

**REPUBLIC OF AZERBAIJAN**

*On the rights of the manuscript*

**ABSTRACT**

of the dissertation for the degree of Doctor of Science

**CONTEMPORARY PRINCIPLES OF OPTIMIZATION  
METHODS FOR DIAGNOSIS, TREATMENT AND  
PREVENTION OF VERTICAL DENTOALVEOLAR  
ANOMALIES**

Speciality: 3226.01 – Dentistry

Field of science: Medicine

Applicant: **Ziba Vagif Gasimova**

**Baku – 2021**

The dissertation work was performed at the department of therapeutic dentistry of the Azerbaijan Medical University

Scientific consultant: doctor of science on medicine, professor  
**Tamara Hajibaba Huseynova**

Official opponents: doctor of medical sciences, professor  
**Olga Ivanovna Arsenina**

doctor of medical sciences, professor  
**Miroslava Stefanovna Drohomiretska**

doctor of medical sciences, professor  
**Hikmat Isfandiyar Ibrahimli**

doctor of medical sciences  
**Kamal Gafar Gafarov**

Dissertation council ED 2.05 of Supreme Attestation Commission under the President of the Republic of Azerbaijan operating at Azerbaijan Medical University

Chairman of the Dissertation council:

doctor of medical sciences, professor  
**Garay Chingiz Garaybayli**

Scientific secretary of the Dissertation council:

doctor of medical sciences, professor  
**Aga Chingiz Pashayev**

Chairman of the scientific seminar:

doctor of medical sciences, professor  
**Rana Kurban Aliyeva**



## GENERAL REVIEW OF THE WORK

### Relevance of the topic.

The vertical dento-maxillar anomalies (VDMA) are one of the most serious issues of modern orthodontics, as a number of matters, related to their classification, diagnostics, prevention and treatment, has not been resolved completely. That is why, studying these issues from the scientific and practical points of view is quite a topical issue.

The literature provides some data on main types of VDMA, leading to morphological, functional and esthetic distortion of dento-maxillo-facial system: supra and infra location of teeth, mainly canine<sup>1,2</sup>, impaction of permanent and supernumerary teeth<sup>3,4</sup>, dental arch and malocclusion in vertical dimension.

However, until very recently, there is no consent on VDMA terminology, for example, dento-alveolar shortening is described with the term “vertical disocclusion”, dento-alveolar extension – deep incisal bite” or “deep incisal occlusion”<sup>5,6</sup>.

---

<sup>1</sup>*Персин, Л.С., Гюева, Ю.А., Бедрединова, Г.Р.* Оценка изменения положения зубов в процессе лечения пациентов с вестибулоположением клыков верхней челюсти // Ортодонтия, – 2019. №3, – с. 23-30.

<sup>2</sup>*Naser, D.H., Abu Alhaija, E.S., Al-Khateeb, S.N.* Dental age assessment in patients with maxillary canine displacement // Am. J. Orthod. Dentofacial Orthop., – 2011. 140(6), – p. 848-55. doi: 10.1016/j.ajodo.2011.04.027.

<sup>3</sup>*Арсенина, О.И., Проскокова, С.В., Сапежникова, С.А.* Современные методы обследования пациентов с ретенрованными зубами // Ортодонтия, – 2010. №1, – с. 20-21.

<sup>4</sup>*Becker, A., Chaushu, S.* Etiology of maxillary canine impaction: a review // Am. J. Orthod. Dentofacial Orthop., – 2015. 148(4), – p. 557-567.

<sup>5</sup>*Тугарин, В.А.* Клиника, диагностика, лечение вертикальной резцовой дизокклюзии // Ортодонтия, – 1999. – №3, – с. 32-40.

<sup>6</sup>*Малыгин, Ю.М., Хорошилкина, Ф.Я., Тайбогарова, С.С.* Диагностика, профилактика и лечение зубочелюстно-лицевых аномалий, сочетающихся с глубоким резцовым перекрытием. Учебное пособие. – Москва: ГБОУ ДПО РМАПО, – 2013. – 55 с.

In our study the terminology is based on the international literature, namely, term “deep bite”<sup>7,8</sup> and “open bite”<sup>9,10</sup>.

Open bite (OB) – dental type appears as result of dento-alveolar shortening in frontal or lateral parts of the dental arch and is characterized with absence of closure between different groups of teeth due to the distortion of swallowing and respiratory functions, harmful habits, postural misalignment and other etiological factors<sup>11,12,13</sup>.

Deep bite (DB) – dental type appears, mainly, due to dento-alveolar extension of the frontal part of the upper dental arch and is characterised by extension of the lower third of a face, gingival trauma in the area of lower frontal teeth<sup>14</sup>.

The relevance of the problem in area like Azerbaijan is in the fact that the data on VDMA prevalence, their combination with sagittal

---

<sup>7</sup>Хорошилкина, Ф.Я., Петрова, Ю.К. Диагностика и лечение глубокого прикуса. Учебное пособие. – Москва: ЦОЛИУФ, – 1989. – 26 с.

<sup>8</sup>Берсенева, А.В. Совершенствование диагностики и лечения глубокого прикуса с учетом направления роста челюстей: / автореферат дисс. кандидата медицинских наук / – Тверь, 2007. – 20 с.

<sup>9</sup>Мешалкина, И.В., Корсак, Л.В., Ткаченко, Т.Б. Проблема открытого прикуса: история вопроса и современное представление // Институт стоматологии, – 2019. №2, – с. 96.

<sup>10</sup>Rijpstra, C., Lisson, J.A. Etiology of anterior open bite: a review // J. Orofac. Orthop., – 2016. 77(4), – p. 281-286.

<sup>11</sup>Степанов, Г.В. Анализ наследственных и средовых факторов в формировании и распространенности аномалий зубочелюстной системы на территории Самарской области / Г.В.Степанов, Ю.В.Мякишева, И.В.Федосейкина [и др.] // Ортодонтия, – 2019. 2 (86), – с. 78-79.

<sup>12</sup>Germa, A., Clément, C., Weissenbach, M. Early risk factors for posterior cross-bite and anterior open bite in the primary dentition // Angle Orthod., – 2016. 86 (5), – p. 832-838.

<sup>13</sup>Дрогомирецкая, М.С., Билоус, М.К., Войтович О.А. Динамика изменения показателей стабильности постурального баланса тела в процессе ортодонтического лечения // Материалы 16-го съезда ортодонтотв России, – Санкт-Петербург: – 9-11 октября, – 2014. Ортодонтия, – 2014. № 3 (67), – с.71.

<sup>14</sup>Лазарева, О.В. Структурные особенности глубокого рецезового перекрытия у взрослых // Ортодонтия, – 2010. №3, – с. 92.

and transversal anomalies, as well as prevention and treatment of patients of different age groups is quite limited<sup>15,16</sup>.

Prevention and treatment of accompanying diseases of oral cavity during orthodontic treatment (OT) of patients with VDMA is another crucial point as orthodontic devices significantly complicate oral hygiene<sup>17,18</sup>.

At the same time, natural means of ancient times, like misvak and propolis, have a favorable impact on the oral cavity organs in term of prevention of such conditions as caries and paradontal diseases<sup>19,20,21</sup>.

The most complicated task for orthodontics remains to be the development of preserving methods of orthodontic treatment, as well as the shortening of treatment time, especially for VDMA, secondary to tooth retention.

Arguments listed herein confirm the relevance of the topic and justify the further studying of issues related to the methods of diagnostics, treatment and prevention of VDMA.

### **Objects of the study:**

Patients with different dento-maxillary anomalies. Experimental animals (non-fertile white rats).

---

<sup>15</sup>*Pənahov, N.A.* Azərbaycan Respublikasında yeniyetmələr arasında diş-cənə anomaliyaların və deformasiyaların epidemiologiyası, ortodontik və ortopedik yardıma ehtiyacın öyrənilməsi, kompleks müalicə və profilaktika tədbirlərinin əsaslandırılması: / tibb üzrə elmlər doktoru diss. avtoreferatı) / – Bakı, 2013. – 40 s.

<sup>16</sup>*Алимский, А.В., Алиева, Р.К.* Частота аномалий зубочелюстной системы у школьников в различных регионах Азербайджана // Ортодент-Инфо, – 1999. №2, – с. 36-37.

<sup>17</sup>*Быкова, В.Е.* Взаимосвязь патологии окклюзии и патологических изменений в пародонте // Ортодонтия, – 2013. №2, – с. 33-34.

<sup>18</sup>*Renkema, A.M., Padmos, J.A., de Quincey, Gd.* Gingival recessions and orthodontics // Ned. Tijdschr. Tandheelkd., – 2015. 122 (11), – p. 611-616.

<sup>19</sup>*Qafarova, D.Q.* Həmilə qadınlarda dişlərin kariyesi və parodont toxuması iltihabi xəstəliklərin profilaktika metodlarının əsaslandırılması: / tibb üzrə elmlər doktoru diss. avtoreferatı) / – Bakı, 2009. – 21 s.

<sup>20</sup>*Гашимов, Р.Г., Тагиев, С.А., Хандагджли, У.Н.* Мисвак – источник получения новых стоматологических препаратов // Sağlamlıq, Баку, – 2001. №8, – с. 36-38.

<sup>21</sup>*Baeshen, H.A., Lingström, P., Birkhed, D.* Effect of fluoridated chewing sticks (Miswaks) on white spot lesions in postorthodontic patients // Am. J. Orthod. Dentofacial Orthop., – 2011, 140(3), – p. 291-297.

**Goal of the study** is the development of optimal integrated method for improving the efficiency of vertical dento-maxillar anomalies diagnosing, treatment and prevention.

**Objectives of the study:**

1. To determine the prevalence of VDMA in patients seeking orthodontic treatment.
2. Identify and systematize main VDMA variations and their combination.
3. Optimize VDMA diagnostic methods on the basis of lateral cephalometric head films and calculations using «Dolphin Imaging – 11,9» software.
4. Study acoustic and histologic changes in the hard tissue structures of permanent dentition under the impact of fixed orthodontic devices, taking in to account the length of treatment.
5. Study, in experiment, the results of impact of different low-frequency ultrasound (LFUS) modes on to dento-maxillar soft tissue.
6. Develop an efficient device to conduct an experimental study.
7. Develop, based on experimental data obtained during studying of the impact of LFUS, an optimal treatment method for VDMA patients, related to permanent tooth eruption.
8. Improve the methods of prevention caries during orthodontic treatment in patients with VDMA, using miswak.
9. Improve the methods of prevention of paradontal diseases during the orthodontic treatment of VDMA using water extract of propolis “A-P-V”.
10. Develop, considering the age of a patient, the algorithm of optimal integrated methods of treatment and prevention of VDMA and compile a set of methodic recommendations to be introduced in to orthodontic practices.

**Methods of the study:**

The examination of patients was carried out using modern integrated methods, including clinical, photometric and biometric, radiological, morphological, acoustic and statistical studies. In the experimental part of the work, the effect of various low-frequency ultrasound modes on experimental animals was investigated. Histological methods of investigation were used.

### **Main thesis of dissertation for defense:**

1. The elaborated method of stimulation of eruption of impacted permanent teeth on the basis of LFUS is reasonable and efficient for use in orthodontic practice.

2. The prevention of focal hypomineralization of dental enamel and paradontal diseases in orthodontic patients with the use of natural “Miswak” and “A-P-V” facilitate the prevention of complications and improvement of treatment efficiency.

3. The elaborated algorithm of integrated methods of diagnostics, treatment and prevention of different VDMA, combined with sagittal and transversal malocclusions, taking in to account age periods of patients, improve the efficiency of orthodontic treatment and reduce its duration.

### **Scientific novelty:**

For the first time based on the integrated methods of investigation:

- different morphological forms of vertical dental-maxillar-facial anomalies during neutro-, disto- and mesio-occlusion in junction with functional distortion and age factor;
- VDMA, conditioned by dento-alveolar shortening is systematized;
- the status of dental hard tissues in the area of bracket binding was studied using the acoustic method, depending on the duration of their impact, along with comparison of such impact on to enamel and dentin;
- optimal LFUS impact modes on to gingival soft tissues and dental hard tissues were studied in the experiment;
- animal restraining device was developed (Eurasia patent № 027001 dated 30.06.2017);
- delayed eruption stimulation methods for permanent dentition based on LFUS was developed (Patent RF № 2559934, dated 20.07.2015);
- the method of prevention of complications in the form of enamel hypomineralisation, appearing during orthodontic treatment in patients with VDMA, using miswak, was proposed;
- the method of prevention of paradontal diseases during ortho-

dontic treatment of patients with VDMA, based on low-frequency ultrasound dispersion (LFUD) of natural water extraction of propolis “A-P-V” was proposed;

- the method of determination of oral cavity hygiene indicators in patients with orthodontic devices was improved.

