

Pelotherapy in Orthodontic Treatment of Patients with Mesial Occlusion and Vestibular Position of Permanent Maxillary Canine Teeth

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Abstract: The research objective is to increase the efficiency of the combined orthodontic treatment of patients with mesial occlusion of denture and vestibular position of permanent maxillary canine teeth by using pelotherapy. The insufficient volume of the physiotherapeutic methods used in the treatment of dental-maxillary and facial abnormalities made the researcher search for the new methods and improve the orthodontic devices in combined orthodontic treatment. The treatment efficiency was proved by analyzing thermal-visiograms. The research is based on diagnostic methods such as photometry, anthropometry of jaw and denture models, roentgenographic methods, thermal-visiography, electroacupuncture according to Voll, method of gas-discharge visualization. The treatment was carried out with the new methods and the device, proposed by the researchers. Application of pelotherapy in a combined orthodontic treatment of patients with mesial occlusion of denture and vestibular position of permanent maxillary canine teeth after diagnostics procedures and final diagnosing, both in the active and retention periods, reduces the duration of orthodontic treatment and ensures stable results. Patients may apply pelotherapy at home, without visiting an orthodontist which makes the combined orthodontic treatment more comfortable. Application of the techniques and devices proposed by the researchers for eliminating the observed abnormalities significantly increases the treatment efficiency and the quality of the achieved result. Invention No. 2146900 of 27 March 2000 by application No. 98118948 of 16 October 1998 (in co-authorship with N.P. Avvakumova, A.I. Agapov); Patent RF No. 2551973 of 10 June 2015, Patent RF No. 142454 of 23 May 2014.

Key words: Humic acids, mesial occlusion, pelotherapy, orthodontic treatment, maxilla, vestibular position of canine teeth

INTRODUCTION

Pelotherapy has been known in medical practice, since, ancient times nowadays it is broadly applied both in hospital treatment and in sanatorium-resort establishments. Sergievskiye mineral waters resort is one of the best resorts in Russia. It is famous for a rare combination of active hydrogen-sulphidous water and mineral mud. The resort is located in the picturesque area of the Middle Volga Region. The basic natural remedies of the resorts are invariable these are sulfide water and silt (lake-spring) hydrogen-sulphidous therapeutic mud. Their action is based on neurohumoral mechanism. The additional treatment methods applied at the resort are: therapeutic physical exercises, hygienic morning physical exercises, sun baths, electric light procedures, external environment: climate, nature and change of scene. All the year round, people with various diseases come here to improve their health cardiovascular diseases, lesions of movement organs, peripheral nervous system, skin

diseases, women's diseases and many others. Humic acids are a biologically active fraction used in orthodontics.

Pelotherapy is a significant part of a combined orthodontic treatment of patients with dental-maxillofacial abnormalities (Khoroshilkina, 2010). Peloids are widely used in medicine for general health improvement and found an application in dentistry as well (Persin, 2015; Khoroshilkina, 2010). To prevent complications in orthodontic treatment, a 0.05% solution of humic acids in isotonic sodium chloride solution is used (pH 7.36), extracted from low-mineralized sulfide silt therapeutic muds of the Volga Region. The prevalence of mesial occlusion in children in the Russian Federation is 1-14% (Arsenina *et al.*, 2013; Gioeva *et al.*, 2014; Persin, 2015; Postnikov, 2016; Suetenkov *et al.*, 2012). There are various reasons for occurrence of mesial occlusion, complicated with vestibular position of permanent maxillary canine teeth (Averyanov, 2010; Karpov, 2014). Great attention is paid to prevention (Khamadeeva and

Arkhipov, 2001; Khamadeeva and Nogina, 2010) and treatment of this abnormality (Stepanov *et al.*, 2013; Kuznetsova *et al.*, 2016; Ulyanova *et al.*, 2017; Stepanov, 2008; Almeida *et al.*, 2015; Ansar *et al.*, 2015; Celikoglu and Oktay, 2015; Chugh *et al.*, 2015). Mesial occlusion is often accompanied by a complex combination of abnormalities of teeth, denture and other types of malocclusion (Persin, 2015). It may have a dentoalveolar and, less frequently, gnathic form (Myagkova and Bimbas, 2015; Postnikov, 2016). Special attention is paid to mesial occlusion of denture and vestibular position of permanent canine teeth with deficit of space for them (Gazdarova and Pankratova, 2005; Postnikov *et al.*, 2016; Stepanov *et al.*, 2007) as these factors determine the duration of orthodontic process (Garbatsevich and Rublevskiy, 2008; Stepanov, 2011). Today, the search for new methods to improve the efficiency of medication treatment continues (Matveev *et al.*, 2012). Special surgical methods as well as using the advanced orthodontic retentional devices, allow preserving the obtained results of combined therapy in the retentional period (Alimova, 2009; Postnikov *et al.*, 2015; Yavorovskaya *et al.*, 2011). The scientifically tested results of treatment prove the efficiency of combined orthodontic correction (Kotelnikov and Shpigel, 2012).

