

Justification for the physiological isolation of the torus based on the pain sensitivity of the oral mucosa

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Abstract. At the current stage of scientific and practical dental development, many patients cannot use removable dentures fully. However, there are many new effective methods for this type of orthopedic dental treatment. We are improving the methods of manufacturing high-quality removable dentures through clinical, functional, and physicomachanical research. Orthopedic dental treatment was performed in 33 patients, for whom dentures were made depending on the pain sensitivity of the torus with a certain thickness of insulation. Measurements of pain sensitivity and compliance of the oral mucosa were performed, and diagnostic models were studied. Patients who had partial and full removable plate prostheses made using our developed techniques noted a positive shift in the quality of life after prosthetics, in comparison with prostheses made earlier. The results showed that after orthopedic dental treatment, the proportion of patients who considered their quality of life to be good increased significantly (78.4%), with the initial indicator (8.1%). In addition, 16.2% of patients considered their quality of life to be satisfactory, and only 5.4% continued to consider their quality of life to be unsatisfactory, although before prosthetics, this indicator was (5.1%). These data show that high-quality dental prosthetics improve the quality of life of our patients since this indicator changed for the better from 8.1% to 78.4%. Diagnostic measures using devices for determining the pain sensitivity of the oral mucosa, the clinical and functional classification of the torus, and recommended methods of its isolation solve the problem of improving the quality of removable prostheses.

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1 Introduction

At the present stage of scientific and practical dental development, many patients cannot use removable dentures fully [1] [2]. It is also known that the most common reason for refusing removable dentures is the poor fixation of the denture and a feeling of pain under the dentures associated with the presence of a pronounced torus and sharp bone protrusions [3] [4]. However, there are many new effective methods for this type of orthopedic dental treatment [5]. Restoration of teeth lost due to tooth loss in different countries and years has been carried out depending on the achievements of scientific and practical dentistry. Currently, the problem of creating removable dentures with complete loss of teeth has several implications and remains relevant for a certain segment of the world's population [6]. This is because of the tendency to increase the loss of natural teeth as a result of complicated caries, inflammatory diseases of the maxillofacial region, and several other reasons. [7] [8]. Thus, the analysis of the above problems shows that the study and proposal for rational isolation of the torus, as well as the use of methods to improve the quality of removable dentures in the case of partial and complete absence of teeth, is a solution to the major problem of improving dental health for a certain contingent of the country's population [9]. This study aimed to improve the methods of manufacturing high-quality removable dentures using clinical-functional and physical-mechanical research methods, modern materials, and new techniques [10].

2 Materials and Methods

Among the patients who applied to the Tashkent State Dental Institute, 33 patients were selected and underwent orthopedic dental treatment. 20 patients were diagnosed with complete toothless in the upper jaw and 13 patients with partial toothless in the lower jaw. The following types of dentures were manufactured : complete removable plate dentures for the upper jaw (maxillary), in the presence of a palatal torus (20 patients), and partial removable plate dentures (13 patients). Clinical-dental and special research methods have been used, such as studying pain sensitivity and compliance of the oral mucosa, and studying diagnostic models [11]. To obtain more accurate and objective information on the state of the denture bed in the presence of a torus, we designed an apparatus to determine the pain sensitivity and compliance of the oral mucosa, with the help of which the sensitivity parameters of the mucous membrane covering the torus were determined [12] [13]. Based on this, we proposed a clinical and functional classification of bone formation. The assessment of the quality of life associated with oral health in our study was performed using a validated Russian-language version of the OHIP-14 Dental Health Impact Profile questionnaire, which allows the assessment of the quality of life of dental patients according to criteria such as problems with eating, communication, and everyday life [14]. Dynamic observations were performed at 1 and 6 months, 1 year, and later after dental prosthetics. When planning treatment, we used the classification of edentulous jaws according to Oksman, the Supple classification for assessing the condition of the oral mucosa, and the severity of the torus determined by our clinical functional classification (patent for utility model RK No. 7577 dated 07/26/2022).

