 7, 9, 10, 15</sup> Parenting stress can affect parent knowledge and attitudes about maintaining oral health.<sup>6</sup>

A surgeon and an orthodontist should work in tandem to determine the anatomical limits of maxillary expansion.<sup>2, 16</sup> What degree of expansion of the upper jaw is sufficient to achieve the set goal and what is the first priority – the elimination of transversal or sagittal deformations, are debatable issues<sup>5</sup> and require confirmation using additional radiography and morphometric methods. It is important to achieve coordinated growth and physiological mutual placement of jaws, for which it is fundamentally important to eliminate forced sagittal and transverse displacements.<sup>2, 5</sup>

Removable and fixed orthodontic appliances used for the elimination of DAD in UCLP have insufficient versatility. Most children have a bony defect of the palate and alveolar process and displacement of cleft fragments of the upper jaw. This indicates the need to develop new constructions of orthodontic appliances with the creation of conditions for asymmetric expansion and simultaneous protraction of the upper jaw.

## Conclusions

In the absence of adequate orthodontic follow-up in children with congenital cleft lip and palate, they develop persistent forms of dentognathic deformations. It is possible to achieve the best treatment results during the period of peak growth of the upper jaw and naso-orbital complex.

Based on the analysis and clinical experience of using removable and fixed orthodontic appliances in patients aged 4.5 to 14.5 years old with the purpose of achieving optimal sagittal and transverse overlap, orthodontic staged correction with a primary effect on the sagittal component of the anomalies and deformations symptom complex complicating the congenital defect is advisable.

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## Declaration of Interest

The authors report no conflict of interest.

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