MATERIALS AND METHODS

About 21 patients with mesial occlusion and vestibular position of maxillary canine teeth underwent combined examination and treatment. About 84 orthopantomograms and teleroentgenograms of head in lateral projection were analyzed. About 42 thermal images were studied. Various diagnostic methods were used including photometry, anthropometry of jaw and denture models, roentgenography, thermography, electroacupuncture according to Voll, gas-discharge visualization method. During combined treatment, the means and devices proposed by the researchers were applied.

RESULTS AND DISCUSSION

During the clinical examination, the patient's dental formulas were specified and their compliance with the chronological and dental age. Special attention was paid to the presence of over-retained primary teeth in particular when the corresponding permanent tooth was erupting on the same jaw. After an early loss of individual primary teeth, we checked the presence of space for permanent teeth in denture. The presence of a diastem or an erupting tooth on the place of an incisor with a cone-shaped crown was one of the indications for

roentgenographic examination, aimed at early diagnosing the presence of supernumerary teeth and a tendency for incorrect position of permanent maxillary canine teeth with mesial occlusion.

In the presence of malocclusions in sagittal, vertical or transversal directions, combined with vestibular position of permanent maxillary canine teeth, we observed a habitual displacement of the lower jaw forward or sideward and in 14% of patients disorders in temporo-mandibular joints.

Special attention was paid to the malocclusions, located next to over-retained primary teeth or denture defect. Orthopantomographic examination of jaws in the periods of combined and permanent occlusions is obligatory in case of a suspected delay in individual teeth eruption.

Frenula of upper and lower lip and of tongue were examined. The low attachment of upper lip frenulum as well as the displacement of the lower part of its attachment can be combined with the vestibular position of canine teeth at mesial occlusion.

Patients with the short frenulum of tongue and malocclusion were referred to plastic surgery of the tongue frenulum at any age which ensured the stable results of malocclusion elimination.

When patients with vestibular position of permanent maxillary canine teeth were prepared for orthodontic treatment, the hygienic status of their oral cavity was estimated. For that, the indices of the Russian Medical Association (RMA) and DMF/dmf (decayed, missing, filled permanent/primary teeth) were used. These data were especially important when choosing the non-removable constructions of edgewise technique.

Studying of the diagnostic models of jaws, obtained before the start of combined treatment, enabled to identify the signs of malformation of denture and malocclusion which are characteristic for mesial occlusion.

The dental formula was thoroughly analyzed for its compliance with the chronological and dental age of the person. The over-retained primary teeth were identified; the shape of all teeth was examined as well as the number of permanent and primary teeth, features of denture occlusion in the front and lateral sections in three mutually perpendicular directions. Special attention was paid to diastemas and diaereses between teeth, in particular with the asymmetry of the latter and a deficit of space for individual teeth in denture. When studying the diagnostic models of jaws, the flattening of the front section of an upper dental arc was found.

The denture width was measured by Pont their average individual norm was specified with Linder-Harth indices and facial shape correction was made by

Schwarz. The length of the front section of dental arcs was measured by Korkhaus. These data were significant to plan the combined methods of treatment in particular to specify the orthodontic indications for individual teeth removal.

Special attention was paid to the detection of mesial migration of teeth and deficit of space for some of them. On the upper jaw, the position of canine teeth crowns, second primary molars and first premolars was examined, as related to RPT line by Schmuth.

The size of lower jaw denture was studied. Its narrowing was similar to that of the upper denture. The length of the front section of the lower dental arc was most often increased due to the retroversion of the upper incisors and in patients with expressed deglutitive problem and mouth breathing.

Displacement of teeth along the denture and their declination in mesial direction, i.e., towards the narrow part of the dental arc in some cases resulted in the reduced width of the dental arc as well as the shortening of its front section. Such lesion was often combined with the denture narrowing. For differential diagnostics, the total length of the dental arc was measured by Nance as well as the occlusion of the denture in the front and lateral sections.

