ISSN: 0975-766X
CODEN: IJPTFI
Available Online through
Research Article
www.ijptonline.com

PREREQUISITES TO THE FORMATION THE CONCEPTS OF "REVERSIBLE" AND “IRREVERSIBLE" TOOTH STABILITY

Alexander V. Tscymbalystov, Alexander A. Kopytov*, Elena V. Volobuyeva, Aleksandr A. Ponomarev
Belgorod State University, 308015, Russia, Belgorod, Pobedy str., 85.
Email: kopitov.aleks@yandex.ru

Received on 08-06-2016 *Accepted on 29-06-2016*

Abstract

There is a concept of "tooth stability”, which, according to dentists, is ensured by the state of periodontal tissue and alveolar bone. When discussing this concept, the experts draw attention to the interdental ligament, passing over the tops of the interdental partitions and connecting the adjacent teeth with the bundle of connective tissue fibers, as well as the severity of interproximal contacts, the teeth axes direction that forms the compensatory curves, and the ratio of intra- and extraalveolar parts of teeth. These clinical factors create conditions for a more uniform distribution of masticatory forces on the tooth periodontium. Physicists define the stability of physical bodies as follows: the most important condition that ensures the stability of the body relying upon several points is the presence of the resultant of the acting force moments within the area, which supports the body, or inside the contour formed by lines connecting the points of support, when projecting this body onto a plane or surface, where the body is located. Considering both approaches, it is possible to describe the clinical status and dynamics of the dental rehabilitation of patients in more detail.

Keywords: Periodontal tissue, Rehabilitation, "reversible" and "irreversible" tooth stability, Laser Doppler flowmetry, Gingival fluid.

Introduction

Incidence and severity of periodontal diseases recategorizes this nosology group as social problems [1-4]. Investigation of the occlusal factor in the occurrence and development of periodontal disease plays a significant role [5-7].

Objective of the research: comparative evaluation of the periodontal tissue response to occlusal loads, occurring after the restoration of consistency of the interproximal contacts by sealing the stable premolars and the premolars having lost more than 10% of the bearing surface projection.

Methods

The study involved dental patients (n=52), aged 18 to 32 years, with carious cavity (cavities) in the approximal surface of premolars. Based on tomographic studies and upon evaluation of the loss of the bearing surface projection of the premolars limiting the defect of the dental arch, two groups of patients were formed. The first group (n=25) included patients with no difference in intra-alveolar projection of the premolars, limiting the defect of the dental arch and contralateral teeth with expressed aproximal contacts. The second group was formed of patients (n=27) with the projection of the intra-alveolar part of the premolars limiting the defect of the dental arch differing by more than 10% of the projection of intra-alveolar parts of contralateral teeth (Table 1).

Table 1. Grouping of patients (n=52) in accordance with the localization of dental arch defect and loss of bearing surface of premolars limiting this defect.

Group 1 – patients with stable premolars (n=25)		Group 2 – patients with unstable premolars (n=27)	
Maxillary dental arch defect	Mandibular dental arch defect	Maxillary dental arch defect	Mandibular dental arch defect
12	13	12	15

Based on the recommendations of [8], the load-caused injury of the periodontal tissue near the premolars after using 1/5 of a pack of chewing gum for twenty minutes was evaluated by determining the gingival fluid exudation by the method [9] using 15×4 mm strips of filter paper. Time for getting the gingival fluid was 3 minutes [10]. The data obtained were compared with the data from table [11].

Evaluation criteria for periodontal response in the premolar area to loading by the number of gingival fluid exudation were as follows. Upon localization of the dental arch defect in the upper jaw, the size of the impregnation area was compared with reference values 0.253 ± 0.08 cm^2, and in the lower jaw - with the index value 0.229 ± 0.04 cm^2. These values correspond to the average impregnation area of filter paper strips in the area of the premolars with intact periodontal tissue.

Structural and functional changes in blood supply to the periodontal tissue were assessed with the use of laser Doppler flowmetry (LDF). The LDF-gram analysis was conducted according to standard procedure: M - arithmetic mean of the microcirculation level (perfusion units); δ - standard deviation of the oscillation amplitude of blood flow from the arithmetic mean M; Kv - variation coefficient, the relation between tissue perfusion (M) and standard deviation of the amplitude (δ), characterizing the microvascular vasomotor activity [12].