**Practical value of the work:**

- the results of the study allowed systematization and summarizing of the peculiar morphological, functional and aesthetic abnormalities of dento-alveolar-facial system during VDMA;
- elaborated integrated treatment and prevention methods for patients with VDMA of different age groups, taking into account their age and maxillar development were scientifically grounded, by means of prediction of orthodontic treatment outcomes using «Dolphin Imaging – 11,9» software;
- the diagnostic relevance of acoustic and hystologic methods of examinations of oral cavity soft and hard tissues was justified;
- the efficiency of sparing VDMA treatment methods during permanent dentition eruption delay, on the basis of LFUS use was proven;
- the proposed method of using natural “miswak” is efficient for prevention of caries during the treatment of patient with both fixed and removable orthodontic devices;
- the proposed method of LFUS dispersion of natural “A-P-V” is effective for prevention of paradontal diseases;
- the treatment algorithm for different age periods taking in to account the stages of bite formation was developed;
- methods and means elaborated not only improve the efficiency of VDMA treatment and prevention of accompanying complications, but also shorten the period of orthodontic treatment.

**Approbation of study outcomes:** Outcomes of the study were reported at: VI Congress of Orthodontists of Russia (Moscow, 2001); VII Congress of Orthodonts of Russia (Moscow, 2002); VII International Conference of Maxillo-Facial Surgeons and Stomatologists



(St.Petersburg, 2002); Scientific-Practical Conference «Сучасні напрямки розвитку стоматології», dedicated to the 75<sup>th</sup> Anniversary of Foundation of Institute of Stomatology of Ukrainian AMS (Odessa, 2003); 6<sup>th</sup> International Specialized exhibition and Conference (St. Petersburg, 2003); IX Congress of Orthodontists of Russia (Moscow, 2004); X Congress of Orthodontists of Russia (Moscow, 2005); XII Congress of Orthodontists of Russia (Moscow, 2009); III All Russian Scientific-Practical Conference on “In-born and Congenital Pathology of Head and Neck in Children: Topical Issues of Integrated Treatment” (Moscow, 2009); scientific-practical conference, dedicated to National leader Heydar Aliyev and 86<sup>th</sup> anniversary of academic Zarifa Aliyeva "Contemporary aspects of dentistry" (Nakhichevan, 2009); VIII International Scientific-Practical Conference on Topical Aspects of Orthodontics (Kiyev, 2011); International Caspian Conference of Implantologists (Baku, 2011); 14<sup>th</sup> Congress of Orthodontists of Russia (Moscow, 2012); V Forestadent Symposium «Tradition meets the future» (Budapest, 2012); ); XXIV International Congress "New and Old Myths in Orthodontic Philosophies" (Firenze, 2012), XVIII International Conference of Maxillo-Facial Surgeons and Stomatologists “New Technologies in Stomatology” (St. Petersburg, 2013); Scientific-Practical Conference on Topical Problems of Medicine – 2017 (Baku, 2017); 1st International Congress of Maxillo-Facial Surgeons (Baku, 2019).

Materials of the dissertation were discussed at the joint meeting of chairs of stomatology, orthopedic, surgical, therapeutic and pediatric stomatology and human anatomy of AMU (Protocol № 5, dated 13.09.2017); at the scientific seminar of the Approbation Commission under the Dissertation Board ED 2.05 AMU (protocol № 1, dated 29.03.2021).

**Introduction of outcomes of the study.** Outcomes of the study are used in the education process at the chair of dentistry of Azerbaijan Medical University (AMU), practical work of the AMU stomatology clinic, National Stomatology Center, Dental clinic №1 in Sumgait city, pediatric Dental clinic of Ganja city.

4 methodological recommendation were published and circulated among dentists.

**The name of the organization where the dissertation has been accomplished.** The dissertation has been accomplished at the department of dentistry (until 2018), therapeutic dentistry and the Scientific Research Center of the Azerbaijan Medical University, as well as at the Institute of Biochemical Physics named after I. N.M. Emanuel of the Russian Academy of Sciences (Moscow).

**Publications.** 80 scientific works, including 34 articles, 35 publications in collections of scientific and practical conferences and congresses, 7 thesis, 4 methodical recommendations were published. 2 patents and 2 certificates on rationalization proposals were obtained.

**Volume and the structure of the dissertation.** The study itself is described on 352 printed pages (370924 symbols), consisting of introduction (12187 symbols), literature review (87025 symbols), chapter of material and methods (45146 symbols), 6 chapters of personal studies (154777 symbols), conclusions (60641 symbols), findings (3170 symbols), practical recommendations (1710 symbols), bibliography (44 pages), appendixes (4 pages). Dissertation contains 198 figures, 20 charts and 13 tables. Bibliography lists 399 sources.

## MATERIALS AND METHODS

To achieve the goals of the study and obtain the set objectives, 7172 patients with dento-maxillar anomalies (DMA) of 2-64 years of age were examined. Patient examination was performed using modern integrated methods, including clinical, photo and biometric, x-ray, morphological, acoustic and statistical methods.

**Clinical methods of examination.** To optimize the study, the orthodontic patient examination form, covering personal data, was developed. Data was imputed in to a digital Microsoft Excel database with digital catalog with pre- and post-orthodontic treatment data.

Out of total 7172 examined orthodontic patients, 2669 were male (37.21%) and 4503 were female (62.79%). Depending on the age patients were divided into following 5 groups:

1 group – 181 children with temporary dentition (2-5 years), of which 23.76% with open and 25.41% with deep bite.

2 group – 1807 children with early mixed dentition (6-9 years), that had first permanent molars and incisors, of which 13.17% were with open and 21.91% with deep bite.

3 group – 2241 children with late mixed dentition (10-13 years), that had first premolars and canines, of which 7.54% were with open and 27.84% with deep bite.

4 group – 1790 adolescents with early permanent dentition (14-18 years), that had second permanent molar, of which 15.31% were with open and 17.99% with deep bite.

5 group – 1153 adults with permanent dentition (19 years and above), that had third permanent molar, of which 14.48% were with open and 20.9% with deep bite (chart 1).

Given the variety of first permanent molars' closure in sagittal dimension by Angle classification, patients were distributed by 3 groups:

1<sup>st</sup> group with Class I – 3545 patients (49.43±0.59%), of which 5.16% with open and 9.65% with deep bite.

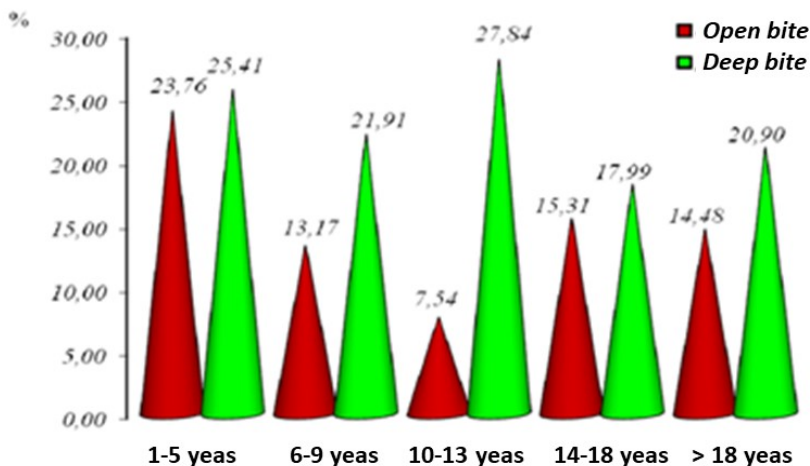
2<sup>nd</sup> group with Class II – 2710 patients (37.79±0.57%), of which 14.8% with open and 41.66% with deep bite.

3<sup>rd</sup> group with Class III – 917 patients (12.79±0.39%), of which 33.48% with open and 17.23% with deep bite.

Patients with Class 1 were predominant in all age groups: in the first group 38.12±3.61%, in the second – 50.86±1.18%, in the third – 49.26±1.06%, in the fourth – 49.48±1.18%, and in the fifth – 49.43±0.59%.

Patients with Class 2 were mostly found in the third age group (41.54±1.04%), then fourth and fifth groups 36.70±1.14%, and 36.25±1.42% respectively. This is, probably, related to the peak of growth in the first and second groups, where the prevalence is basically the same – 35.36±3.55% and 35.42±1.13% respectively.

In terms of Class 3, it is most prevalent in the age group of younger patients – 26.2±3.28%, and them adults – 15.18±1.06%. in the second and fourth groups the distribution of patients was practically the same – 13.72±0.81% and 13.41±0.81% respectively. Least of all patients with Class III by Angle, was noted in the third age group – 9.19±0.61%.



**Chart 1. The prevalence of open and deep bite in different age groups.**

At the same time the combination of sagittal, vertical and transversal plane anomalies were detected – Table 1

**Table 1**

**Distribution of patients by Angle’s classification and types of correlations of dental pathologies in sagittal, vertical and transversal planes**

Classes	Pathology of position of frontal teeth and bite				
	Protrusion	Retrusion	Open	Deep	Overbite
Class 1 (n=3545)	297 8.38±0.47%	29 0.82±0.1%	183 5.16±0.37%	342 9.65±0.50%	258 7.28±0.44%
Class 2 (n=2710)	1291 * 47.64±0.9%	232 * 8.56±0.5%	401 * 14.80±0.6%	1129 * 41.66±0.9%	116 * 4.28±0.39%
Class 3 (n=917)	4 * ^ 0.44±0.22%	9 ^ 0.98±0.3%	307 * ^ 33.48±1.5%	158 * ^ 17.23±1.2%	252 * ^ 27.48±1.47%
Total (n=7155)	1592 22.20±0.4%	270 3.76±0.22%	891 12.42±0.39%	1629 22.71±0.49%	626 8.73±0.33%

*Note: Statistically significant different in patient indicators:  
1 class: \* -  $p_1 < 0.001$ ; 2 Class: ^ -  $p_2 < 0.001$*

In sagittal plane, besides the correlation of first permanent molars by Angle, the protrusion and retrusion of teeth, as well as open bite dental type and deep bite dental type and overbite in transversal plane is determined.

Frontal teeth protrusion was detected in 1592 (22.20±0.49%) patients, and at that, patients with Class II were most prevalent – 1291 (47.64±0.96%) ( $p_1 < 0,001$ ;  $p_2 < 0,001$ ).

Retrusion was determined in 270 (3.76±0.22%) patients, with majority being Class II patients - 232 (8.56±0.54%).

Vertical incisal disocclusion or open bite (OB), was determined in 891 (12.42±0.39%) subjects, deep bite (DB) – in 1629 (22.71±0.49%) patients and overbite in 626 (8.73±0.33%).

Out of total subjects with DMA, depending on the Angle classification, patients were distributed by groups with different location anomalies in vertical direction – with vestibular location, with supernumerary teeth (SNT) and retention.

Vestibular location of canines was mostly prevalent in patients with Class I and II – 25.28±0.73% and 21.62±0.79% respectively. Patients with Class III the supralocation of canines are less prevalent – 12.10±1.08, which is, most probably, related to reduction of apical basis of maxilla. Such patients had their canines retained or erupted towards palate.

In terms of such pathologies like agenesis, impaction and transposition, we had not detected any statistically reliable difference in their prevalence depending on the class by Angle classification.

SNT was more prevalent in patients with Class I, and mostly, in the area of maxillary incisors, so called mosiodens, as well as in the area of mandibular premolars, and, in average, were about 3.02±0.29%, however, patients with Class II and II had roughly similar levels – 11.22±0,61% and 11.01±1.03.

**Oral cavity hygiene index.** During the treatment of 120 patients with DMA, oral cavity hygiene efficiency was assessed and hygiene indexes, such as Green-Vermillion (1964), Fedorova-Volodkina (1971), gingiva bleeding index SBI and paradontal index PĪ were determined.

In patients with brackets our modified hygiene index was determined. The method is about determining dental plaque on labial surface of 11 and 31, buccal surface of 16 and 36 and lingual surface of 26 and 46. While applying a die, plaque were assessed based on following coding:

0 point - no plaque;

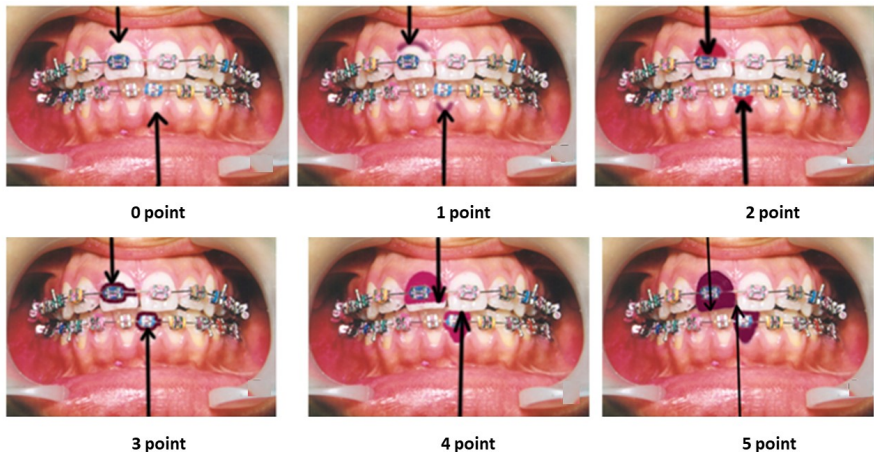
1 point - plaque is around neck;

2 point - plaque is between neck and orthodontic band or bracket edge close to gingiva;

3 point - plaque is around edges of the bracket, bands or under the archwire;

4 point - plaque is on the entire bracket or band surface until occlusal edge of the tooth;

5 point - plaque covers the entire tooth (fig. 1).