Measuring of diagnostic jaw models including the sum of mesio-distal widths of the four maxilla incisors and the denture width by Pont method with correction by Linder-Hart as well as the length of the front section of dental arcs by Korkhaus was performed for those patients for whom it was necessary to change the transversal and sagittal sizes of dentures by orthodontic treatment or state the indications for individual teeth removal to normalize occlusion. In these cases, orthodontic braces with broadening or elongating devices or devices for incisor retroversion were chosen. For this purpose, we used removable single-jaw devices, removable functional devices and non-removable devices (broadening Nord devices, edgewise technique).

The shortage of space in a denture is one of the key reasons for the wrong position of permanent maxillary canine teeth in mesial occlusion. The denture narrowing was often combined with macrodontia and mesial displacement of lateral teeth which also leads to the shortage of space.

Among the patients with the denture narrowing in mixed and permanent occlusion periods, narrowing was observed in the final stage of mixed occlusion period. The average value of the denture narrowing in millimeters was determined for each age group. It was found that the degree of denture narrowing virtually does not change but apex basis narrowing is often observed in the permanent occlusion period.

The study of the age distribution of the patients with the denture narrowing as well as that combined with

lateral teeth mesial occlusion, showed that the number of patients with those abnormalities grew with age which aggravated the dental-maxillary abnormalities, determined by the deficit of space for individual teeth in a denture.

Some patients had over-retained primary teeth in their denture. Mesio-distal sizes of the crowns of primary incisors and canine teeth are smaller than those of permanent ones and sizes of second primary molars are larger than those of second premolars. To determine the difference in sizes, we measured the mesio-distal sizes of the crowns of primary central incisors, canine teeth and second molars. The obtained sizes were compared to those of the permanent teeth replacing them.

The patients accepted for treatment lost primary teeth early, as a result of which the first permanent molars were displaced towards the defect and turned around their axis on the palatine root which enlarged the deficit of space for permanent maxilla canine teeth.

Roentgenologic examination included the study of close-focus roentgenograms of teeth and alveolar ridge, orthopantomograms of jaws and as necessary, tomograms of temporomandibular joints in case of their dysfunction. Roentgenographic research revealed the risk factors of vestibular eruption of permanent maxillary canine teeth.

Teleroentgenographic research enabled to detect the breach of linear and angle parameters which is essential for making the final diagnosis and deciding on the correct treatment plan for patients with mesial occlusion and vestibular position of permanent maxillary canine teeth. The thermal-visiographic examination enabled to compare the data of thermal-visiograms of dental-maxillary and facial zone.

Color thermal-visiograms show the shades characterizing the temperature of teeth crowns and alveolar ridge mucosa. The color intensity shows the tissue temperature which is depended on blood supply. The lower part of a thermal-visiogram contains an aggregate graph indicating the state of heat exchange. The thermal-visiograms were made before and after the combined treatment and when checking the remote results. Thermal-visiographic examinations were performed during morning hours, at the room temperature of $23.0 \pm 1.00^\circ\text{C}$, air speed not more than 0.25 m/sec, relative humidity 50-75%. Lower air temperature and air streams may lead to reflex spasm of peripheral vessels, change of the thermogram in the dentogingival zone and consequently to erroneous conclusions.

Before the thermal-visiographic examination, we excluded intake of pharmacological substances, execution of physical and physiotherapeutic procedures which could influence the peripheral blood flow. The patients were examined after thorough hygienic procedures of the oral cavity. The reliability of the obtained results was

Table 1: Results of statistics processing of temperature in the teeth area before and after treatment

Parameters, t°C taking into account the optimal position of teeth	Average temperature (°C)	$M = \sum_{i=1}^n T/n$	$\sigma = \sqrt{\sum_{i=1}^n (M - T)^2 / n - 1}$	$\gamma = \sigma/M \times 100$ (%)	M±m	d±md	p-value
Before treatment	37.884		1.298	3.426	37.884±2.511	0.9±0.285	<0.001
After treatment	36.984		0.346	0.936	36.984±1.069		

controlled by a blackbody with the permanent temperature of 33.00°C. Patients were examined in sitting position, at the distance of 0.5 m from the infrared imager. A stomatological retractor was used to abduct lips and cheeks.