3 Results

We developed a basic diagram of a device for measuring the pain sensitivity of the oral mucosa, based on which a working device was created for work in an orthopedic dentistry clinic. The device we created received a patent from the Republic of Kazakhstan (patent for

utility model RK No. 6592 dated 08/19/2021). In the dentistry clinic, we managed to use this device ; for this, we accepted treatment and performed measurements in 20 patients aged 60 years and older with a complete absence of teeth. The measurement areas were determined for both the upper and lower jaws. On the upper jaw in areas 11, 12, 21, 22, 16, and 26 the anterior third of the palate and the area of the suture of the hard palate. Measurements were performed on the lower jaw in areas 31, 32, 41, and 42, as well as in the molars of 36 and 46 teeth.

The results of our study showed that the pain threshold in the area of the front teeth of the upper jaw showed from 20.0 g/mm². The maximum value is 40 g/mm². In the area of chewing teeth, the device readings fluctuated from 40 to 60 g/mm², in the area of the anterior third of the palate from 60 to 80 g/mm², and in the area of the hard palate suture, the indicators ranged from 20 to 60 g/mm². In the lower jaw, the pain threshold was in the area of the front teeth from 10 to 20 g/mm², the device showed a pain threshold from 30 to 50 g/mm² in the area of chewing teeth. The results of our study showed that pain sensitivity was most pronounced in the frontal section compared with the area of chewing teeth, almost twice as much, in both the upper and lower jaws [15]. When comparing device data in the frontal area, it was found that esthesiometer readings in the upper jaw were twice as high as those in the lower jaw (Table 1).

Table 1. Pain sensitivity in the area of the upper and lower jaw. (g/mm²).

Areas	Upper jaw	Lower jaw
Frontal teeth	20-40	10-20
Molars	40-60	30-50
Anterior third of the palate	60-80	
Hard palate suture	20-60	

Even in two patients, the maximum reading was 40 g/mm² in the area of the frontal teeth of the upper jaw. When comparing the device readings in the area of the chewing teeth of the upper and lower jaws, the highest readings were found in the upper jaw compared with the lower jaw data by 10 units. These data refer to the minimum and maximum readings used for comparison. The area of the anterior third of the palate had the lowest pain sensitivity, where the maximum readings reached 80.0 g/mm² and was slightly lower in the area of the suture of the third palate, where the maximum readings were 60.0 g/mm². The data obtained from our device were consistent with those reported in the literature. Therefore, according to our data, the threshold of pain irritation lies within 35-65 g/mm², which corresponds to our indicators. In our study, we focused on the complaints of patients who presented with various complaints and different pain intensities regardless of the shape and size of the torus. During an objective examination, the frequency of complaints depended more on the sensitivity of the mucous membrane covering the bone formation. The more sensitive the mucous membrane is, the more frequent and intense the pain under removable dentures [16]. Our studies to determine the pain sensitivity of the mucous membrane of the prosthetic bed showed that the most sensitive areas were the sharp bone protrusions, exostoses, and torus of the upper jaw. In some cases, it only touches upon the pain in the patient. Therefore, esthesiometry indicators ranged from 0 to ≥10 or more g/sm². The results of the objective examination and esthesiometry allowed us to identify orthopedic dentistry type III sensitivity of the oral mucosa covering the torus of the upper jaw. Below is a brief description of our classification, which forms the basis for the clinical classification of torus, depending on the degree of pain sensitivity of the oral mucosa.

Type I (class), low pain sensitivity of the oral mucosa, especially in the area of the torus, and sharp bone protrusions. Esthesiometric indicators were $0 > 10 \text{ g/sm}^2$. In Type II (class), the mucosa had moderate pain sensitivity. Esthesiometric indicators were as high as 10 g/sm^2 . Type III (class), highly sensitive pain sensitivity of the oral mucosa, especially in the area of the torus, and sharp bone protrusions. Esthesiometry indicators included $0\text{-}1.0 \text{ g/sm}^2$ pain that occurred when the torus surface was touched.