**Fig. 1. Determining oral cavity hygiene index based on modified method.**

Index is calculated as following: for each component data, for all 6 teeth is added up and divided by 6.

Calculation formula

$$\text{OHI-S- modified} = \frac{\text{plaque indicators for 6 teeth}}{6}$$

Index is interpreted as follows:

0.0-1.2 – good hygiene;

1.3-3.0 – satisfactory;

3.1-6.0 – poor.

**Photometric examination** of a face in frontal and sagittal planes was performed in all patients, admitted for treatment, with different types of DMA before and after orthodontic treatment. Photos were made according to a widely accepted scheme: extraoral frontal, smile, profile; intraoral front, left side, right side, occlusal maxilla, occlusal mandible. For the purpose of photometric examination, following lines were used: tangential to the upper contour of skull trichion and eyebrows, papillar, sub-nasal, occlusal and mental (in horizontal plane) and mid-face lines. Then the (te) point was connected with the base of tragus of right and left ears (tr); also drawn lines – mandibular angle to contours of mandible.

While assessing profile photos, the attention was paid to the shape of the face, location of the root of the nose, upper lip contours and menton relative to Ricket's aesthetic line, lip-seal distortion and facial proportions, facial, naso-labial and supramental angles, as well as upper and lower lip angles.

**X-ray examinations** included: analysis of X-rays, including intraoral close-focus images of teeth and alveolar rim, orthopantomogram (OPTG), frontal and lateral X-rays (cephalograms) of the head. Once required, TMJ and CBCT was also performed.

Angulation of erupted teeth and their germs were determined relative to orbital plane, by drawing a line through the center of occlusal grooves of germs and tip of the tooth root or root bifurcation. Such method is suitable while determining RZ angulation, especially during orthodontic treatment and allows dynamic examination, both manually and with the help of computer software.

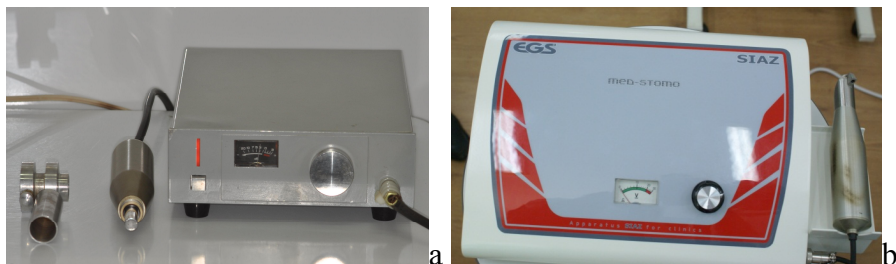
**Integrated computer diagnostics** was performed using «Dolphin Imaging – 11,9» software, allowing to do measurements on photos, OPTG, lateral X-rays, Cone Beam Computer Tomograms, as well as photos and scanned digital models of jaws. To optimize the software,

we proposed cephalometrics measurement methods modification, consisting of selecting most important and frequent data from among of existing diversity of measurements, allowing the choice of optimal orthodontic treatment version with or without tooth extraction, as well as prediction of treatment outcomes.

**Biometric measurements** were performed on diagnostic models manually and using «Dolphin-Imaging – 11.9» by comparing cast dental model with its digital analogue. Moreover, digital models in stereolithography format (stl), obtained by scanning teeth before and after orthodontic treatment were processed by “Romexis” software by Finnish company “Planmeca”.

Study showed that cast model and digital measurement data didn't have significant differences and computer analysis of diagnostic models practically matched the diagnosis, made on the basis of measurements using cast models.

**Use of low-frequency ultrasound** to improve the orthodontic treatment efficiency and reduce its duration, namely during treatment of VDMA caused by retention of permanent dentition, as well as prevention of complications, emerging during orthodontic treatment was provided by use of LFUS device «SIAZ» (fig. 2).



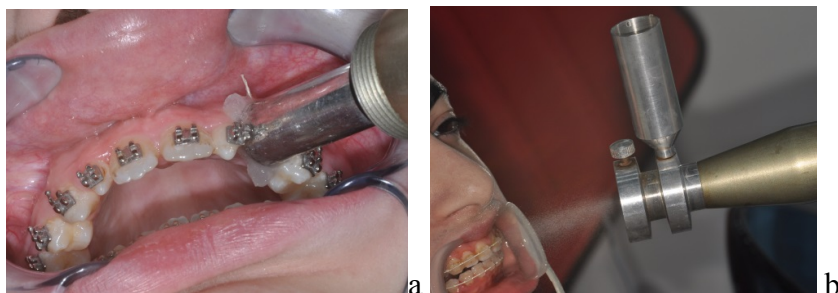
**Fig. 2. Low-frequency ultrasound devices:  
a – «SIAZ», b – «SIAZ-EGS».**

«SIAZ» devices allow affecting tissues by two means: contact and remote fine spraying of liquid medical substances.

The essence of the first method in the point that working part of handle, using the intermediate agent (cotton swab with paraffin oil) directs LFUS exactly on to the area of retained tooth location (fig. 3a).



The second method is about dynamic interaction of the working part of LFUS handle of the device with the medication that ensure the fine-particle spraying and even distribution of the medication on the surface of the damaged biological tissues (fig. 3b).



**Fig. 3 a – direct effects, b – spraying method.**

**Hystological and acoustic examinations.** Hystologic examination were performed at the pathomorphologic of microscopic pathology of the “Omur” clinic and Central Custom’s Hospital of the Republic of Azerbaijan.

Soft and hard tissues of the excised fragments of mandible were processed in modes, generally accepted in hystological practices. Part of gingiva and soft-tissue stroma of mandible were fixed in 10.0% neutral formalin solution, the other part in cold-conserving medium «Tissue Freezing Medium» for cold-knife «Leica» for the purpose of further histochemical analysis of relevant samples.

In total there were 49 teeth subjected to hystological analysis and 152 micro slides. Hard tissues of removed teeth were among those under the impact of brackets during orthodontic treatment from 1 to 270 days, which allowed to determine the condition and changes in the structure of enamel and dentin.

To study the condition of hard tissue of teeth the modern method of acoustic microscopy on the basis of scanning acoustic microscope «ELSAM», working on the basis of “reflection” regime from company «Leitz» (Germany). Studies were performed in the hard tissues laboratory (head – cand. med sc. A. A. Denisova) of the International Center for Studying Modern Materials at the Institute of Biochemical Physics of RAMS after Emmanuel (Moscow).

To determine the impact of bracket drive on the tooth enamel depending on the duration of their use during the treatment, thin-section slices were examined by methods<sup>22,23</sup>. Hard tissue particles were fixed in 20% neutral formalin solution, then fine slices were prepared by diamond saw (d=50 mm, width 0.5 at the speed of 1500 rpm). At that the cutting edge was water cooled. Then, the surface of the slice was processed on metal discs with the use of corundum powder with particle size of 40 micron. Further the samples were manually sliced using abrasive powder of 5 micron. Compliance was checked visually.

Materials for acoustic microscopy consisted of 54 teeth (predominantly premolars with brackets), removed based on orthodontic indications. At that, the examination of structural changes of hard tissues was dynamic.

The subject tissues of removed teeth were of those under impact of brackets during 1-270 days over the course of orthodontic treatment, allowing the determination of the status and changes in the microstructure of enamel and dentin.

Acoustic microscopy of healthy teeth was performed for control purposes, as well as to compare outcomes of optical morphohistological and acoustical examinations of teeth hard tissues. Teeth the brackets attached to were removed after a certain period of time, sliced transversally in two parts parallel to the long axes of the tooth through the brackets mid-line.

During the acoustic microscopy, in all cases, teeth were located in such a way that the bracket surface of the tooth was always on top. Special attention was paid to the area of enamel surface around the band.

Upon completion of processing the surface of the preparation was

---

<sup>22</sup> *Ахмедханов, А.А., Денисова Л.А., Ахмедханов И.А.* Возможности акустической микроскопии при исследовании особенностей дентина зуба // Российский стоматологический журнал, – 2008. №2, – с. 9-10.

<sup>23</sup> *Маев, Р.Г.* Методы акустической микроскопии в исследовании микроструктуры и физико-химических свойств материалов: / автореферат дисс. доктора физико-математических наук) / – Москва, 2002. – 50 с.

rinsed by water, then polished by chrome dioxide and rinsed by distilled water. Samples were stored in saline solution with some thymol to prevent ichorization.

Thus, the acoustic microscopy is distinct with the mass of information on changes taking place in heard cellular and tissues microstructures of teeth.

**Experimentation methods of examination.** To determine regimes of low-frequency ultrasound impact (LFUSI) on to soft and hard tissues of dento-maxillar system, we had conducted experimental studies on 160 white outbred mice.

The nature of the experiment was in single contact LFUS through the intermediate media (paraffinic oil) in the area of mucus and teeth of mice during 1, 2, 3, 4, 5 and 10 sec. To optimize the experiment and create simple and comfortable conditions for such impact on to dento-maxillar part of mice, we had elaborated a devise to fix laboratory subjects (Eurasia patent № 027001, dated 30.06.2017)<sup>24</sup>.

**Digital data statistical processing methods.** Collected digital data was statistically processed using methods of variance (t-Student), correlation (tetrachoric and polychoric Pirson's bond index) and discrimination analysis. Calculations were actually made using EXCEL-2010.

## RESULTS AND DISCUSSIONS

**The results of histologic study of teeth hard tissue conditions** for extracted teeth based on orthodontic indications during the treatment using brackets for 1 to 270 days, speak in favor of polymorphism of identified inexplicit micro distortions in the structure of hard tissues and pulp of a teeth.

Explicit pathologic changes in tooth tissues, in the form of micro-distortions of cellular-tissues manifestations were detected in hard tissues preparations of teeth from patients using brackets up to 270 days. At that, hard tissues micro-structure of teeth of such patients

---

<sup>24</sup>Гасьмова, З.В. Устройство для фиксации мелких лабораторных животных в эксперименте, Евразийский патент № 027001 от 30.06.2017 / Р.Г.Гашимов.

show insignificant segregation of dentin canals, expansion of enamel contours; in pulp cellular changes like vascular congestion, micro-circulatory stasis, signs of hardening.

The results of hard tissue histological examinations for teeth removed based on orthodontic indications while using brackets during 1 to 270 days speak for polymorphism of detected inexplicit micro-distortions in the structure of hard tissues of teeth and their pulp. It should be noted that during the short period of use of brackets – up to 14 days, enamel and dentin tissues showed no changes, except for pulp reaction in the form of increased looseness of connective tissue. Hard tissue changes were partially manifested in dentine and dentine canals. Exception was only in one case of insignificant segregation of dental cuticle under 53 days of bracket impact, which is related to individual peculiarities of the patient. In terms of dental pulp, as a quite sensitive receptive organ, it is very susceptible to mechanical impact of orthodontic devices. Thus, the pulp of removed teeth with brackets over short period of time showed negligible morphological changes, distinct with monotypic processes that are compensatory to a certain extent. More exacerbated hard tissue changes are detected during the use of brackets for 153-270 days. Although brackets cover the crown part of a tooth, impact of the load affects its root part as well.

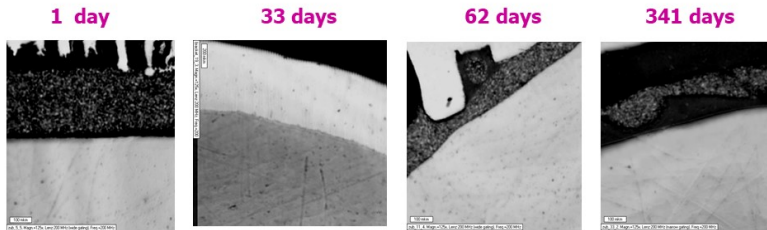
So, changes, under the impact of brackets, in the structure of hard and soft tissues identified during morphological examinations prove the direct relation between the duration of the treatment and complications, as well as the importance of searching for optimal ways of speeding up orthodontic treatment, as it is the case with low-frequency ultra-sound [64].

**Acoustic microscopy of patients' teeth hard tissue.** The advantage of this method is in the fact that acoustic microscope doesn't overlay underlying tissues, giving clearer picture of outlines of micro-pores and micro-cracks.

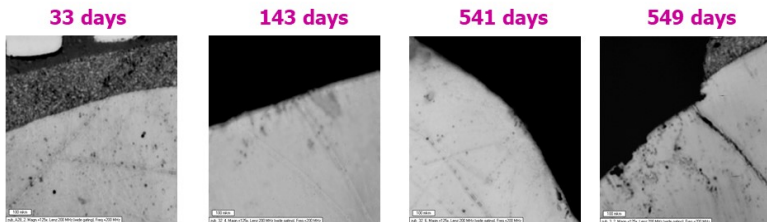
Changes identified via acoustic microscopy resemble specific changes, typically observed at the stage of "white spot", i.e. at the beginning of caries. However, moving deeper, acoustic impedance gradually increases until normal values. At that, the section of

decreased density is around 600 microns long and around 100 microns deep. While moving from the labial surface towards proximal, occasionally areas of partial enamel destruction in the center of image, with decreased density of tissues is observed from surface going deep. It has small size – less than 20 microns deep and around 100-micron long.