Computer processing of the obtained thermograms enabled to allocate the temperature range, determine the area of the allocated spot in pixels (minimal flashing dot perceived by the device), perform filtration, digitalization and text processing of the obtained data, trace the graphic thermal profile of the studied area in any direction, determine the change dynamics by superposition of the images, to register the difference and to control the treatment efficiency.

The research data show normalization of the thermal field. The temperature fluctuated from 36.3880-37.2660°C. The results of statistics processing are shown in Table 1.

Electroacupuncture according to Voll was applied for the patients with weakened health, chronic diseases and for hereditary tainted children. Allergy for plastic or metals was detected. In case of reaction to metal, we applied with braces of chine, sapphire, plastic or with gold coating. As necessary, the patients were referred to other doctors (therapist, endocrinologist, urologist, pulmonologist, homeopath, etc.) for relevant treatment.

The Gas-Discharge Visualization method (GDV) was used for diagnosing the diseases of various organs and systems as it is essential to detect the state of health of the patient who applied for orthodontic treatment. The data obtained by examination were submitted to therapists and other specialists for relevant medical aid to the patients.

Bioenergy field was estimated quantitatively before and after treatment by the area (S) of the longitudinal section of a human biofield in square centimeters. The statistical processing of the results was made for 9 patients before and after the combined treatment. The research results showed that the area of the biofield section after the correction was on average $S = 757.1 \text{ cm}^2$ while before the correction it was on average $S = 501.2 \text{ cm}^2$, i.e., it increased 1.511 times on average. Before the combined treatment, psychological prophylaxis was needed.

Effective orthodontic treatment was usually combined with surgery. Fear of the patients, especially children, of the operation, often leads to their refusal of

treatment or postponing it for the older age. This may result in aggravation of dental-maxillary abnormalities, complicates treatment and hinders the achievement of positive result.

Successful combined treatment largely depends on a good psychological contact between the patient with parents, relatives and the doctor. This contact can be strengthened by psychological prophylaxis before medical procedures. To win confidence and authority with the patient, a doctor has to state the objective and tasks of treatment, its stages, probability of complications if the doctor's prescriptions are not observed thoroughly. The calm, self-confident and friendly tone of conversation enhances the patient's trust. Psychological prophylaxis before the combined treatment was performed both individually and collectively, 1-4 times every 2 days. A doctor convinced patients in the necessity and possibility of the correction of dental-maxillary abnormalities, spoke about its impact on the development of adjacent organs and the whole organism.

The psychological prophylaxis of patients their parents and relatives before the treatment and if necessary, during treatment ensured the accurate observance of the doctor's recommendations, timely visits to a polyclinic, regular use of orthodontic devices and reduction of the treatment duration by 2-6 months.

Pelotherapy was recommended to all patients who received orthodontic treatment. If parents could not accompany a child to the clinics daily for pelotherapy, we made individual devices with therapeutic mud and gave them to parents to make medical procedures at home.

To stimulate teeth shifting, alongside with physiotherapeutic procedures we recommended massage of alveolar ridge and using the removable orthodontic devices. To prevent complications of orthodontic correction, we performed pelotherapy with 0.05% solution of humic acids on isotonic sodium chloride solution (pH 7.36), extracted from low-mineralized sulfide silt therapeutic muds of the Volga Region. A cotton tampon was soaked in the solution and applied on the alveolar ridge mucosa in the area of the shifted teeth for 12-15 min. The procedure was repeated daily during 15 days.

We selected therapeutic muds from four largest lakes in Samara Region which are the basic therapeutic mud deposits of the Sergievskiye mineral waters resort. Sergievskiye mineral waters is one of the oldest resorts in Russia. It is situated in the forest-steppe part of the

Samara Trans-Volga Region, 120 km away from Samara in the basin of middle course of the Sok River a left-bank tributary of the Volga River. These muds are used in 21 sanatoriums.

Humic acids are non-specific biostimulators of a wide specter of activity. They improve metabolic processes in tissues, thus enhancing the local loosening of the bone tissue and create optimal conditions for shifting the incorrectly placed teeth. The medication has no side effects.

The described technique of shifting the individual permanent teeth was successfully applied in the treatment of 21 patients, 3 of them in combination orthodontic treatment with a prosthetic appliance. The analysis proves the more rapid shifting of the teeth. The patients underwent treatment well. The technique is simple to use it was recommended to be performed at home which saved time for visiting a doctor. We used the technique of stimulating the over-retained permanent teeth eruption, proposed by Stepanov *et al.* (2013) for which a patent for invention was obtained No. 2146900 of 27 March, 2000 by application No. 98118948 of 16 October, 1998 (in co-authorship with Avvakumova and Agapov).

