

**COMPARATIVE EVALUATION OF THE INFLUENCE OF VARIOUS
DESIGNS OF REMOVABLE DENTURES ON THE PROSTHETIC BED IN
CASE OF PARTIAL ABSENCE OF TEETH**



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Abstract: Partial absence of teeth is one of the most common pathologies of the dentition. To replace defects in the dentition in orthopedic dentistry, various designs of removable dentures are often used (S.A. Ponomarev, 2004; V.V. Brovko, Yu.V. Kresnikova, A.Yu. Maly, 2007; Yu.V. Kresnikova, 2008; A.B. Onufriev, 2009). Removable plate and clasp dentures are used to restore the integrity of the dentition. A distinctive feature of clasp prostheses is the transfer of most of the masticatory pressure on the abutment teeth through a system of support-retaining clasps. Lamellar prostheses transfer most of the load to the mucous membrane and bone tissue compared to clasp prostheses (G.P. Sosnin, 1981; A.P. Perevezentsev, 2002). This effect is not a physiological factor for these tissues.

Keywords: partially removable dentures, dentoalveolar system, relief of the prosthetic bed, antagonistic teeth

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Introduction. It is known that the constant impact of removable dentures on the underlying tissues is accompanied by a change in the relief of the prosthetic bed, resulting in a discrepancy between the basis of the prosthesis and the prosthetic bed (A. H. Fenton, 1994, Y. Igarashi, 1989; V. Yu. Kurlyandsky, 1962). The discrepancy between the relief of the base of the prosthesis and the prosthetic bed often causes an uneven distribution of masticatory pressure with the occurrence of overload zones in the underlying tissues. In such cases, orthopedic structures have a negative impact more than they perform a therapeutic and prophylactic function (A.N. Salnikov, 1991; T.I. Ibragimov, 2006). Atrophic changes in the tissues of the prosthetic bed often lead to the failure of the orthopedic structure and in the future can significantly complicate the repeated prosthetics of patients (V.A. Zagorsky, I.S. Redinov, 1993).

Carrying out regular follow-up examinations of patients using removable dentures helps to timely detect changes in the underlying tissues and prevent or slow down unwanted processes (A.N. Ryakhovsky, 1992). The generally accepted terms for control examinations are the same for patients with various designs of removable dentures. At the same time, the processes of atrophy under plate and clasp prostheses occur with different intensity, respectively, the frequency of control visits and the timing of relocation may differ.

Timely relining can not only stabilize the state of the tissues of the prosthetic bed, but also increase the period of use of prostheses. However, the authors did not

come to a consensus in determining the timing of relocation. Very often in everyday clinical practice, the need to relin the prosthesis is determined by a violation of its stability or balance (R. F. Souza, J. Marra, 2009). Sometimes relining of removable dentures is carried out when the patient already makes the relevant complaints.

The question of the intensity of atrophic processes in the immediate and long-term periods after orthopedic treatment with various designs of removable dentures has not been sufficiently studied. This issue is relevant and requires careful study and obtaining more accurate data that will help improve the effectiveness of orthopedic treatment of partial absence of teeth using removable plate and clasp prostheses.

The purpose of the study was to increase the effectiveness of orthopedic treatment using various designs of removable dentures in patients with partial absence of teeth.

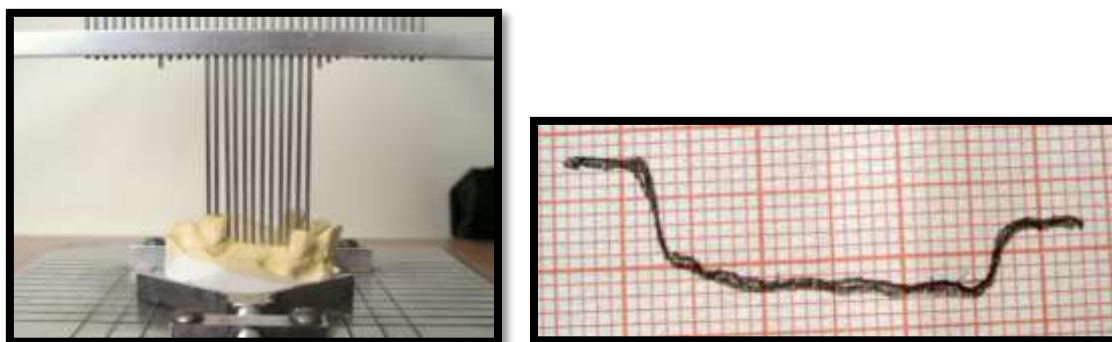
Material and methods. The study involved 103 patients (49 men and 54 women) using removable plate and clasp dentures. Patients were made 123 removable dentures, including 68 plate and 55 clasp dentures. The inclusion criteria were partial absence of teeth in the upper and lower jaws, primary prosthetics with removable plate and clasp prostheses, or if patients for various reasons did not use manufactured prostheses for more than two years, a history of tooth loss due to caries and its complications. The exclusion criteria were type IV of the mucous membrane according to Supple, tooth mobility I, II, III degree, systemic diseases (diabetes mellitus, thyroid disease, etc.), a single tooth in the jaw.