Based on the morpho-acoustic data on hard tissues of teeth under different periods of impact of brackets, we had identified various, mostly normal structure of enamel (fig. 4).



**A - Tooth enamel adjacent to brace base - unchanged**



**Changes in the density of enamel under the brace, microcracks**

**Fig. 4. Acoustic examination of hard tissues of teeth under different periods of bracket impact.**

Acoustic images of hard tissues conditions for teeth under significant period of use of brackets for 300 and more days is subject of a special interest. Such materials were obtained from transferred patients that received treatment from other doctors. Such patients, after long term impact of brackets, along with fine condition of enamel, had cases speaking in favor of some of its micro-distortion in the form of changes of surface density and micro-cracks with

multiple foci's of hypo mineralization and increased number of pores [31, 68].

During long-term use of brackets some changes significant to diagnostic purposes were detected. Such changes include decrease of acoustic impedance – indicator describing the change in density in enamel surface areas, fine changes in the form of effacement of enamel prism contours, dissection of dentin strips, increased porosis of enamel and micro-cracks.

It should be noted that in the course of acoustic examination, in a number of cases, proximal surfaces of teeth showed hidden caries foci, that are clinically invisible, however not connected to bracket impact.

Determining hard tissue distortions by means of acoustic examination in teeth under long term bracket impact speaks of a necessity to elaborate efficient ways of reducing the duration of orthodontic treatment, as well as methods of prevention of possible complications or such treatment.

### **Histological assessment of gingival tissue condition during the impact of low-frequency ultrasound.**

During experimental studies, to create perfect conditions to perform LFUS impact on maxillary part of head of rats, we had elaborated a device to fix laboratory subjects during experiment (Eurasia patent № 20140115 AI). This device consists of 0.375-0.5 l polyethylenterephthalate (PET) bottle with bottom cut at the level of 10.0-15.0 cm. In order to be able to have elasticity and free separation of both sides, 2 cut were made along the neck of the bottle.

The device is used as follows. A rat, using special forceps or gloves, is taken by its tale, and, head down, brought to the open bottom of the bottle, which is located upside down, and placed in to the bottle. The rat, under the gravity, falls down towards the neck and its head comes out of the bottle.

The device is easy in making and comfortable in use. The use of proposed device for restraining laboratory subjects allows efficiently implementing procedures with their head, namely, performing, both

contact and distant, the application of ultrasound on to maxillary and mandibular tissues, using a handle.

As the results of experiments showed, 1-4 sec long impact on LFUS on to mandible of white outbred mice cause reversible changes of epithelium (epithelial lamina propria) and stroma (intrinsic connective tissue lamina propria) of gingiva. Such changes fall within the range of morpho-functional and hysto-chemical fluctuation of the lining and stroma of gingiva. Gradually increasing apoptosis in the lining blend with loosening of its layers with appearance of more inter-cellular spaces with bridges (nails). As the exposition extends, tissue activity of basophiles (granulocytes) – regulators of local homeostasis in gingiva. The tight filamentous skeleton of stroma gradually loosens and loses its barrier and mechanical properties [63].

Important fact is that 1-4 sec impacts do not cause aseptic inflammation, gingival necrosis, however 5 sec procedure leads to some morpho-histochemical changes, being sub-compensated lesion of both lining and lamina propria of gingiva.

10 sec LFUS impacts can be interpreted as irreversible distortion of gingival morphological structure with predominant necro-biosis in epithelium and swelling, inflammation and vascular lesions in gingival stroma.

The assessment dento-gingival junction of intact rats is marked with free lumen of and junction.

Studying the dento-gingival junction under different LFUS regimes revealed that [44, 69]:

- 1 sec impact leads to discirculatory distortions in gingival stroma and periodontum, while epithelio-dental contact is retained;
- during 3 sec impact the partial fragmentation of junction epithelium and partial loosening of its circular layer is observed;
- during 4 sec impact both layers of the ligament gets loose;
- during 5 sec impact junction epithelium gets deformed and thinner;
- during 10 sec impact skeleton gets swollen and junction

epithelium gets destroyed.

Thus, the analysis of the obtained data of experiments to determine the status and nature of changes of gingival tissue of rats under LFUS with different exposition period allows concluding that 1-4 second of exposure lead to reversible changes; 5 sec – to dull subcompensated and reversible changes and 10 sec exposures to decompensated, locally alternative-necrotic changes.

On terms of morphologic manifestation of molecular-cellular lesions one can note the loosening of gingival cover and stroma, which facilitate and tooth eruption in clinical conditions.

Cellular and tissue changes observed as appearing under LFUS exposure, also were a reason for preventive interventions. For this purpose, liquid medication ultrasound spraying (USS) was applied.

### **Histologic assessment of gingival tissue of patients with LFUS exposure.**

After LFUS exposure of gingiva around the retained tooth hyperemia and slight “keratinization” of mucus was visually observed and, respectively, soft tissue samples (biopsy slice) were taken from 25 patients at the age of 8-16 years.

During microscopic assessment of gingival epithelium, a special attention was paid to general structure, the nature of possible keratosis, loosening degree, inter-cellular bridges, swelling degree and dystrophia.

It should be noted that neither granule of keratoglyaline in epithelicytes, nor hard or soft type of true keratosis at the superficial layer of the cover were detected. This may be the proof of the fact that LFUS exposure of gingiva doesn't change the essence of the cellular differentiation in the gingival surface, neither it causes keratinization. Clinically detected little “keratosis” is only the thickening of the false keratin layer of the gingival surface. At that the number of cellular layers is variable, around 8-18, which corresponds to “intact” indicators of a healthy person.

Differentiation in to 3 main layers (basal, intermediate and superficial) is maintained and the biggest thickness and the number of cellular layers are in the intermediate layer. Borders between



layers are not clearly marked. Intermediate layer is visualized as self-consistent, though its width, the number of cellular layers and looseness intensity is highly variable. The cells of intermediate layer had maintained nucleus, layer is loose, with linear swelling, and disassociation of cells is noted. Basal layer is clearly marked. Relatively frequent figures of mitosis in deep supra-basal layers seen, we believe, are the reflection of stimulation of multiplication and differentiation of epithelial cells under the LFUS influence. This is confirmed also by sufficiently high level of mitotic indicator in the basal layer (6.0-8.0%) with the norm of 3.0-6.0%.

Based on the experiments and clinical studies and positive results, an integrated method of treatment of patients with permanent teeth retention, using LFUS, was elaborated.

The essence of the above-mentioned method is in the stimulation of eruption of an uninterrupted tooth, including drug-free local physiotherapy in the area of its location. As a source of influence LFUS is used daily during 3-10 sec with 1-7 procedures until eruption of the tooth [60].

**Dento-alveolar shortening, conditioned upon vestibular location of teeth.** Total 1593 (22.21±0.49%) patients out of pool of 7172 persons had 2579 teeth with vestibular location, with 2085 of them located on maxilla (0.291±0.006 per patient out of total), and 494 teeth (0.069±0.003) on mandible (p <0,001).

As the most prevalent case is the vestibular location of maxillary canine, the study was performed mostly in this direction. Vestibular location of 13<sup>th</sup> teeth on maxillar was diagnosed in 936 patients (13.05±0.40%), 23<sup>th</sup> tooth in 843 patients (11.75±0.38%), vestibular location of both canines in 553 patients (7.71±0.31%).

896 patients (25.28±0.73%) with Class I bite of permanent molars, had vestibular location of 1473 teeth (0.416±0.011) per person, of which on maxilla 1142 (0.322±0.010), on a mandible 331 teeth (0.093±0.005).

586 patients with Class II (21.62±0.79%), (p<sub>+</sub><0.001) vestibular location was detected in 938 teeth (0,346±0,011) per person, of which on a maxilla 792 (0.292±0.010), on a mandible 146 teeth

(0.054±0.004).

111 patients with Class III (12.10±1.08%), ( $p_1 < 0.001$ ;  $p_2 < 0.001$ ) vestibular location is detected in 168 teeth (0.183±0.014) per person, of which on a maxilla 151 (0.165±0.013), on a mandible 17 teeth (0.019±0.004).

During sagittal correlation of dentition with Class I vestibular location of canine was identified in 3545 patients (49.43±0.59%), with Class II in 2710 patients (37.79±0.57%) and Class III in 917 patients (12.79±0.39%).

In terms of vertical plane, patients were divided into groups: 1 group with OB – 891 patients (12.42±0.39%), 2 group with OB – 1629 (22.71±0.49%) patient.

In OB group 136 patients (15.26±1.20%) had vestibular location of 210 teeth (0.236±0.016) per person, of which 190 (0.213±0.015) were on maxilla and 20 (0.022±0.005) on mandible.

In DP group 262 patients (16.08±0.91%) ( $p_1 > 0,05$ ) had vestibular location of 398 teeth (0.244±0.012) per person, of which 330 teeth (0.203±0.011) on maxilla and 68 teeth (0.042±0.005) on mandible [1, 62].

To make accurate diagnosis and appropriate treatment plan we used «Dolphin Imaging – 11.8» software, elaborated an algorithm of orthodontic treatment individual plan for each patient, taking into account the correlation of maxillary bony and soft tissue profile of the face.

### **Dento-alveolar shortening due to super-numerary teeth.**

During clinical and X-ray examination of 7172 patients at the age of 2-46 years, there were 164 patients with SNT, which is 2.29±0.18%, of which 85 (51.83%) males and 79 (48.17%) females.

The SNT prevalence depending on sagittal and vertical disposition of dentition was also determined. Thus, patients with Class I had 107 SNT (3.02±0.29%), with Class II – 43 SNT (1.59±0.24) and Class III – 14 SNT (1.53±0.40%).

During vertical anomalies SNT were detected in 11 patients (1.23±0.37%) with OB and in 22 patients (1.35±0.29%) with DB.

164 patients had total 255 SNT with average 1.55±0.097 tooth per

person with 190 ( $1.159\pm 0.084$ ) on maxilla and 65 teeth ( $0.396\pm 0.049$ ) on mandible.

In the case of maxilla, there mostly were supernumerary central incisors – in the area of 11<sup>th</sup> tooth – 56 ( $32.32\pm 3.65\%$ ), 21st tooth – 55 ( $33.54\pm 3.69$ ), then lateral – in the area of 12th tooth – 21 ( $0.29\pm 0.06\%$ ), in there are of 22<sup>nd</sup> tooth – 13 ( $0.18\pm 0.05\%$ ). In case of mandible SNT was mostly identified in there are of first molars – 15 teeth ( $9.15\pm 2.25\%$ ) on the right and 14 teeth ( $8.54\pm 2.18\%$ ) on the left. Rarely extra incisors and canines, mostly in patients with multiple SNT and different syndromes, for example –  $\beta$  talassemiya mayor.

Integrated surgical and orthodontic treatment of patients with SNT is recommended in cases when such teeth is located deep in jaw bones, as well as between teeth roots or teeth primordia. In such cases accurate diagnosis based on CT analysis, is important, taking in to account the age of a patient, form and size of SNT, inter-location of their germs with roots of permanent regular teeth [53, 57].

### **Dento-alevolar shortening due to impacted teeth**

Among the 7172 examined patients, 899 retained teeth were detected, making  $12.53\pm 0.39\%$  of the cases. At that, impacted teeth were more prevalent among women – 64.5% than men – 35.5% of cases impacted teeth prevalence, depending on the interposition of first permanent molars by Angle, is as follows:

- of 3545 patients with Class I, permanent teeth impaction was noted in 494 patients, which is  $13.94\pm 0.58\%$  of cases, at that these patients totally had 727 teeth, i.e. in average  $0.21\pm 0.01$  tooth per patient;
- of 2710 patients with Class II, retention was noted in 304 patients, which is  $13.94\pm 0.58\%$  (Chance Ratio) = 1.28; 95% TI (trusted interval): 1.10-1.49;  $p_2 < 0.05$ , at that in total these patients had 501 impacted teeth, i.e. in average  $0.18\pm 0.01$  tooth per patient;
- of 917 patients with Class III, permanent teeth impaction was noted in 101 patients, which is  $11.01\pm 1.03\%$  of total cases,
- CR = 1.31; 95% DI: 1.04-1.64;  $p_3 < 0.05$ ), at that these patients

had in total 177 retained teeth, i.e. in average  $0.19 \pm 0.01$  per patient.

The prevalence of teeth retention depending on interposition of dentition in vertical direction was also identified. Of 891 patients with OB, 81 retained teeth were detected, which is  $9.09 \pm 0.96\%$ ; however, in 1629 patients with DB there were 181 teeth detected, i.e.  $11.11 \pm 0.78\%$  of cases. (CR = 0.80; 95% DI: 0.61-1.05;  $p > 0.05$ ).

On maxilla, most prevalent is the impaction of canine (right –  $2.29 \pm 0.18\%$  and left –  $2.44 \pm 0.18\%$ ), on mandible – second premolars (left –  $2.2 \pm 0.17\%$  and right –  $1.85 \pm 0.16\%$ ) and wisdom teeth (38 –  $2.27 \pm 0.18\%$  and 48 –  $2.50 \pm 0.18\%$ ).