To prevent relapses after malocclusions elimination and to reduce the treatment duration by drug application, we designed a therapeutic-preventive retainer by Stepanov *et al.* (2013) (TPR) (RF Patent No. 142454 of 23 May 2014). The device may be used for stabilization of the results of active period of orthodontic treatment and probably in the treatment of parodont diseases.

TPR is cheap to manufacture, it enables to broaden the specter and increase the functional efficiency of orthodontic treatment, to reduce the retention period through using medications, to broaden indications for person with allergic reactions. It is aesthetically acceptable, convenient and easy to use. TPR shows low risk of deformation and ensures preservation of the optimal concentration of a medication in the depot.

TPR is made of thermoplastic by vacuum formation on an appliance and has border. The first border at the vestibular and buccal surfaces goes 2 mm higher than the mucogingival fold on the mandible and 2 mm below it on the maxilla, by-passing all mucous bands and frenula. The first border of the therapeutic-preventive retainer at the lingual surface goes by mandible alveolar ridge 1-1.5 mm higher than the oral cavity bottom on the maxilla it goes on palatine surface 10-15 mm below the A line. TPR has a space for medication depositing: on the mandible it is situated at the vestibular, buccal and lingual surfaces from the dentogingival sulci to the mucogingival fold by the alveolar ridge in the area of teeth roots projection on the maxilla the space is situated at the vestibular, buccal and

palatine surfaces from the dentogingival sulci to the mucogingival fold by the alveolar ridge in the area of teeth roots projection, the space is located 1-2 mm from the TPR border there is a release cut from the first molar on the left to the first molar on the right on the TPR vestibular surface above the clinical equator of the crowns.

The device construction is simple, aesthetically acceptable, does not cause allergic reactions due to the absence of residual monomer and is not expensive to manufacture. The device construction has low risk of deformation as it is made of homogeneous material. The device does not influence negatively on the oral cavity hygiene as it is made of standard plates. It enables to achieve the optimal preservation of the result of orthodontic treatment active period as the TPR construction includes a space for depositing medications which ensures the combined approach to eliminating the abnormalities in the retention period of orthodontic treatment. Due to its construction and the borders of medication depositing, TPR closely fits the teeth and alveolar ridge which prevents mixing the applied medications with the mouth liquid and ensures their optimal concentration. There is a release cut from the first molar on the left to the first molar on the right on the vestibular surface which ensures the comfortable use of the device, preventing the mucosa traumas during putting on and taking off of the device. The release cut goes above the clinical equator of the crowns, thus, preserving the firm adherence of the device to the teeth surface. TPR is made of transparent plates, thus, it is aesthetically acceptable. TPR (RF Patent No. 142454 of 23 May, 2014) is shown in Fig. 1-3.

The technique and method of manufacturing the therapeutic-preventive retainer: When using pelotherapy in the combined treatment of patients with mesial occlusion of denture and vestibular position of permanent maxillary canine teeth we applied the technique of manufacturing the therapeutic-preventive retainer (RF patent No. 2551973 of 10 June, 2015). We found the necessity to reduce the complexity and cost of the device manufacturing; to reduce the counter-indications to the clinical use of the device in people with allergy anamnesis to broaden and increase its functioning efficiency in orthodontic treatment to reduce the retention period duration by using it in combination with the medications favorably influencing the parodont tissues.

On the working model, before making the space for medication depositing, the clinical equator of the teeth crowns is found with parallelometer for the teeth embraced by the therapeutic-preventive retainer. On the working model, the borders of the therapeutic-preventive retainer and the borders of the space for medication

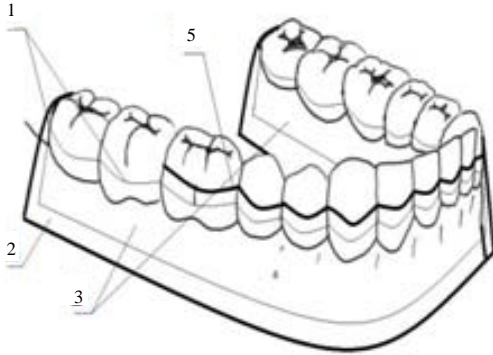


Fig. 1: Side view of TPR; 1: Clinical equator of the teeth crowns; 2: Alveolar ridge; 3: Space for medication depositing; 4: TPR and 5: Release cut