Patients were examined before prosthetics and 3, 6, 12, 18 and 24 months after fitting and applying removable structures. The examination included a clinical examination, which determined the color, moisture content of the mucous membrane, the presence or absence of pathological changes, the extent of defects in the dentition (according to the classification of E.I. Gavrilov), the type of design of the antagonist teeth, and the localization of defects in the dentition. Also, the examination determined the degree of atrophy of the edentulous alveolar process and the alveolar part, the presence of exostoses. The determination of the mobility of the remaining teeth, the level of bone tissue resorption was carried out, the reserve forces of the periodontium were evaluated according to the odonto-periodontogram of V.Yu. Kurlyandsky, taking into account the X-ray data.

The study of relief changes was carried out by profilometry and by comparing three-dimensional computer models, which were obtained by scanning plaster models at various periods of using removable dentures. Plaster models were made from impressions taken on the day of prosthesis placement and at follow-up examinations after 3, 6, 12, 18, and 24 months. For an objective assessment of

changes in the relief of the prosthetic bed on plaster models, impressions were obtained with identical pressure on the mucous membrane to display the relief of the underlying tissues under the same compression conditions, for which an original technique was developed (Nevskaya V.V., Malyi A.Yu., Shibeko V. A., Morozov K.A., 2009) .

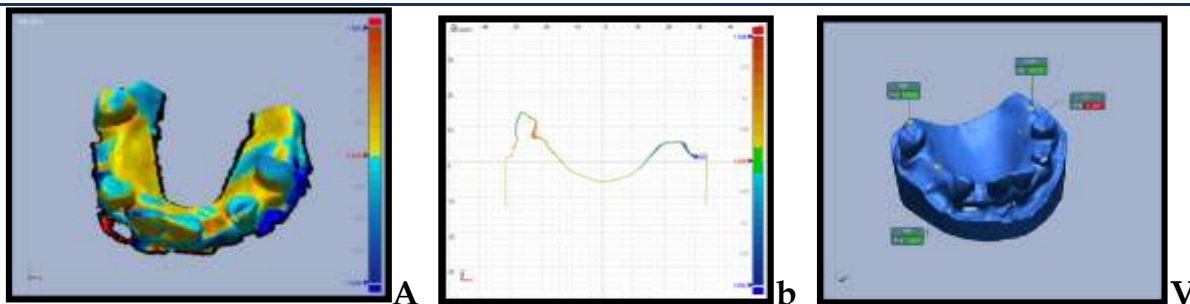
For the graphical method of registering the contour of the relief of the prosthetic bed and the subsequent comparison of the graphs, a profilometer device was used. The registration of the relief contour was carried out according to the well-known method (V.Yu. Milikevich , A.P. Kibkalo , 1984): the plaster model is fixed on the movable table of the profilometer, after which the measuring rods are lowered, and the upper border of the rods is outlined on graph paper. The graphs are compared by matching the lines in the area of the abutment teeth, the amount of discrepancy between the alveolar process or the alveolar part is calculated. 615 plaster models were studied by profilometry (Fig. 1a, 1b).



a b

Rice. 1. Determination of changes in the relief of the prosthetic bed by the method of profilometry : a) a plaster model fixed in a profilometer when receiving a profilogram ; b) profilograms of plaster models, combined along the relief of the supporting teeth.

Three-dimensional scanning of plaster models was carried out on the device " Stereo SCAN 3D" (Germany) with an accuracy of 0,01 mm. Three-dimensional computer images of plaster models at various periods of use of removable dentures were combined using the Rapid Form ". The combination was carried out according to the relief of the abutment teeth. Visually, the change in the relief of the prosthetic bed was assessed by the color scheme of the three-dimensional model, which allows you to determine magnitude and localization of changes (Fig. 2a). The program made it possible to estimate the magnitude of the discrepancy from graphs in various sections of the three-dimensional model (Fig. 2b) and from markers with numerical values of relief changes (Fig. 2c).