The distribution of the examined patients (20 people) by age was as follows: up to 60 years (17.9%), up to 70 years (37.5%), and over 70 years (44.6%). The largest number of those examined were women (61.5%). For patients with a complete absence of teeth, dentures with a soft lining of UFI Gel H (Germany) were made.

The conducted studies established that all the examined patients complained of impaired chewing and poor fixation of the dentures on the upper and lower jaw, depending on the condition of the denture bed [17]. Patients do not always objectively assess the condition of their dentures. For example, some patients had been using dentures for ≥ 10 years and considered them to be of good quality. Only an objective examination was possible to correctly assess the condition of the denture and to recommend replacing it. More than 80.0% of the patients complained of impaired aesthetics, speech, and pain under the dentures. There were significantly fewer complaints about the lack of stabilization, poor quality dentures, and the need to replace old dentures with new ones. After an objective examination and thorough conversation, the patients agreed on the need to replace their old dentures with new ones. Thus, almost all examined patients presented with a specific complaint regarding removable dentures. Objectively, the nature and frequency of complaints correspond to the degree of atrophy of the alveolar processes, the presence and severity of bone formations (especially the torus), the quality of the manufactured prostheses, and the hygiene of the dentures and oral cavity. To analyze the condition of patients with complete removable plate dentures and partial removable plate dentures in the absence of teeth, we considered it necessary to provide an extract from the outpatient cards of some patients.

Complications of the mucous membrane of the palate due to improper torus isolation. For example, 1. Patient K.M., 80 years old. For over 10 years, he had been using a removable plate denture with a complete absence of teeth in the upper jaw. According to the patient, dense bone formation on the palate does not interfere with the patient. He used the dentures well and provided hygienic care. He sought help in correcting the occlusal relationships of the teeth in removable dentures. During objective examination of the oral cavity. According to Oksman, the alveolar process is uniformly atrophied (class II). The mucous membrane of the prosthetic bed in the area of torus isolation was hyperemic and hypertrophied. (Figure 1).



Fig. 1. Trauma of the oral mucosa.

A new miniature form of palate was created in the oral cavity from the inflamed hypertrophied mucous membrane. The patient was painless to touch and did not experience bleeding. (Figure 2).



Fig. 2. Hypertrophy of the alveolar mucosa

The mucous membrane of the alveolar process in the frontal area is hypertrophied and painless upon palpation, and the stroma and structure of the mucous membrane are preserved. (Figure 3).



Fig. 3. Painlessness of the hyperemic mucous membrane of the oral cavity

Examination of the prosthesis used by the patient showed a clear isolation boundary on the base of the removable dentures with a rounded shape. The boundaries of the isolated area on the prosthesis were not uniform and there were several protrusions along the edge of the isolation. The hygienic condition of the prostheses was good (Figure 4).



Fig. 4. Patient's removable denture

On palpation, there is dense bone formation on the palate, which does not protrude above the level of the mucous membrane. The patient had new removable dentures without isolation of the dense bone base on the palate. The patient had been using dentures for more than a year, with no complaints. The patient and denture were in a good condition.

Patient P. K., 54 years old. Application to rational prosthetics. The existing bridge prosthesis was removed, and the patient wanted to restore the fixed prosthesis. During an objective examination, protruding bone formation in the form of a ball was found on the back third of the palate, which occupied a significant part of the palate. According to the patient, this formation has been present since childhood and does not cause discomfort (Figure 5).



