MEDICINE

MATHEMATICAL JUSTIFICATION OF DESIGN OF REMOVABLE CLASPLESS DENTURE

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Abstract. Purpose: *To improve the orthopedic treatment of patients with partial edentulism by using the mathematical justification of removable dentures with claspless fixation.*

Methods: *The technique of making claspless partial dentures by using A-silicone material is based on the idea of using the elastic forces generated in the wedge-shaped body of elastic material under the influence of an external force, which resets the prosthesis. Based on the considerations, was developed a scheme of the model of the claspless denture and the mathematical modeling of the method of fixation of partial removable laminar dentures with elastic material, resulting in the special formula.*

Results: *After analyzing the results, we suggest to use in the clinic simplified table. With their help you can easily determine the rationality of claspless denture, which is planned to produce on the technology that we offer. For this you need to determine the ratio of the magnitude undercut and height of the inclined teeth and to compare them with the data tables.*

Conclusion: *Thus, the fixation and stabilization of the claspless denture will be carried out using wedge-shaped body of elastic material, the amount of which is calculated individually depending on the above parameters and fills the area between the denture and supporting teeth of the patient.*

Keywords: *removal partial dentures, A-silicone material, claspless denture, fixation of denture, design of denture.*

Using of partial removable laminar dentures with clasp fixation is difficult to solve the problem of aesthetics. Placing parts of clasp on the abutment teeth disrupts their usual appearance, makes visible metal parts during talking and smiling and often significantly violate the volume and shape of the external surface of the teeth, which significantly reduces the rate of habituation to the prosthesis [1].

In our opinion, clasp fixation of prostheses is quite hard, so using it, especially in the mesio-distal inclination of the teeth, can lead to overload the abutment teeth, further loosening and the rapid loss, and in some cases makes clasp fixation not possible [3].

The development of dental materials science, especially of the domestic production of structural and auxiliary dental materials, can meet the growing demands of aesthetics dentures, clinical and functional efficiency and terms of exploitations [4].

Purpose: To improve the orthopedic treatment of patients with partial edentulism by using the mathematical justification of removable dentures with claspless fixation.

Materials and methods: The technique of making claspless partial dentures by using A-silicone material is based on the idea of using the elastic forces generated in the wedge-shaped body of elastic material under the influence of an external force, which resets the prosthesis. Therefore, the main and indisputable condition of using this method of prosthesis is the possibility of constructing two wedge-shaped bodies of elastic material, which due to its elastic properties would hold the denture during function. In other words, you must have at least two abutment teeth, which have a mesiodistal inclination.

As you know, holding devices should be passive at rest and prove its properties only during functions [2]. If this condition is violated, then the holding devices are very harmful for the periodontium of the abutment teeth and will destabilize them in a very short period of time [5]. The same is true for the sphenoid form body by elastic material, which we use for the fixation of the prosthesis. But during a function, when the prosthesis under the influence of resetting efforts will move relative to the reference teeth in the vertical direction, it must develop an elastic force that would be moving the prosthesis on the 0.5-1 mm (within compliance of the mucous membrane of the alveolar process) was equal to or greater than resetting efforts. So, it should be designed carefully, considering the angle of the tooth crown, or the ratio of the magnitude of the undercut and height, as well as the elastic properties of the material used in the prosthesis. Based on these considerations, was developed a scheme of the model of the claspless denture (Fig.1) and the mathematical modeling of the method of fixation of partial removable laminar dentures with elastic material, resulting in the formula:

$$\frac{F}{2} = \frac{E * U * Ly * p^2}{L * (H - h)} * \ln \frac{H - U *]}{U * (H - h - p)}$$

This reflects the relationship between the magnitude of the external force (F) and the magnitude of the vector displacement of the prosthesis, under the influence of this force. Taken into account: friction force (F_{fr}), friction coefficient (k), the elastic modulus of the elastic material (E), displacement (U), undercut (p), additional undercut (H), gap (h), the angle of inclination of the tooth crown (a), the height of the crown (L), the removing of the prosthesis(+), putting on the prosthesis (-), length of contact with the tooth (Ly).