Rice. Fig. 2. Three-dimensional models of the upper jaw of patient K. in various windows of the Rapid Form »: a) the degree of relief discrepancy is displayed in different colors of the model (blue color indicates changes in the direction of volume reduction, red - in the direction of volume increase); b) the degree of terrain discrepancy is displayed in the form of graphs in various sections of the model; c) the degree of terrain discrepancy is displayed by numerical values on the markers.

A total of 285 plaster models were examined by 3D scanning.

The compliance of the mucous membrane of the prosthetic bed was studied in order to identify a possible effect on the change in the relief of the tissues of the prosthetic bed when using removable dentures. The study was carried out with an improved device for measuring compliance with a dosed load D.I. Chernov (1964) at certain points (zones) on the alveolar process of the upper jaw, the hard palate and the alveolar part of the lower jaw. On the upper jaw, measurements were taken at the top of the alveolar process in the region of the missing second molars (zone 1), first premolars (zone 2), frenulum of the upper lip (zone 3), at the intersection of the median line of the hard palate with a horizontal line passing at the level of the canines (4 zone), in the area 2 mm anterior to the blind pits (5 zone) and at the intersection of the line "A" with a longitudinal line passing at the level of the first premolars (6 zone). On the lower jaw, measurements were taken at the top of the alveolar part in the area of the second molars, second premolars and central incisors. A total of 3788 measurements were carried out.

Statistical data processing was carried out by the method of variation statistics with the calculation of the arithmetic mean values of confidence intervals and the standard deviation, followed by the calculation of the Student's test T and the probability of differences P. Differences were considered significant at values of $P < 0.05$.

Research results

The results of the study of changes in the relief of the prosthetic bed in patients using removable dentures.

The analysis of the data obtained showed that after three months of using the prostheses, changes in the relief of the prosthetic bed were not determined or were insignificant both under the clasp and under the plate prostheses. Significant

changes in the relief of the prosthetic bed were determined after 6, 12, 18 and 24 months of using removable dentures.

Under laminar prostheses, changes took place more evenly in different parts of the alveolar process or alveolar part than under clasp prostheses. With end defects of the dentition under removable dentures in 99 patients (96.1%), the greatest changes in the tissues of the prosthetic bed occurred in the distal parts of the defect in the dentition.

However, when using laminar prostheses, these changes are 11.2% less than changes in the distal areas of end defects under clasp prostheses. When using clasp prostheses, 7.2% of patients showed an increase in the volume of marginal gingival tissues near the abutment teeth.

With included defects in the dentition under the clasp prostheses, a uniform change in the relief was observed (0.37 ± 0.04 mm), which is 2.2 times less pronounced than with the end defects of the dentition (0.8 ± 0.06 mm)

With included defects under laminar prostheses, changes in the relief of the prosthetic bed (0.61 ± 0.03 mm) develop more intensively by 64.8% than under clasp prostheses (0.37 ± 0.03 mm).

It should be noted that when using removable dentures, changes in the relief of the prosthetic bed occur not only at the top of the crest of the alveolar process, but also on its slopes, as a result of which it is possible to observe the displacement of the prosthesis during function not only in the vertical, but also in the transversal plane. In most cases (81.8%), the degree of change in the relief on the slopes of the alveolar processes was 16.1% - 23.2% less than the change in the relief at the top of the alveolar process or the alveolar part. In some cases, the degree of relief change on the slopes of the alveolar process or alveolar part was comparable to the changes on their tops.

When studying the influence of the length of the defect on the degree of change in the relief of the prosthetic bed, it was revealed that under the clasp and plate prostheses, minimal changes in the relief were observed with defects of small length (according to E.I. Gavrilov). With an increase in the length of the defect, the changes in the relief are more intense at all periods of use of plate and clasp prostheses. Under lamellar prostheses, the maximum values of relief changes are observed with defects of large length, under clasp prostheses - with defects of medium length (with end defects of large extent, clasp prostheses were not made) (see Fig. 2, 3). The intensity of changes in the relief of the prosthetic bed under the clasp and lamellar prostheses with defects of small extent during the first year are comparable. However, when defects are included under clasp prostheses, the intensity of relief change is less (increases to 50% in the first year) compared to changes in the relief of the prosthetic bed under lamellar prostheses with defects of

small extent (increases up to 150% per year). At the same time, the intensity of changes in the relief of the prosthetic bed under lamellar prostheses with defects of medium and large length in the first year of use increases up to 3 times. After 24 months, under clasp prostheses, the intensity of relief changes increases by 3 times, under laminar prostheses - from 3.5 to 5 times.