Fig. 5. The presence of a bone formation on the palate

During the objective examination, teeth 13 and 14 were missing from the oral cavity. Supporting teeth 12 and 15 were discolored and acquired a dark color. It is noticeable that the food got under the bridge prosthesis, which led to the decalcification of the supporting teeth. The supporting tooth 16 was so destroyed that only its palatine root was visible. The mucous membranes inside the supporting teeth were hyperemic and edematous. On the surface of the palate, closer to its back, a large formation covered with a mucous membrane of normal color is visible. The formation was painless on palpation. The formation consisted of two egg-shaped formations with a bridge in the middle. The painless middle depression extends over the entire surface of bone formation. On bone formation closer to the pharynx,

two protrusions from the mucous membrane were noticeable on the surface of the bone formation. They were mobile and painless. In general, bone formation is painless and the mucous membrane on its surface does not change in color. In general, the patient did not experience any discomfort due to this formation. Therefore, we decided to conduct dispensary observations. Conduct treatment of the supporting teeth and create a new bridge prosthesis for patients. This patient is unique in that, in the literature and in our practice, a torus appears only in the complete absence of teeth in the upper jaw. In this regard, the appearance of the torus in our patient remains unclear. Further observation of such large ones will allow us to achieve certain successes in further research.

Patient B.M., 74 years old, with a pronounced torus and complete absence of teeth on the upper jaw. The oral mucosa in the patient's oral cavity was pale pink and moderately moist. The frenulum of the upper and lower lips is attached to the middle of the alveolar ridge. Alveolar process atrophy grade II according to Oksman and mucosal compliance type II according to Suple on the upper jaw. On palpation of the hard palate, slight pain sensitivity of the oral mucosa in the torus area was observed. When pressing on the torus, it was painless (Figure 6 and 7).



Fig. 6. Condition of the upper jaw



Fig. 7. Condition of the lower jaw

When examining the torus with a device for determining the pain sensitivity of the oral mucosa, the esthesiometry values were up to 10 g/sm². In the oral cavity, there are completely removable plate dentures on the upper jaw made of pink acrylic base plastic (Figure 8).



Fig. 8. In the oral cavity there is an old complete removable denture of the upper jaw

Severe abrasion of the plastic teeth was observed. The borders of the upper jaw prosthesis are shortened on the buccal and labial sides, do not reach the transitional fold, and the tubercle of the upper jaw is not completely covered. The prosthesis does not meet the clinical and technical requirements. Fixation of the upper jaw prosthesis was unsatisfactory. A bilateral terminal defect was observed in the lower jaw. The remaining teeth in the lower jaw are stable. Uniform atrophy of the alveolar ridge has also been observed in the lower jaw.

Treatment: The first stage involved the fabrication of metal-ceramic crowns. Mandibular prostheses have traditionally been made. All stages of making fully removable plate prostheses were carried out according to the generally accepted method (Figure 9).



Fig. 9. Wax composition of a complete removable denture

At the prosthesis base modeling stage, we isolated the torus to the thickness of the oral mucosa compliance, that is, to a thickness of 0.4-0.6 mm. After fitting and handling the prostheses, the patient was provided with recommendations on the care and use of the prostheses (Figure 10).



Fig. 10. New removable dentures in the oral cavity

4 Discussion

The patient had been using prostheses for more than a year and had no complaints. In 50.0% of the patients examined, poor fixation and pain under complete removable plate dentures were due to the severity and sensitivity of the torus on the upper jaw. Such bone formation is unfavorable for prosthetics. According to K. L. Hait, the palatine ridge is considered a variant of the normal structure, which is not only a consequence of the overgrowth of the palatine suture but also other reasons. Therefore, the author classified the torus according to the shape of the bone formation as fusiform, ovoid, mixed, lobular, or atypical. By localizing the torus, he identified the central, posterior, and total torus. The authors did not highlight any features of dental prosthetics. Based on our clinical experience, we recommend a clinical classification of torus depending on the pain sensitivity of the oral mucosa, which provides the clinician with successful orthopedic treatment of patients with torus in the complete absence of teeth.

Type I (class) : low sensitivity, but bone formations with unclear boundaries, quite voluminous, the mucous membrane has sufficient thickness, and painful sensations appear with strong pressure ; esthesiometry indices are more than 10 g/sm². This type is often found in patients with a wide flat palatine vault, moderately or almost absent alveolar process, and weakly expressed tubercles. The bone base was uniformly dense and painless. It has been found in patients who have used dentures for a very long time or have lost teeth a long time ago. Often, one can find multiple removals of loose teeth can be found in the anamnesis.