Integrated orthodontic and surgical treatment of DMA, condition by permanent teeth impaction, was performed according to the standard protocol after diagnosing by means of clinical, biometric, X-ray studies. To optimize impaction related DMA treatment, methods we had developed an algorithm, taking into account the age of a patient and level of severity of the pathology.

Treatment of patients with temporary bite (2-5 years) and early stage of mixed bite (6-9 years) was about elimination of causes of impaction and making a space using removable devices. For control group patients irritating biteplate was developed and finger massage applied. To stimulate the eruption of impacted permanent teeth patients of the main group had LFUS based on our protocol.

64 patients with permanent teeth eruption delay at the age of 8 to 15 years were subjected to treatment based on our method.

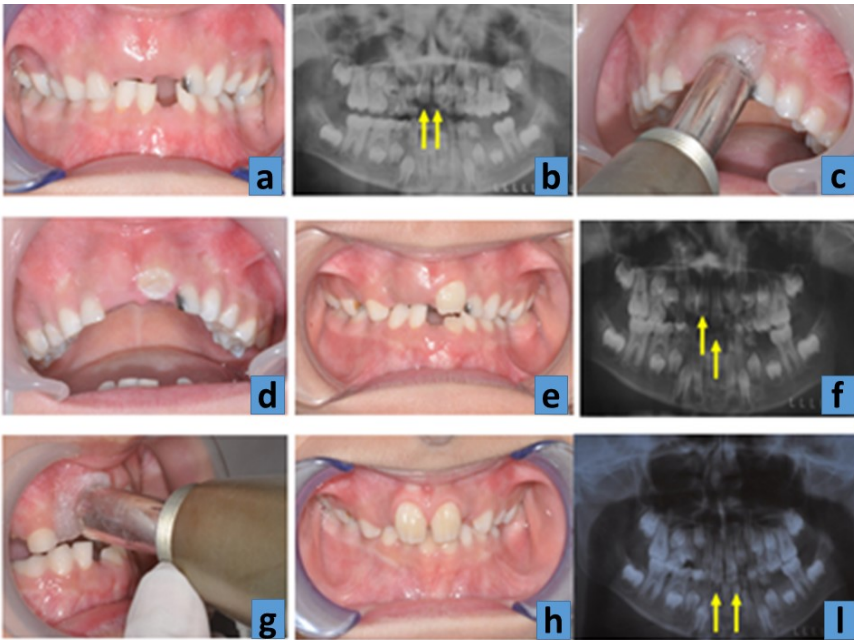
Fig. 5 shows the clinical case of using eruption stimulation for upper central incisors based on LFUS. According to intraoral image before treatment there is a space to permanent teeth (fig. 5a), OPTG show germs at the same level (fig. 5b). LFUS in the area of 21<sup>st</sup> tooth (fig. 5c), situation immediately after (fig. 5d).

After 2 months following the treatment, 21<sup>st</sup> tooth erupted to 3/4 (fig. 5e), OPTG - 11<sup>th</sup> tooth germ is at initial position (fig. 6f). Total 11 teeth were exposed to LFUS (fig. 5g), intra-oral images (fig. 5h) and OPTG after treatment (fig. 5i).

Positive treatment outcomes for patient with retention related VDMA confirm the advantage of use of LFUS, consisting of

minimal trauma, absence of complications and shortening of orthodontic treatment duration.

Treatment of patients from 3<sup>rd</sup> and 4<sup>th</sup> age groups, as a rule, was about preliminary activities on elimination of causes of retention before orthodontic treatment and consisted of removal of remaining temporary and supernumerary teeth; removal of permanent teeth based on orthodontic indications (mostly first molars); surgical operations on cysts, odontomas, lip and tongue frenulum.



**Fig. 5. Intra-oral images and OPTG female patient A.F., 8 years and 6 months., patient record № 5825.**

After creating a space in dental arch by means of orthodontic devices, the crown part of teeth was exposed surgically using piezosurgical technique, an orthodontic button, bracket or eyelet with chain was attached and it was pivoted in to the arch using low gentle force.

During the treatment of patients at the late stage of permanent bite after the eruption of third permanent molars (older than 18 years), an

integrated method of orthodontic and surgical methods was applied as well. For that purpose accompanying pathology of a bite, using micro-implants, lingual techniques, laser correction of gingiva and orthopedic methods [4, 16, 28, 76].

**Integrated methods of diagnostics and treatment of dento-maxillofacial anomalies, connected to dentoalveolar shortening.**

Absence of occlusion contacts between teeth in frontal and lateral parts of DMS, namely OB is one of the most complicated forms of VDMA. Oral cavity examination included the assessment of dental status, occlusion contacts for frontal and lateral teeth, determining functional violations – chewing, swallowing, and speech.

Of 3545 examined patients with Class II OB was detected in 183 persons ( $5.16 \pm 0.37\%$ ); of 2710 patients with Class II there were 401 persons ( $14.80 \pm 0.68\%$ ); (CR=3.19; 95% TI: 2.66-3.83;  $p_1 < 0.05$ ), of 917 patients with Class III there were 307 persons identified ( $33.48 \pm 1.56\%$ ); (CR=2.90; 95% TI: 2.44-3.45;  $p_2 < 0.05$ ).

OB was accompanied with incisal protrusion in 235 patients ( $26.37 \pm 1.48\%$ ), overbite in 97 patients ( $10.89 \pm 1.04\%$ ) and overcrowding in 171 patients ( $19.19 \pm 1.32\%$ ) (table 2).

**Table 2**

**Data on possible sagittal and transversal anomalies during open and deep bite**

Pathology	OB (n=891)	DB (n=1629)	CR 95% TI	P
Protrusion of incisors	235 $26.37 \pm 1.48\%$	663 $40.70 \pm 1.22\%$	0.52 (0.44 – 0.62)	<0.05
Retrusion of incisors	2 $0.22 \pm 0.16\%$	202 $12.40 \pm 0.82\%$	0.02 (0.00 – 0.06)	<0.05
Overbite	97 $10.89 \pm 1.04\%$	37 $2.27 \pm 0.37\%$	5.26 (3.57 – 7.75)	<0.05

During the examination of patients with OB some bad habits were identified: in 38% – sucking tongue or pushing it through teeth, in 31% – sucking fingers or pushing different objects through frontal

teeth, in 26% – biting and sucking lips, in 5% etiology couldn't be identified.

To treat OB at different ages an algorithm of integrated treatment was elaborated:

Patients with early mixed bite had orthodontic treatment taking in to account sagittal interposition of jaws and type of their growth. For this group of patients following devices were used: miovestibular devices, correctors, activators and Frenckel appliance. In case of narrow maxilla expansion screw with acrylic pivot was used.

Patients with permanent bite had fixed appliances. Following the leveling stage special arches, reverse archwires, through the bite elastics to achieve cusp-to-groove contacts were used.

To plan orthodontic treatment, the main type of jaw growth was determined. Studies showed that horizontal type of growth leads to rotation of mandible upwards and accelerate orthodontic treatment. OB treatment outcomes during obvious morphological distortions in horizontal and neutral directions of jaw growth were more favorable than that of in vertical direction.

Given the fact that treatment of OB during Class II in patients with vertical type of growth of jaws, is complicated due to the increase of the size of basal angle, orthodontic treatment was performed in junction with removal of some teeth, namely, first premolars or first permanent molars. Special attention was paid to shortened and attached to the tip of the tongue frenulum which was a reason for referral to plastic surgery. During gnathic anomalies of a bite expanded the indication for surgical reconstruction procedures.

Within Class III patients, along with day long use of orthodontic device, using head-chin cup and extra-oral torque was recommended. Based on indications, grooves of temporary canine and molars were selectively polished.

Patients with late permanent dentition had treatment by means of fixed orthodontic appliance using micro-implants (TAD's) for dentoalveolar extension of frontal teeth. Adult patients had integrated orthodontic and surgical treatment.

Our OB treatment algorithm at different age periods allows obtaining positive results.

## **Integrated methods of diagnostics and treatment for dentoalveolar-facial anomalies couples with dentoalveolar extension.**

Analysis of clinical materials showed that out of the total number of examined patients, there were 1629 patients with DB ( $22.71 \pm 0.49$ , including male – 681 persons (41.8%), female – 948 persons (58.2%).

Dentoalveolar extension was diagnosed with taking in to account the type of lateral occlusion. Studies showed that during neutral occlusion (Class I by Angle) DB is conditioned by dentoalveolar distortions, during distal and mesial occlusion (Class II and III by Angle) – with maxillary growth and development distortions.

Research data is as follows:

- out of 3545 patients with Class I there were 342 patients with DB ( $9.65 \pm 0.50\%$ );
- out of 2710 patients with Class II DB was in 1129 ( $41.66 \pm 0.95\%$ ); CR = 0.15; 95% TI: 0.13-0.17;  $p_2 < 0.05$ );
- out of 917 patients with Class III DB was diagnosed in 158 patients ( $17.23 \pm 1.25\%$ ; CR = 0.51; 95% TI: 0.42-0.63;  $p_2 < 0.05$ ).

In such case DB was coupled with protrusion of incisors in 663 patients ( $40.70 \pm 1.22\%$ ), with retrusion of incisors – in 202 patients ( $12.40 \pm 0.82\%$ ), overbite – in 37 patients ( $2.27 \pm 0.37\%$ ) and overcrowding – in 357 patients ( $21.92 \pm 1.02\%$ ).

Data on studying the correlation of chances (CC) in patients with DB and OB with sagittal and transversal anomalies of bite are presented in Table 2.

According to the table data, correlation of chances for protrusion diagnosis during OB to DB is  $CC=0.52$  with 95% TI (0.44-0.62);  $p < 0.05$ . retrusion of incisors during OB to DB was detected only in 0.02 with TI (0.00-0.06);  $p < 0.05$ .

The prevalence of DB in the first age group of children with temporary bite is 25.41%, in patients from second and third age group — 24.31% and 38.31%, which is related to the peak of growth of jaws in children. Patients from fourth and fifth groups manifested the prevalence of deep incisal overbite little less and at the level of 19.77% and 14.79% respectively.



We had developed an algorithm of treatment of DB taking in to account lateral teeth occlusion, patient's age, occlusion establishment of the bite, level of severity and facial skeleton structural peculiarities.

Patients with temporary bite at the beginning of the mixed dentition stage during mouth breathing and open mouth, infantile swallowing and bad habits positive treatment outcomes were achieved using vestibular plates with bite turbo for frontal teeth. At that, the use of vestibular plate was recommended upon consultation with ENT doctor.

At the beginning period of a mixed dentition to position a tooth right in an arch between permanent teeth, based on indications, in a sequence, certain temporary teeth were extracted by HOTS method and removable orthodontic devices of mechanical or combined action were applied.

During the eruption of first permanent molars lateral teeth disarticulation was applied by prosthetics with bite turbos, which facilitated dentoalveolar extension in lateral parts and reduction of incisal overbite.

For patients with Class I deep bite, in the course of treatment, to disarticulate lateral teeth and dento-alveolar extension removable appliances with bite turbos around incisors were used. In case of underdeveloped apical basis of frontal parts of upper and lower dentitions, to extend both upper and lower lip, devices were supplied with labial bumpers.

To eliminate wrong position of tooth and dental arch form, devices with bite turbos were provided with mechanical accessories, for example, screws, protraction springs, lingual and vestibular wires.

During the treatment of deep distal bite, using Frenkel appliance, the mandible development was stimulated, while maxillary growth was suppressed.

Patients with very severe morphological and functional distortions were obtained through staged approach: during mixed bite, bimaxillary removable functional devices, while during permanent, bite – fixed appliances, using through the bite elastics, micro-

implants, distalisers, etc.

During patient assessment, depending on the stage of their growth and development, features of facial skeleton and bone development directions were taken in to account. For patients with DB and horizontal type of bone growth, orthodontic devices, stimulating vertical growth of alveolar processes in lateral parts were used. Based on indications, permanent molars were moved distally, which facilitated and opening of the bite in frontal part till normal 20% overbite [42].

Patients with vertical type of maxillary growth, for dentoalveolar extension in the area of lateral upper teeth and its limitation in the area of frontal ones utilized intraoral orthodontic devices with facial arch and extra-oral torque, as well as reverse arch and microimplants.

Treatment outcomes for patients with such anomalies were sustainable, as the vertical growth of alveolar processes facilitated the reduction of incisor overbite. Efficient outcomes were obtained during the eruption of permanent molars, canines, second molars, i.e. during the physiological elevation of the bite.

Treatment option choice was made taking in to account types of DB, upper incisors' angle, distortion of size and form of dentoalveolar arches, sagittal bite anomalies. In case of macrodentia and narrow face, agenesis or persistent permanent teeth impaction, as well as in patient with advanced age and severe underdevelopment of one of jaws, teeth removal indications were extended. Patients with neutral bite had teeth of maxilla and mandible, with distal bite – predominantly from maxilla, with mesial - mandible.