In a comparative assessment of the influence of various types of orthopedic structures on the degree of relief change, it was revealed that under clasp prostheses, the greatest changes in the relief of the prosthetic bed were observed in patients with fixed orthopedic structures on antagonist teeth (0.81 ± 0.06 mm). Minimal changes in the prosthetic bed were observed in patients with complete removable dentures on the antagonist jaw (0.35 ± 0.02 mm), which were almost 2 times less than with fixed structures on the antagonist teeth. With plate and clasp prostheses on the antagonistic jaw, the degree of relief change had intermediate values.

Under lamellar dentures, the highest relief changes were observed with fixed orthopedic structures on antagonist teeth (0.79 ± 0.08 mm), the least degree of relief change was observed with complete removable dentures on the antagonist jaw (0.4 ± 0.03 mm). Changes in the relief of the prosthetic bed with plate dentures on the antagonizing jaw (0.54 ± 0.04 mm) differ slightly from changes in the relief with complete removable dentures on the antagonizing jaw (0.4 ± 0.03 mm). With clasp prostheses on the antagonizing jaw, the changes in the relief of the prosthetic bed were almost 1.9 times greater than with complete removable dentures on the antagonizing jaw. Consequently, the change in the relief of the prosthetic bed under the clasp prostheses, with fixed orthopedic structures on the antagonist teeth, occurs 2.2 times more intensively compared to the changes in the relief with complete removable dentures on the antagonist jaw. In patients with lamellar prostheses on the antagonizing jaw, changes in the underlying tissues under the clasp prostheses occurred 37.3% less compared with patients with non-removable orthopedic constructions on antagonist teeth.

clasp prostheses on the antagonistic jaw, changes in the relief of the underlying tissues were 18.6% less compared to changes in the relief with fixed structures on the antagonist teeth. % less intense than in patients with clasp prostheses on the antagonist jaw and 27.6 % more intense than when using complete removable dentures on the opposing jaw. When using clasp dentures in both jaws, there is an increase in the degree of change in the relief of the prosthetic bed by 44.2% than with complete removable dentures on the antagonistic jaw.

When studying the influence of the localization of a defect in the dentition on the degree of change in the relief of the prosthetic bed, it was revealed that in the frontal sections the degree of change in the relief is less than with the localization of

defects in the lateral sections. In the lateral sections, where food is chewed, the alveolar process or the alveolar part perceive a greater load than the underlying tissues in the frontal section during biting. In the period from 12 to 24 months, changes in the relief of the prosthetic bed in the frontal section were insignificant (0.08 ± 0.01 mm), compared with changes in the first year of using prostheses (0.17 ± 0.03 mm). In the lateral section, the increase in the intensity of changes in the relief of the prosthetic bed in the period from 12 to 24 months is 34.6% of the magnitude of changes in the relief of the prosthetic bed up to 12 months. Under plate prostheses, changes in the relief of the prosthetic bed were more pronounced in the lateral and frontal sections than under clasp prostheses.

In the second year of using the prostheses, the relief changes in the frontal section were 0.17 ± 0.05 mm, in the lateral section - 0.18 ± 0.03 mm, which is almost the same. When analyzing the results of the study, it was revealed that the intensity of atrophic processes in the upper and lower jaws when using plate and clasp prostheses differed slightly. Therefore, the recommended timing of follow-up examinations and relocations for patients who use prostheses in the upper or lower jaws do not differ. The patterns of changes in the relief of tissues of the prosthetic bed in patients who use removable laminar and clasp prostheses for the first time have been deduced. These data were used to justify the timing of follow-up inspections, delayed corrections and relocations.

The results of changes in the compliance of the mucous membrane when using removable dentures.

When using plate prostheses, the maximum changes occur in areas with a pronounced submucosal or fatty layer (posterior third of the palate and peripheral zones). Minimal changes were observed in the region of the torus, alveolar process or alveolar part (Table 1).

Table 1

Changes in the compliance of the mucous membrane of the prosthetic bed when using removable lamellar dentures (in mm)