Type (class) II: bone formation with distinct borders, thin mucous membrane, and pain is determined by pressure and palpation; esthesiometry indices of up to 10 g/sm². Average atrophy of alveolar processes. The palatine vault area was relatively high. The tubercles of the upper jaw are expressed and preserved, the torus is visible and has a different shape, and can be located in the anterior, middle, or posterior part of the palate. The mucous membrane of the torus was uniformly thinned. In anamnesis, tooth loss occurred a long time ago. Removable dentures were used regularly. Both successful and unsuccessful dentures were also observed.

Type III (class): the palatine torus has a clear or pronounced border, can occupy a large area of the palatine suture, the mucous membrane is thin, atrophic, and painful when touched, upon examination the relief of the bone formation is noticeable, esthesiometry indicators are 0-1.0 g/sm². The upper jaw was narrowed, the alveolar process was expressed, minor atrophy was noted, and the torus was visible with sharp surfaces. Often, the torus is formed by suturing of the hard palate and can continue from the front to the back of the palate. The elevating torus has the greatest convexity. The base of the bone formation is less painful on palpation. The greatest pain occurred at the top of the torus. It occurs in patients who have lost their teeth in recent years and have problems with bone metabolism. Anamnesis often includes complex extractions and anomalies in the development of the jawbones and teeth.

To solve these clinical problems, we propose the following methods of torus isolation : I-type (class) production of removable dentures with mandatory isolation of the torus area, any material described in the literature. However, we recommend heat-resistant silicone 0.4-0.6 mm thick. II - type (class) of removable dentures using two-layer bases. Isolation is carried out using silicone with a thickness of 1.0 layer of base wax, i.e. by 0.6-0.8 mm. III - type (class) of removable dentures using two-layer bases + isolation using silicone with a thickness of 2 layers of base and clasp wax, i.e. by 1.2-1.4 mm. In our orthopedic dentistry clinic, we made dentures with a two-layer base for patients with a complete absence of teeth in class II and III of the clinical classification of torus, and for those who had the I type (class), dentures were made of acrylic plastics. Observations were performed at 1–12 months. In the first few days of using removable dentures with soft linings, patients anxiously expected a feeling of pain. Improvement in functional qualities allowed

patients to fully use the dentures immediately after the first day. Complaints were made regarding pain at certain points under the denture, which were easily eliminated. The patient fully performed the act of chewing and felt comfortable. After 3-10 days, they fully adapted, successfully used the dentures, did not complain, noted better fixation of the dentures, and the absence of pain under the denture, but some remained wary of the appearance of pain or possible breakage of the dentures. Clinical studies on the dynamics (6, 90, and 365 days) showed that the use of soft pads in removable dentures led to good fixation of complete removable plate dentures in 72.7% of cases and satisfactory fixation in 27.3% of cases. The results showed that after orthopedic dental treatment, the proportion of patients who considered their quality of life to be good increased significantly (78.4%), with the initial indicator (8.1%). In addition, 16.2% of patients considered their quality of life to be satisfactory, and only 5.4% continued to consider their quality of life to be unsatisfactory, although before prosthetics, this indicator was (5.1%). These data show that high-quality dental prosthetics improve the quality of life of our patients since this indicator changed for the better from 8.1% to 78.4%.

5 Conclusion

The method we proposed for isolating sharp bone protrusions in the form of a torus, based on studies of pain sensitivity, improved the effectiveness of prosthetics (good fixation of prostheses was noted in 72.7% of cases, satisfactory in 27.3%). But the patient's psychological unpreparedness for using prostheses, pain and fear of not being able to use them lead to some complications. In addition, prostheses due to the individuality of the organism may cause an allergic reaction in some patients or may not be able to adapt to the body. It is necessary to create alternative prostheses that can eliminate such problems in the future.

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