During the treatment of deep bite Class III in growing patients, devices for bite opening, stimulating the maxillary growth, namely Reichenbach - Bruckla device, maxillary device with triple screw Bertoni, Frankel appliance type III, bracket-system with elastics of Class 3, as well as, extra-oral facemask – «Delaire» and head-chin cup [43].

Treatment of DB in adults, due to retarded maxillary growth, is complicated and bite elevation is possible only at the account of dento-alveolar extension in lateral parts or dentoalveolar impaction of frontal teeth. Patients with such pathology had non-removable

technique (vestibular and lingual) together with micro-implants, piezo-surgical corticotomy and orthognatic surgery.

In terms of etiopathogenesis of DMA, along with congenital genetic anomaly factors, an important role is given to social and epidemiological factors. To study this issue, we performed interviews among 540 patients with CDMA and 208 patients without DMA.

The analysis of the obtained data allowed us to determine a certain pattern in the emergence of these anomalies. Thus, among children under 7 years of age, still having temporary dentition in the arch, certain nosologic forms of DMA are detected, around  $7.5 \pm 1.3\%$ . Closer to the complete change of dentition, the prevalence of DMA increases, reaching a level of  $16.3 \pm 1.5\%$  at  $p < 0.01$  in the 7-11 years' age group.

DMA is most prevalent in the 12-15 years' age group,  $29.7 \pm 1.69\%$ ,  $p < 0.001$ , when the formation of permanent dentition is almost completed. In adolescents above 15 years of age, the prevalence slightly reduces (down to  $20.2 \pm 1.5\%$ ),  $p < 0,001$ , which, we believe, can be explained by self-regulation of dental arches.

The difference in DMA prevalence is also determined – less among boys compared to girls ( $17.7 \pm 1.1$  and  $22.6 \pm 1.1\%$  respectively,  $p < 0,01$ ).

The analysis of the obtained data showed that factors contributing to the establishment of DMA, to a certain extent, are dental diseases - first of all, caries and periodontal inflammatory diseases. The prevalence of dental diseases in children with DMA is higher than that of those without them.

It has to be mentioned that in children with DMA the caries prevalence indicator in the age group below 7 years is  $37.9 \pm 9.2\%$ , while in the age group of 7-11 years it grows sharply to  $62.4 \pm 4.8\%$  ( $p < 0.05$ ).

In the age group of 12-15 this figure goes down to  $53.3 \pm 3.1\%$ , ( $p > 0.05$ ). In children above 15 years of age, it is  $47.1 \pm 4.0\%$  ( $p > 0.05$ ). At low figures, such dynamics are also observed in children without DMA. In the age group below 7 years, the frequency indicator for caries is  $15.9 \pm 1.9\%$ , in 7-11 age group –  $43.9 \pm 2.2\%$  ( $p < 0,001$ ), 12-15 years –  $42.4 \pm 2.0\%$  ( $p < 0.05$ ), above 15 years –  $35.7 \pm 1.9\%$  ( $p < 0.05$ ).

During periodontal diseases, the situation is somewhat different. Though the gingivitis frequency among children with DMA is much higher than that of without ( $23.1\pm 1.8$  and  $12.4\pm 0.7\%$  ( $p < 0,001$ ) respectively), a certain pattern is observed among them. It is about higher the age – higher is the prevalence of periodontal diseases. For example, among children with DMA below 7 years of age, the periodontal disease prevalence is  $10.9\pm 5.8\%$ . As the age of children increases, this indicator gradually goes up and at 15 years of age, it is  $31.4\pm 3.8\%$  ( $p < 0.01$ ). The same tendency is observed among children without DMA – in the same age groups, the prevalence of periodontal diseases goes up from  $4.5\pm 1.1\%$  to  $21.2\pm 1.7\%$  ( $p < 0.001$ ).

The obtained data gives ground to believe that dental diseases are one of the etiological factors of DMA. That is why an epidemiological survey on caries and periodontal diseases allows us to determine the causes of their great prevalence and to set effective prevention measures. This, to a certain extent, may contribute to the reduction of DMA levels among children [52, 70].

The hygiene factors also greatly contribute to the development of DMA, as confirmed by the data from the survey on compliance of children with oral hygiene requirements. According to the data from questionnaires, in the first group of children who did not comply with oral hygiene requirements ( $27.6\pm 1.9\%$ ),  $33.1\pm 2.0\%$  of children ( $p > 0.05$ ) rarely complied. Only  $14.3\pm 1.5\%$  of children comply ( $p < 0.001$ ) and  $9.6\pm 1.3\%$  of children complied regularly ( $p < 0.05$ ).

In the second group, the listed peculiarities of compliance with oral hygiene were distinct with the best characteristics of difference in indicators. For example, the total  $10.3\pm 0.7\%$  of children did not comply with oral hygiene,  $25.8\pm 1.0\%$  of children did that rarely ( $p < 0.001$ ); a significant number of children complied irregularly –  $31.8\pm 1.0\%$  ( $p < 0.001$ ),  $19.1\pm 0.4\%$  of children in this group complied regularly ( $p < 0.001$ ). In  $13.1\pm 0.7\%$  of children, it was impossible to determine the degree of compliance with oral hygiene requirements ( $p < 0.001$ ).

The epidemiological situation on the provided data allows mentioning that non-compliance with oral hygiene requirements create a prerequisite for the development of caries and periodontal diseases,

as well as DMA. Such a situation confirms the necessity to search for new, natural means of oral hygiene. Natural means used since ancient times, namely miswak and propolis, that have favorable effect on the status of the oral cavity in terms of prevention and treatment of such conditions as caries and periodontal diseases, are yet to be used in orthodontal practices.

Positive treatment outcomes of orthodontic treatment patients with DB from different age groups and different morphological and functional distortions speak in favor of efficiency of use of integrated approach.

### **Prevention during the treatment of patients with VDMA using miswak.**

To maintain oral hygiene during VDMA treatment we applied natural floral bush miswak, used in the East since ancient times.

During treatment of 120 patients with DMA, to prevent dental caries using miswak, hygiene indexes were determined and oral hygiene efficiency comparative assessment was conducted. Patients were divided in to two groups:

1<sup>st</sup> main group – 60 patients with different construction of non-removable and removable orthodontic devices, that used miswak for oral hygiene.

2<sup>nd</sup> control group – 60 patients with same type of devices that used traditional means of hygiene, namely tooth brush and pastes.

Oral hygiene baseline point before treatment was similar:  $2.20 \pm 0.10$  in the main group and  $2.15 \pm 0.16$  in control, proving their comparability before treatment. In 1 month, patients from the 1<sup>st</sup> group, after use of miswak, had OHI-S going down to  $1.01 \pm 0.14$  and continuing, reaching  $0.10 \pm 0.12$  by 4<sup>th</sup> month.

Control group patients also manifested oral hygiene improvement. After 1 month OHI-S was  $1.85 \pm 0.11$  and  $1.04 \pm 0.19$  by the month 2, continuing to improve till 0.8 by 4<sup>th</sup> month. OHI-S index of patient from the main group appeared to be lower than that of control, proving the efficiency of use of miswak.

Observations show that miswak is quite and efficient mean of comprehensive oral hygiene. Systematic use of miswak prevents

dental caries, especially with regards teeth with brackets. The proposed method of use of miswak is simple and effective, allowing to recommend for wide use in orthodontic practice [5, 21, 22, 36]

**Prevention of paradontal diseases during treatment of patients with VDMA based on use of propolis water extract «A-P-V».**

During dentoalveolar anomalies, especially in the course of treatment, paradontal diseases in the form of kataral, traumatic, hypertrophic gingivitis and local paradontitis appear quite often.

To prevent periodontal diseases and their elimination, we applied natural water extraction of propolis “A-P-V”, using LFUS, which had anti-inflammatory, anti-viral and antibacterial effect.

To study the efficiency of ultrasound spraying “A-P-V” during the integrated treatment of periodontal diseases in patients with VDMA, more than 80 patients, divided in to two groups, were examined:

Group 1 – the main, consisting of 40 patients with different periodontal diseases – gingivitis, palatinitis. In the course of treatment of patients from this group, during each visit they had ultra-sound spraying of “A-P-V” solution, followed by oral rinsing after evening tooth brushing for 2-3 min with the same solution.

Group 2 – control, consisting of 40 patients with paradontal conditions, that used traditional rinses.

Obtained results are shown in the Table 3.

**Table 3**

**The dynamics of index indicators in the course of treatment in patients from main and control groups**

In- dex- es	Before treatment		In 2 weeks		In 4 weeks	
	Main	Control	Main	Control	Main	Control
PMA	17,1±0,25	18,9±1,57	10,9±0,21*	16,6±1,49*	9,2±0,18*	13,2±0,83*
SBI	1,29±1,84	1,33±0,38	1,03±0,28	1,14±0,13	1,28±1,76	0,95±0,08
PI	1,56±0,09	1,42±0,06	1,04±0,07	1,13±0,04	0,95±,08	1,01±0,09

Note: p <0.05\*- statistically valid compare to before treatment indicator

PMA index baseline in patients with periodontal diseases from both groups were similar –  $17.1\pm 0.25\%$  for main and  $18.9\pm 1.57\%$  for control group. Patients from the main groups already in two weeks had a significant reduction of PMA indicator till  $10.9\pm 0.21\%$ . This indicator in one month remained at the same level of  $9.2\pm 0.18\%$ , which also confirms the anti-inflammatory effect of “A-P-V”. Control group patients had reduction of this index, but less significant:  $16.6\pm 1.49\%$  in 2 weeks and  $13.2\pm 0.83\%$  in a month.

Comparison to bleeding index SBI for patients from main and control groups shows the advantage of LFUSS of “A-P-V”. Patients from control group had indication index had reduced in two weeks to  $1.14\pm 0.13$ , however in a month almost reached the baseline level  $1.28\pm 1.76$ . At that main group patients had stable reduction of this indicator, in two weeks –  $1.03\pm 0.28$ , in a month  $0.62\pm 0.55$ .

Similar situation was observed also during the statistical analysis of PI index with only difference that this index in both groups continued reduction. In the main group it was lower and in two weeks was  $1.04\pm 0.07$ , in a month –  $0.95\pm 0.08$ , unlike the control group with  $1.13\pm 0.04$  and  $1.01\pm 0.09$  respectively.

Thus, an integrated method of treatment of patients with VDMA and use of natural remedy “A-P-V” by means of LFUS to prevent and treat periodontal diseases gives basis to recommend it for use in orthodontic practice.

## FINDINGS

1. While examining 7172 patients applying for orthodontic help with different dento-maxillofacial system, the following figures of dentomaxillary anomalies were discovered:  $22.21\pm 0.49\%$  – vestibular location of teeth,  $2.29\pm 0.18\%$  – supernumerary,  $12.53\pm 0.39\%$  – permanent teeth impaction,  $12.42\pm 0.39\%$  – open bite,  $22.71\pm 0.49\%$  – deep bite [4, 15, 53, 61, 66, 70].
2. Combinations of vertical anomalies of bite with individual teeth location anomalies were determined: open bite with vestibular location of teeth  $12.42\pm 0.39\%$ , supernumerary teeth  $6.9\pm 0.18\%$ , permanent teeth impaction  $9.09\pm 0.96\%$ ; deep bite with

vestibular location of teeth  $22.71 \pm 0.49\%$ ; supernumerary teeth  $13.9 \pm 0.15\%$ , impaction of permanent teeth  $11.11 \pm 0.78\%$  [6, 15, 39, 57, 62, 66].

3. Improved by us method of computer calculation of lateral X-rays of head of patients based on «Dolphin Imaging – 11.9» facilitate the optimization of VDMA diagnosing and choice of relational plan for orthodontic treatment [45, 47, 51, 54, 56, 74].
4. The results of acoustic studies of permanent teeth hard tissues under brackets during long treatment period, speak, mostly, in favor of normal structure of enamel, however in a number of cases there were minor changes in the form of reduction of acoustic impedance, blurring of enamel prism contours, dissection of dentin straps and micro-cracks [31, 32, 66, 68].
5. Experiments on white outbred mice showed that low frequency ultrasound exposure of gingival soft tissues for 3 to 5 seconds leads to so called “molecular stress syndrom” and initiate minor morphohistochemical changes. 5 to 10 sec exposure lead to morphohistochemical changes in the form of keratinisation of mucousa and loose of density of epithelial lining, which clinically leads to facilitation of delayed teeth eruption [63, 64, 69].
6. For comfort and ease of experiments on the head of white outbred mice we proposed, as invention, a special device [66].
7. The invention of the ease method of tooth eruption stimulation, based on the application of low frequency ultrasound, facilitate and improve orthodontic treatment efficiency and shorten its duration by 1.5-2 times [44, 60, 65, 67, 78, 79].
8. When use of natural remedy miswak in patients on orthodontic treatment the OHI-S goes down from  $2.20 \pm 0.10$  to  $1.01 \pm 0.14$  within one month and continues reducing to forth month to the level of  $0.10 \pm 0.12$  [5, 19, 21, 35, 36].
9. Application of low-frequency ultrasound spraying of a natural remedy – water extraction of propolis «A-P-V» to prevent periodontal diseases in patients under orthodontic treatment leads to reduction of index indicators within one month: PMA from  $17.1 \pm 0.25$  to  $9.2 \pm 0.18$ , SBI from  $1.29 \pm 1.84$  to  $1.28 \pm 1.76$ ,



PI from  $1.56 \pm 0.09$  to  $0.95 \pm 0.08$  [66, 78, 79].