Areas of the prosthetic bed	Before prosthesis	In 3 months	In 6 months	After 12 months
1 zone	0.32 ± 0.03	0.26 ± 0.03	0.24 ± 0.04	0.24 ± 0.03
2 zone	0.34 ± 0.03	0.26 ± 0.04	0.25 ± 0.03	0.24 ± 0.02
3 zone	0.35 ± 0.03	0.3 ± 0.04	0.26 ± 0.03	0.24 ± 0.04
4 zone	0.46 ± 0.05	0.4 ± 0.04	0.36 ± 0.05	0.35 ± 0.04
5 zone	0.5 ± 0.04	0.42 ± 0.03	0.4 ± 0.05	0.4 ± 0.03
6 zone	0.98 ± 0.07	0.86 ± 0.06	0.81 ± 0.08	0.79 ± 0.08
Alveolar part of the lower	0.3 ± 0.02	0.25 ± 0.02	0.24 ± 0.02	0.23 ± 0.02

jaw				
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When using clasp prostheses, the maximum changes in the compliance of the mucous membrane occur in the distal parts of the alveolar process and the alveolar part. Minimal changes were observed in the region of the torus, peripheral areas of the palate, and the distal third of the palate. Perhaps this is due to the lack of a tight fit of the arch of the clasp prosthesis to the hard palate. Comparative evaluation shows that changes in mucosal compliance under plate prostheses are more pronounced than when using clasp prostheses. However, at the top of the alveolar process and the alveolar part, the changes in compliance under plate and clasp prostheses are almost the same. The values of changes in the compliance of the mucous membrane of the alveolar process and the alveolar part do not have significant differences (Table 2).

table 2

Changes in the mucous membrane of the prosthetic bed when using clasp prostheses (in mm)

Areas of the prosthetic bed	Before prosthesis	After 3 Months	Through 6 Months	Through 12 Months
1 zone	0.33 ± 0.04	0.27 ± 0.03	0.27 ± 0.03	0.26 ± 0.02
2 zone	0.32±0.03	0.27 ± 0.02	0.26 ± 0.02	0.26 ± 0.02
3 zone	0.34±0.03	0.3 ± 0.04	0.3 ± 0.03	0.31 ± 0.03
4 zone	0.47 ± 0.04	0.46 ± 0.03	0.44 ± 0.03	0.46 ± 0.04
5 zone	0.49±0.04	0.45 ± 0.03	0.44 ± 0.03	0.42 ± 0.03
6 zone	1.02±0.08	0.89±0.07	0.86 ± 0.07	0.8±0.05
Alveolar part of the lower jaw	0.33 ± 0.03	0.27 ± 0.03	0.26 ± 0.02	0.26±0.03

Under clasp and plate prostheses, the greatest changes occur in the first 3 months of using prostheses, which can be explained by increased pressure of the prosthesis base during chewing (see Table 2).

Correlation between indicators of changes in mucosal compliance and changes in the relief of tissues of the prosthetic bed has not been established. However, it was found that in the first three months, the compliance of the mucous membrane under removable dentures changes significantly. Subsequently, the compliance indicators almost do not change. At the same time, during the first three months, no changes in the relief of the prosthetic bed were revealed, and later on, the contour of the relief of the tissues of the prosthetic bed undergoes significant changes.

Conclusions

1. The intensity of changes in the relief of the prosthetic bed under removable dentures in the period from 3 to 12 months is greater than the changes in the period from 12 to 24 months. Under clasp prostheses with end defects from 12 to 24 months, changes in the relief of the prosthetic bed occur more intensely than under plate prostheses.

2. With end defects, changes in the relief of the prosthetic bed occur more intensely than with included defects under lamellar and clasp prostheses. With included defects, uniform changes in the relief under the plate and clasp prostheses were observed. The greatest changes in the relief of the prosthetic bed occur with end defects, defects of great length, with fixed structures on antagonist teeth, in the lateral sections of the dentition. The smallest changes in the relief of the prosthetic bed were observed with included defects, defects in the dentition of a small extent, with complete removable dentures on the antagonistic jaw, in the frontal part of the dentition.

3. Changes in the relief of the underlying tissues in the upper and lower jaws were similar in values, the differences were not statistically significant.

4. The magnitude of changes in mucosal compliance depends on the localization of the area of the prosthetic bed in proportion to the severity of the submucosal layer. The greatest changes in compliance are observed after 3 and 6 months of using removable dentures. The type of removable denture design does not affect the magnitude of the change in mucosal compliance.

5. The developed technique for obtaining impressions with the same pressure on the tissues of the prosthetic bed makes it possible to obtain impressions at different periods of patient management with an identical distribution of the pressure of the impression material on the mucous membrane of the prosthetic bed.

6. The developed algorithm for managing patients with removable lamellar dentures includes a set of preventive measures with recommended relining periods depending on the group and extent of the defect, as well as on the type of orthopedic structure on the opposing jaw, which makes it possible to increase the period of using laminar dentures.

7. In the developed algorithm for managing patients with clasp prostheses, a set of preventive measures is proposed with recommended terms of relocation depending on the group and extent of the defect, as well as on the type of orthopedic structure on the antagonist jaw, which reduces the frequency of complications.

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