Fig. 4: On the working model, borders of TPR and the space for medication depositing are marked

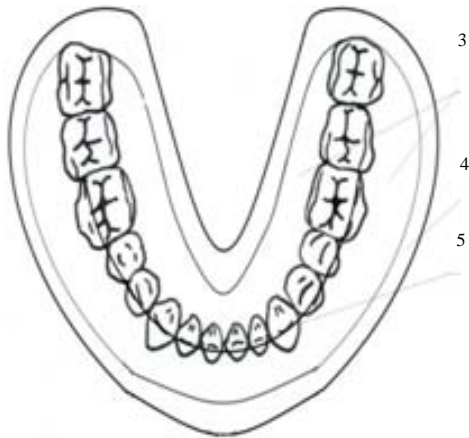


Fig. 2: TPR fixed on mandible teeth, view from occlusion surface; 3: Space for medication depositing; 4: TPR and 5: Release cut



Fig. 5: Between the marked borders of the space for medication depositing, a layer of molding silicone rubber is placed, 0.5-1 mm wide

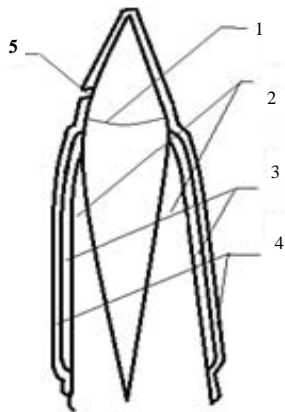


Fig. 3: Sagittal view of TPR; 1: Clinical equator of the tooth crown; 2: Alveolar ridge; 3: Space for medication depositing; 4: TPR and 5: Release cut

depositing are marked; the space should be 1-2 mm from the border of the therapeutic-preventive retainer. Between the marked borders of the space for medication depositing (Fig. 4), a layer of molding silicone rubber is placed, 0.5-1 mm wide (Fig. 5). Then, the working model is placed into a vacuum molder and pressed with thermoplastic mass; TPR is cut along the marked borders the release cut is made from the first molar on the left to the first molar on the right on the TPR vestibular surface above the marked clinical equator of the teeth crowns, the therapeutic preventive retainer is grinded and polished (Fig. 6).

The proposed manufacturing technique is simple, requires no special skills and saves working time. The material used does not cause allergic reactions, due



Fig. 6: Finished TPR

to the absence of residual monomer. This technique is not costly. The device construction has low risk of deformation, due to the use of a single plate of thermoplastic material without additional elements. The construction of the therapeutic-preventive retainer includes a space for depositing medications located in the area of the teeth roots projection which ensures the combined approach to eliminating the malocclusions in the retention period of orthodontic treatment. The borders of TPR and the space for medication depositing, provided in this manufacturing technique, ensure the preservation of the optimal concentration of a medication when using this retainer.

Physiotherapeutic methods are not very broadly used in the combined treatment of dental-maxillary abnormalities. These methods include galvanization and electrophoresis, ultrasound therapy, hydrotherapy, paraffinotherapy, massage, electrophoresis with hyaluronidase medications (Persin, 2015). These methods are mainly used for treatment of stomatological diseases. The performed analysis of the results of treatment of patients with mesial occlusion and vestibular position of permanent maxillary canine teeth with pelotherapy proved the efficiency of the combined treatment and the increased quality of the obtained results. The combined treatment with the new methods and improved orthodontic device in the form of a therapeutic-preventive retainer testify to the new approach to the treatment of dental-maxillary abnormalities, researched in this research. Due to the application of pelotherapy in the combined treatment of patients with mesial occlusion of denture and vestibular position of permanent maxillary canine teeth, the duration of orthodontic treatment is reduced and the correction efficiency is increased as well as the stability of the obtained results.

CONCLUSION

The proposed methods and the therapeutic-preventive retainer for treatment of patients with mesial

occlusion, complicated with vestibular position of maxillary canine teeth ensure optimization of the denture shape and occlusion. The researchers marked normalization of the thermal profile in the dentogingival area. It is recommended to apply the new methods and TPR in stomatological healthcare organizations.

RECOMMENDATIONS

The materials of the study are valuable for orthodontists and stomatologists. The efficiency of the proposed methods and the therapeutic-preventive retainer in combined treatment of dental-maxillary abnormalities is proved.

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