10. The algorithm we developed for the treatment of patients with VDMA of different ages is optimal among integrated methods of treatment and can be recommended for introduction into orthodontic practices [1, 2, 6, 9, 14, 26, 34, 40, 71, 75, 80].

## PRACTICAL RECOMMENDATIONS

1. During early period and mixed bite period, to prevent VDMA, it is important to communicate with parents of patients to teach them breastfeeding, elimination of bad habits and timely treatment of teeth.
2. In the period of mixed bite it is expedient to use vestibular plates, correctors, selective grinding of canine cusp, administration of miogymnastics, control by ENT doctors and traumatologists-orthopedists to normalize breathing and developing a good posture.
3. During permanent bite in patients with VDMA, taking into account the severity of morphologic, functional and aesthetic distortions, it is recommended to remove individual teeth, selective grinding of edges of teeth, cusps and proximal surfaces, as well as application of removable and non-removable orthodontic devices coupled with low-frequency ultrasound, laser, piosurgery, orthognatic surgery.
4. During integrated orthodontic treatment of patients with delayed eruption of permanent teeth it is recommended to apply gentle regime of low-frequency ultrasound stimulation of their eruption.
5. To prevent caries and periodontal diseases during treatment of patients with VDMA it is recommended to use natural remedy miswak and low-frequency ultrasound spraying of propolis water extraction «A-P-V».
6. For efficient rehabilitation of patients with VDMA it is expedient to establish a multi-disciplinary center, uniting orthodontists, dental therapists, surgeons, orthopedists with pediatricians, ENT doctors, allergologists, orthopedists-traumatologists.

**LIST OF SCIENTIFIC REFERENCES,  
PUBLISHED ON THE TOPIC OF THE DISSERTATION:**

1. Гасымова, З.В., Ага-заде, А.Р. Комплексное лечение при зубоальвеолярном укорочении // Ортодент-инфо, – 2001. № 4, – с. 20-24.
2. Гасымова, З.В. Возможности комплексного лечения для обеспечения привлекательной улыбки // Стоматология для всех, – 2001. № 4, – с. 26-28.
3. Гасымова, З.В. Вертикальные перемещения отдельных ретенированных зубов и анализ достигнутых результатов // Тезисы науч.-практ. конф.: «Достижения в стоматологии и пути совершенствования последипломного стоматологического образования». – Москва: – 13-14 декабря, – 2001. – с. 207-208.
4. Гасымова, З.В. Ретенция отдельных зубов, диагностика и комплексное лечение // Ортодент-инфо, – 2002. № 2, – с. 2-7.
5. Гасымова, З.В., Гашимов, Р.Г., Асланова, Ф.К. Применение Мисвака в ортодонтии // Ортодонтия, – 2002. № 4, – с. 12-15.
6. Гасымова, З.В. Опыт комплексного метода лечения зубочелюстно-лицевых аномалий, сочетающихся с зубоальвеолярным удлинением // – Баку: Sağlamlıq, – 2002. № 5, – s. 14-18.
7. Гасымова, З.В. Тактика комплексного подхода к лечению вертикальной дизокклюзии // – Баку: Sağlamlıq, – 2002. № 7, – s. 46-51.
8. Гасымова, З.В. Комплексная диагностика и результаты комплексного лечения при ретенции отдельных зубов // Материалы VII международной конференции челюстно-лицевых хирургов и стоматологов. – Санкт-Петербург: – 28-30 мая, – 2002. – с. 37.
9. Гасымова, З.В., Асланова, Ф.К. Комплексное лечение при вертикальных зубочелюстных аномалиях // Akademik M.C.Cavadzadənin 75 illik yubileyinə həsr olunmuş Respublika elmi-praktik konfransın materialları. – Bakı: “Çaşıoğlu” nəşriyyatı, – 2002. – с. 162-166.
10. Гасымова, З.В. Диагностика и комплексное лечение зубоче-

люстных аномалий у детей с ротовым дыханием и нарушенной осанкой // Akademik M.C. Cavadzadənin 75 illik yubileyinə həsr olunmuş Respublika elmi-praktik konfransın materialları. – Bakı: “Çaşıoğlu” nəşriyyatı, – 2002. – с. 166-171.

11. Гасымова, З.В., Гашимов, Р.Г. Профилактика кариеса при применении эджуайз-техники // Пути совершенствования последиplomного образования специалистов стоматологического профиля. Актуальные проблемы ортопедической стоматологии и ортодонтии. – Москва: – 19-20 декабря, – 2002. – с. 260-262.
12. Гасымова, З.В. Диагностика и комплексное лечение при ретенции резцов и клыков верхней челюсти // Пути совершенствования последиplomного образования специалистов стоматологического профиля. Актуальные проблемы ортопедической стоматологии и ортодонтии. – Москва: – 19-20 декабря, – 2002. – с. 263-265.
13. Гасымова, З.В. Комплексное лечение зубочелюстных аномалий, сочетающихся с ротовым дыханием и нарушенной осанкой // Пути совершенствования последиplomного образования специалистов стоматологического профиля. Актуальные проблемы ортопедической стоматологии и ортодонтии, – Москва: – 19-20 декабря, – 2002. – с. 265-267.
14. Гасымова, З.В. Взаимосвязь зубочелюстно-лицевых аномалий с ротовым дыханием, нарушенной осанкой и способы комплексного лечения // Стоматология для всех, – 2003. № 1, – с. 22-25.
15. Гасымова, З.В. Частота ретенции зубов по данным ортопантограмм // Российский стоматологический журнал, – 2003. № 2, – с. 35-37.
16. Ага-заде, А.Р., Гасымова, З.В. Комплексный подход к выведению ретенированных клыков нижней челюсти // – Санкт-Петербург: Институт стоматологии, – 2003. № 2, – с. 24-25.
17. Гасымова, З.В. Наследственные формы зубочелюстных аномалий и их лечение // Материалы VII международной конференции «Здоровье семьи – XXI век». – Пермь-Валетта: – 3-

- 5 мая, – 2003. – с. 54.
18. Гасымова, З.В. Частота ретинированных зубов по данным панорамных исследований // Материалы VIII международной конференции челюстно-лицевых хирургов и стоматологов. – Санкт-Петербург: – 26-28 мая, – 2003. – с. 47-48.
  19. Гашимов, Р.Г., Гасымова, З.В., Хандагджи, У.Н. Мисвак в профилактике стоматологических заболеваний // Материалы VIII международной конференции челюстно-лицевых хирургов и стоматологов. – Санкт-Петербург: – 26-28 мая, – 2003. – с. 48.
  20. Гасымова, З.В. Основные принципы ортодонтического лечения взрослых и подростков // Материалы Российского научного «Стоматологического форума 2003». Москва: – 18-21 ноября, – 2003. – с. 20-21.
  21. Гасымова, З.В. Применение гигиенического средства «Мисвак» в комплексном ортодонтическом лечении. Методические рекомендации / З.В.Гасымова, З.В., Р.Г. Гашимов, У.Н.Хандагджи. – Баку: Типография Азербайджанской Государственной Нефтяной Академии, – 2003. –21 с.
  22. Qasımova, Z.V. Kompleks ortodontik müalicə zamanı «Misvak» gigiyenik vasitəsinin tətbiqi. Metodik vəsait / Z.V.Qasımova, U.N.Xandaqđji, R.Q.Həşimov. – Bakı: Azərbaycan Dövlət Neft Akademiyasının mətbəəsi, – 2003. – 20 s.
  23. Гасымова, З.В. Современные подходы к лечению зубочелюстных аномалий // – Баку: Azərbaycan Tibb Jurnalı, – 2004. № 1, – с.72-75.
  24. Гасымова, З.В. Психологические аспекты при лечении зубочелюстных аномалий // Azərbaycanca Tibb Elmi və Praktik Səhiyyənin müasir nailiyyətləri, I cild. – Bakı, – 2004. – s. 53-60.
  25. Гасымова, З.В. Диагностика и лечение зубочелюстных аномалий современными методами //Azərbaycanda Tibb Elmi və Praktik Səhiyyənin müasir nailiyyətləri, II cild. – Bakı, – 2004. – s. 96-104.
  26. Гасымова, З.В. Взаимосвязь зубочелюстно-лицевых аномалий с ротовым дыханием, нарушенной осанкой, способы комплексного лечения // Стоматология детского возраста и

- профилактика, – 2004. № 3-4, – с. 59-62.
27. Гасымова, З.В., Ага-заде, А.Р. Комбинированное ортодонтическое и пьезохирургическое лечение при ретенции зубов // Ортодонтия, – 2004. № 3-4, – с. 65-67.
28. Гасымова, З.В., Ага-заде, А.Р. О целесообразности применения пьезохирургического метода удаления ретенированных зубов мудрости // Материалы VIII международной конференции «Здоровье семьи – XXI век». – Гоа, Индия, – 2004. – с. 57-58.
29. Ага-заде, А.Р., Гасымова, З.В., Ага-заде, Р.Г. Тактика комплексного лечения при адентии // Стоматологична Імплантологія Остеоінтеграція. Перший Український Міжнародний Конгрес. – Київ, Україна, – 2004. – с. 89-90.
30. Ага-заде, А.Р., Гасымова, З.В. Об эффективности комплексного подхода к диагностике и лечению одонтогенных кератокист // – Bakı: Azərbaycanca Tibb Elmi və Praktik Səhiyyənin müasir nailiyyətləri, – 2005. №2, – с. 198-202.
31. Гасымова, З.В. Применение метода акустической микроскопии в ортодонтической практике // – Баку: Azərbaycan Tibb Jurnalı, – 2005. № 4, – с.56-58.
32. Гасымова, З.В., Денисова, А.А. Опыт использования акустической микроскопии в ортодонтической практике // Материалы IX международной научной конференции «Здоровье семьи – XXI век». – Далянь, Китай: – 28 апреля – 8 мая, – 2005. – с. 77-78.
33. Гасымова, З.В. Роль гигиенического фактора в профилактике стоматологических заболеваний у стоматологических больных // Материалы X международной научной конференции «Здоровье семьи – XXI век». – Бангкок, Таиланд: – 27 апреля – 9 мая, – 2006. – с. 83-84.
34. Гасымова, З.В., Ага-заде, А.Р. Комплексное лечение кератокист с использованием пьезохирургических и ортодонтических методов // Материалы XI международной конференции челюстно-лицевых хирургов и стоматологов. – Санкт-Петербург, – 24-26 мая, – 2006. – с. 36.
35. Гасымова, З.В. Об эффективности применения гигиениче-

- ского средства «Мисвак» в комплексном лечении ортодонтических больных» // İctimai sağlamlıq və səhiyyə (sosial gigiyena və səhiyyənin təşkili kafedrasının yaradılmasının 80, prof. İ.İ.Felin anadan olmasının 100-illik yubileyinə həsr olunmuş elmi məcmuə), – Bakı, – 2006. – s. 41-44.
36. Гасымова, З.В., Асланова, Ф.К., Хандагджи, У.Н. Применение мисвака в стоматологической практике / 5-ci Beynəlxalq Elmi-Praktiki konfrans «Stomatologiyanın aktual problemləri». – Bakı: – 29 sentyabr, – 2006. – s. 32-33.
37. Гасымова, З.В. Основные направления в профилактике зубочелюстных аномалий // Сборник научных статей международной конференции, посвященной 100-летию заслуженного деятеля науки, профессора К.А.-С.Балакишиева. – Баку, – 2006. – с. 250-252.
38. Гасымова, З.В., Аббасова, Н.И. О роли естественных факторов в распространенности зубочелюстных аномалий у детей // Professor İ.Ə.Axundovun 110-illik yubileyinə həsr olunmuş elmi konfransın materialları. – Bakı, – 2007. – s. 64-66.
39. Гасымова, З.В., Мамедалиева, Д.А. Некоторые эпидемиологические аспекты зубочелюстных аномалий // Əziz Əliyevin 110-illiyinə həsr olunmuş elmi konfransın materialları, – Bakı, – 2007. – s. 238-240.
40. Гасымова, З.В., Асланова, Ф.К., Аббасова, Н.И. Диагностика и лечение зубочелюстно-лицевых аномалий и их осложнений // – Баку: Azərbaycan Tibb Jurnalı, – 2008. № 1, – с. 142-145.
41. Гасымова, З.В., Гасанов, И.Э., Гасымов, О.Ф. Аномалии зубочелюстной системы у больных с талассемией // Материалы XII международной научной конференции «Здоровье семьи – XXI век». – Эйлат, Израиль: – 29 апреля – 7 мая, – 2008. – с. 180-181.
42. Гасымова, З.В. Опыт комплексного лечения дистального прикуса, в зависимости от периодов созревания шейных позвонков // Материалы XIII международной научной конференции «Здоровье семьи – XXI век». – Хургада, Египет: – 26 апреля – 3 мая, – 2009. – с. 126-127.
43. Гасымова, З.В., Гасымов, О.Ф. Лечение мезиального прикуса