A simplified model of the claspless denture as follows:

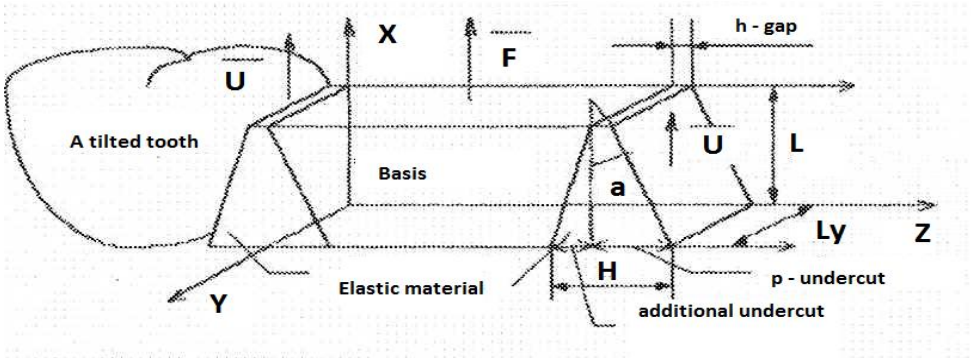

Fig. 1. The model of claspless denture

The gap (h) was set to 1 mm. the value of additional undercut set as half of the value of undercut. The gap and additional undercut necessary in order to ensure the introduction of the prosthesis on the prosthetic bed without damaging the layer of elastic material.

Results: After testing we found that the tensile strength at break is of 2.55 MPa, or 25.5 kg, elongation at break – 45,0%. For calculations, we determined the elastic modulus of A-silicone material according to Hooke's law:

$$\sigma = E * e$$

where σ is the tensile stress,
E - the modulus of elasticity,
e - relative elongation of the sample (in percent).
So,

$$E = \frac{\sigma}{e} * 100\%$$

which is of 5.67 kg.

Using these figures was made the calculation of the ratio of undercut and height by which denture under the power of 0.15 kg moves in a vertical direction by 0.5 mm relative to the tooth crown. Calculations were performed for all teeth upper and lower jaw, using the data of V. L. Ustimenko relative to the size of tooth crowns.

After analyzing the results, we suggest to use in the clinic simplified table. With their help you can easily determine the rationality of claspless denture, which is planned to produce with the technology that we offer. For this you need to determine the ratio of the magnitude undercut and height of the inclined teeth and to compare them with the data tables 1 and 2.

The most efficient should be considered claspless denture, if both of the inclined abutments have a ratio of the magnitude of undercut and height more than the ratio specified in the second column of the table, when the value F/2=0,3 kg U= 1 mm. In this case, it can be argued that claspless denture under the influence of resetting efforts 0,3 kg will move in the vertical direction less than 0.5 mm, and under the influence resetting efforts to 0.6 kg less than 1 mm. But if one or both of the sloping supporting the tooth have the ratio of the magnitude of undercut and a height of about one (an angle of about 45°), then there will be difficulties with the introduction of claspless dentures on the prosthetic bed.

Table 1. Justification of use claspless denture on the upper jaw

the ratio of the magnitude undercut and height of the inclined teeth			
forces resetting of the prosthesis	F/2=0,15 kg U= 1 mm	F/2=0,15 kg U= 0,5 mm F/2=0,3 kg U= 1 mm	F/2=0,3 kg U= 0,5 mm
medial cutter	0,24	0,40	0,71
lateral cutter	0,27	0,49	0,87
canine	0,23	0,41	0,76
the first premolar	0,22	0,41	0,73
the second premolar	0,22	0,41	0,75
the first molar	0,17	0,28	0,49
the second molar	0,15	0,29	0,50

Table 2. Justification of use claspless denture on the lower jaw

the ratio of the magnitude undercut and height of the inclined teeth			
forces resetting of the prosthesis	F/2=0,15 kg U= 1 mm	F/2=0,15 kg U= 0,5 mm F/2=0,3 kg U= 1 mm	F/2=0,3 kg U= 0,5 mm
medial cutter	0,3	0,58	1,00
lateral cutter	0,28	0,54	0,92
canine	0,28	0,50	0,85
the first premolar	0,24	0,47	0,85
the second premolar	0,22	0,41	0,82
the first molar	0,16	0,26	0,75
the second molar	0,14	0,27	0,50

If one or both of the sloping supporting teeth have a ratio of the magnitude of undercut and height more than the ratio stated in the first column of table, but less than it specified in the second column, then the design of claspless denture will be less rational. In this case, it can be argued that claspless denture under the influence of resetting efforts 0,3 kg will move in the vertical direction less than 1 mm.

Conclusions: Thus, the fixation and stabilization of the claspless denture will be carried out using wedge-shaped body of elastic material, the amount of which is calculated individually depending on the above parameters and fills the area between the denture and supporting teeth of the patient.

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