- в соответствии с периодами созревания шейных позвонков // *Материалы III Всероссийской научно-практической конференции «Врожденная и наследственная патология головы, лица и шеи у детей: актуальные вопросы комплексного лечения».* – Москва: – 8-10 сентября, – 2009. – с. 93-95.
44. Гасымова, З.В. Аппарат «SIAZ» в ортодонтии / З.В.Гасымова, Р.Г. Гашимов, Т.Э.Имамалиев [и др.] // *Тезисы XIII съезда ортодонтов России. Ортодонтия,* – 2010. № 3 (51), – с. 52-53.
45. Гасымова, З., Гасымов О., Зейналов, Г. Применение программы «Dolphin-imaging-11,5» для диагностики и планирования лечения зубочелюстно-лицевых аномалий // *“Medicina Stomatologica” Asociatia stomatologilor din Republica Moldova,* – 2011. № 1 (18), – р. 58-62.
46. Гасымова, З.В., Мамедалиева, Д.А., Мамедбекова, Г.Д. Результаты оптической микроскопии твердых тканей и пульпы зубов в периоды ортодонтического лечения брекетами // – Баку: *Sağlamlıq,* – 2011. № 2, – с. 90-93.
47. Гасымова, З.В., Гасымов, О.Ф. Современный метод диагностики зубочелюстно-лицевых аномалий с применением программы “Dolphin-Imaging” // *Ортодонтия,* – 2011. № 3 (55), – с. 24-28.
48. Гасымова, З.В., Гасымов, О.Ф. Диагностика зубочелюстно-лицевых аномалий с применением современной программы «Dolphin-Imaging-11» // *Материалы XV международной научной конференции «Здоровье семьи – XXI век».* – Торремолинос, Испания – Пермь, Россия, – 2011. – с. 114-115.
49. Гасымова, З.В. Retensiya olunmuş dişlərin çıxmasını stimullaşdıran fiziki üsullar // *İmplantoloqların IV Beynəlxalq Xəzər Konfransı.* – Bakı: – 6-8 may, – 2011. – s. 40-41.
50. Гасымова, З.В. Современные методы диагностики лечения адентии и ретенированных зубов / З.В.Гасымова, Р.Г. Гашимов, О.Ф. Гасымов [и др.] // *Ортодонтия,* – 2012. №1 (57), – с. 56.
51. Aghazada, H. Application of the «Dolphin Imaging 11.5 Soft-

- ware for a choice of different treatment options of the patients with agenesis of maxillary lateral incisors / H.Aghazada, Z.V.Gasimova, A.R.Aghazada [et al.] // Abstracts of XXIV International Congress "New and Old Myths in Orthodontic Philosophies". – Firenze, Italy: – 10-13 October, – 2012. – p. 143-144.
52. Гусейнова, Т.Г., Гасымова, З.В. Социально-эпидемиологические аспекты зубочелюстных аномалий // – Баку: Патологические процессы и методы их коррекции, – 2012. – с. 128-132.
53. Гасымова, З.В. Сверхкомплектные зубы - распространенность, современные методы диагностики и комплексного лечения // – Баку: Azərbaycan Tibb Jurnalı, – 2013. № 1, – с. 173-178.
54. Гасымова, З.В. Прогнозирование результатов ортодонтического лечения пациентов с глубоким дистальным прикусом и ретенцией клыков на основе применения компьютерной программы «Dolphin-imaging 11.5» // Современная ортодонтия, – 2013. № 01 (31), – с. 14-16.
55. Гасымова, З.В. О распространенности ретенции моляров // Вісник проблем біології і медицини, – 2014. Вип. 2, – т. 1 (107), – с.87-92.
56. Гасымова, З.В., Ага-заде, Г.Р., Гасымов, О.Ф. Использование программы «Dolphin-imaging 11,5» для совершенствования лечения пациентов с первичной адентией боковых резцов верхней челюсти // Ортодонтия, – 2013. № 4 (65), – с. 43-46.
57. Гасымова, З.В., Шадлинская, Р.В., Ниязова, Л.А. Частота сверхкомплектных зубов на ортодонтическом приеме // Əməkdar elm xadimi, tibb elmləri doktoru, professor Z.T.Guliyevanın 90-illik yubileyinə həsr edilmiş elmi konfransın materialları. – Bakı, – 2013. – s. 164-165.
58. Гасымова, З.В., Ага-заде, Г.Р., Гасымов, О.Ф. Современные методы диагностики и лечения первичных адентий верхних латеральных резцов // Материалы XVII международной научной конференции «Здоровье семьи – XXI век». – Лиссабон, Португалия: – 27 апреля – 06 мая, – 2013. – p. 79-80.
59. Гасымова, З.В. Планирование ортодонтического лечения с



- помощью современных компьютерных технологий // XVIII международная конференция челюстно-лицевых хирургов и стоматологов «Новые технологии в стоматологии». – Санкт-Петербург, Россия: – 14-16 мая, – 2013. – с. 45-46.
60. Гасымова, З.В. Современные подходы к диагностике и лечению ретенированных зубов // Вестник Российской Академии Медицинских Наук, – 2014. № 3-4, – с. 14-18.
61. Гусейнова, Т.Г., Гасымова, З.В., Шадлинская, Р.В. Этиопатогенез вестибулярно-расположенных клыков, метод диагностики и прогнозирования лечения // “Təbabətin aktual problemləri” mövzusunda elmi konfransın materialları. Bakı, – 2014. – s. 150-151.
62. Гусейнова, Т.Г., Гасымова, З.В., Шадлинская, Р.В. Вестибулярное положение клыков – современные методы диагностики и комплексного лечения // Əməkdar elm xadimi, tibb elmləri doktoru, professor T.Ə.Tağızadənin 90-illik yubileyinə həsr olunmuş beynəlxalq elmi-praktik konfransın materialları. – Bakı, – 2014. – s. 91-93.
63. Гасымова, З.В., Гасанов, И.А., Гашимов, Р.Г. Экспериментальное исследование по разработке оптимальных режимов воздействия низкочастотного ультразвука на мягкие ткани нижней челюсти // – Полтава: Світ медицини та біології, – 2015. № 2 (49), – с. 88-92.
64. Гасымова, З.В. Клинико-морфологическая оценка применения низкочастотного ультразвука при задержке прорезывания зубов // Казанский медицинский журнал, – 2015. Т. ХСVI, – № 4, – с. 510-514.
65. Гасымова, З.В. Применение низкочастотного ультразвука для стимуляции прорезывания зубов / З.В.Гасымова, Р.Г.Гашимов, И.А.Гасанов [и др.] // 1<sup>st</sup> International scientific conference European Applied Sciences: challenges and solutions. – Stuttgart, Germany: 2015, – p. 40-45.
66. Гасымова, З.В. Оптимизация методов диагностики, лечения и профилактики вертикальных зубочелюстных аномалий // – Баку: Azərbaycan Tibb Juranalı, – 2016. № 3, – s. 158-163.
67. Гашимов, Р.Г., Гасымова, З.В. Новые способы лечения паци-

- ентов с зубочелюстными аномалиями на основе применения низкочастотного ультразвука // *Материалы XVII съезда ортодонтов России.* – Санкт-Петербург: – 26-28 мая, – 2016. Ортодонтия, – 2016. № 2 (74), – с. 48-49.
68. Гасымова, З.В. Акустическая микроскопия в практике ортодонтии // *Казанский медицинский журнал,* – 2017. Т. ХСVIII, – № 3, – с. 452-456.
69. Гасымова, З.В. Экспериментальное обоснование применения низкочастотного ультразвука в комплексном лечении зубочелюстных аномалий / З.В.Гасымова, Р.Г.Гашимов, И.А.Гасанов [и др.] // *Magyar Tudományos Journal,* – 2017. № 3, – р. 32-36.
70. Гусейнова, Т.Г., Гасымова, З.В., Алиева, Л.А. Распространенность зубочелюстных аномалий среди детей и подростков г. Баку // *Актуальные проблемы науки XXI века. Сборник статей,* – Москва: Cognitio, – 31 октября, – 2017. – с. 11-16.
71. Гасымова, З.В., Алиев, М.А., Джалилова, Г.И. Тактика лечения зубочелюстных аномалий у подростков // *Tibb elmləri doktoru, professor S.N.Axundovun 120 illiyinə həsr olunmuş elmi-praktik konfransın materialları.* – Bakı, – 2017. – s. 275-276.
72. Шадлинская, Р.В., Гасымова, З.В., Гасымов, О.Ф. Цефалометрические особенности челюстно-лицевых параметров у пациентов большой  $\beta$ -талассемией // *Azərbaycan Xalq Cümhuriyyətinin 100 illiyinə həsr olunmuş Azərbaycan Tibb Universitetində keçirilən, Otorinolarinqologiya üzrə Beynəlxalq Elmi-Praktiki Konqresin tezisləri.* – Bakı, – 2018. – s. 68.
73. Шадлинская, Р.В., Гасымова, З.В., Гасымов, О.Ф. Сравнительная характеристика челюстно-лицевых параметров пациентов с большой  $\beta$ -талассемией и дистальной окклюзией // *Клиническая стоматология,* – 2019. № 1 (89), – с. 46-50.
74. Шадлинская, Р.В., Гасымова, З.В., Гасымов, О.Ф. Анализ данных цефалометрических исследований пациентов с большой  $\beta$ -талассемией, проживающих в Азербайджане // – Москва: Стоматология, – 2019. № 4 (98), – с. 65-70.

75. Гасымова, З.В. Современные методы лечения ретенированных зубов / I<sup>st</sup> International scientific congress Azerbaijan Society of Oral and Maxillofacial Surgeons. – Baku: – 14-16 March, – 2019. – p. 86-87.
76. Шадлинская Р.В., Гасымова, З.В., Ага-заде, А.Р. Ретенция зубов у пациентов с врожденной и наследственной патологией // Материалы XX съезда Ортодонтотв России. – Москва: – 23-5 мая, – 2019. Ортодонтия, – 2019. № 2 (86), – с. 87.
77. Shadlinskaya, R., Gasimov, O., Gasimova, Z. Cephalometric measurements of patients with  $\beta$ -thalassemia major, living in Azerbaijan // 95<sup>th</sup> European orthodontic society congress. – Nice, France: – 17-22 June, – 2019. – SP 320.
78. Qasimova, Z.V. Daimi dişlərin retensiyası ilə əlaqədar olan dişçənə anomaliyalı pasiyentlərin kompleks müalicəsində aşağıtezlikli ultrasəsin tətbiqi. Metodik vəsait / Z.V.Qasimova, R.Q.Nəşimov. – Bakı: Doculand, – 2019. – 74 s.
79. Гасымова, З.В. Низкочастотный ультразвук в комплексном лечении пациентов с зубочелюстными аномалиями, обусловленными ретенцией постоянных зубов. Методическое пособие / З.В.Гасымова, Р.Г.Гашимов. – Баку: Doculand, – 2019. – 76 с.
80. Гасымова, З.В., Гасымов, О.Ф., Велиева, В.А. Планирование комплексного лечения деформаций зубочелюстной системы, вызванной ретенцией моляров // Azərbaycan Tibb Universitetinin yaradılmasının 90 illik yubileyinə həsr olunmuş “Təbabətin aktual problemləri – 2020” mövzusunda beynəlxalq Elmi-Praktik Konqresin materialları. Bakı: – 19-20 dekabr, – 2020. – s. 326-328.

## **Rationalization proposals**

1. Modification of hygienic index in treatment of orthodontic patients with edgewise system // Rationalization proposal № 442. Azerbaijan State Advanced Training Institute for Doctors named after A. Aliyev, 7 April 2003.
2. Modification of lateral X-ray methods measurements // Rationalization proposal № 03. Azerbaijan State Advanced Training Institute for Doctors named after A. Aliyev, 07.10.2011 / O.F.Gasimov, O.S.Seyidbayov, Z.U.Aliyev).

## **Patents**

1. Gashimov, R.G. Stimulation method for permanent impacted teeth, Patent № 2559934, 20.07.2015, Russian Federation / Z.V.Gasimova.
2. Gasimova, Z.V. Fixation device for small lab animals in experiment. Eurasia patent № 027001, 30.06.2017 / R.G.Gashimov.

## LIST OF ABBREVIATIONS AND SYMBOLS

DB	– deep bite
DMA	– dento-maxillar anomalies
OB	– open bite
LFUS	– low frequency ultrasound
SNT	– supernumerary tooth
VDMA	– vertical dento-maxillar anomalies

A handwritten signature in blue ink, appearing to be 'G. A. M.', is centered on the page.



The defense will be held on 31 05 2021 at 14<sup>00</sup> at the meeting of the Dissertation council ED 2.05 of Supreme Attestation Commission under the President of the Republic of Azerbaijan operating at Azerbaijan Medical University.

Address: AZ 1022, Baku, A.Gasimzade str, 14 (meeting hall).

Dissertation is accessible at the Azerbaijan Medical University Library.

Electronic versions of dissertation and its abstract are available on the official website of the Azerbaijan Medical University.

Abstract was sent to the required addresses on 28 april 2021.

Signed for print: 22.04.2021

Paper format: 60 x 84 1/16

Volume: 70258

Number of hard copies: 30