The next day, the integrity of the dental arch was restored by remodeling the aproximal contacts of the premolars by their sealing. After the implementation of the applied occlusal load, the response to loading of tooth periodontium with restored aproximal contacts was assessed. A month later, the patients were examined in order to assess the response of premolar periodontium to the applied load.

Main Part

Until the restoration of the aproximal contacts, the implementation of the applied occlusal load leads to an increase in gingival fluid exudation in the region of stable premolars, as compared with the data specific to the intact periodontal tissue, by 42.6 - 44.9%. The second group had increase in the amount of gingival fluid near the premolars having lost more than 10% of bearing surface projection by 96.9 – 99.2%. Consequently, an increase in gingival fluid exudation in the second group has been caused by periodontal occlusal loading. In the second group, the increase in exudation develops under the influence of occlusal trauma caused by the increasing specific pressure on the operating periodontium, due to the reduction of the bearing surface projection. According to the LDF, the first group of patients, as compared with intact periodontal tissue, had the level of capillary blood flow increasing by 10.9%, and the second group - by 20.1%. While the index of the standard deviation of erythrocyte flow fluctuations decreased in the first group by 3.2%, and in the second group - by 9.8%. Vascular vasomotor activity in the premolar area in the first group of patients decreased by 11.6%, and in the second group - by 23.7%. The LDF data indicate a pronounced venous congestion in the microcirculature in premolars in patients of both groups. According to [13], the patients with premolars having lost more than 10% of the bearing surface projection had the value of vascular vasomotor activity corresponding to the values typical of mild periodontitis (Table 2).

After the restoration of dental arch integrity, the implementation of the occlusal load caused an increase in the amount of gingival fluid in the first group by 21.3- 26.2%. The LDF data in the first group show that the applied occlusal load does not lead to significant disturbance of blood flow, which indicates its physiological effect. Restoration of the consistency of occlusal contacts and return to the translational motion of premolars under the influence of the occlusal load ensures the physiological functioning of the periodontal tissue.

In the second group of patients, the gingival fluid exudation has decreased as compared with the previous observation, but exceeded the indicators specific to the intact periodontal tissue by 55.8-57.3%. According to LDF data, the capillary blood flow level has also decreased, but still exceeded the data specific to the intact periodontal tissue by 12%. Standard deviation index of erythrocytes flow fluctuations has increased as compared with the

previous observations, however, was lower than the normal by 5.4%. After the restoration of the dental arch integrity, the increase of K_v index indicates causal recovery of the aproximal contacts, leading to a decrease congestion in the venous region of the microvasculature. This venous congestion in the microcirculature of the premolars is maintained, since the projection of bearing surface of the studied teeth remains 10% smaller than the same of contralateral teeth, which causes an increase in the specific pressure and excessive loading of periodontal tissue.

Table 2. Effect of aproximal contacts recovery on the clinical and functional status of periodontium of the premolars limiting the dental arch defect.

		Prior to approximal contacts recovery		After approximal contacts recovery		One month after approximal contacts recovery	
Indicators		Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
Impregnation area, cm^2	u/j	0.361±0.1* (42.6%)	0.504±0.12 (99.2%)	0.307±0.08* (21.3%)	0.398±0.12 (57.3%)	0.317±0.09* (25.2%)	0.416±0.14 (64.4%)
	l/j	0.332±0.1* (44.9%)	0.451±0.11 (96.9 %)	0.289±0.09* (26.2%)	0.357±0.11 (55.8 %)	0.301±0.09* (31.4%)	0.357±0.11 (62.4%)
M		19.31±1.3* (10.9%)	20.88±1.4 (20.1%)	18.4±1.3* (6.8%)	19.66±1.4 (12.0%)	18.1±1.3* (4.1%)	18.6±1.4 (6.9%)
δ		2.67±0.4***** (3.2%)	2.49±0.5 (9.8%)	2.71±0.4*****	2.61±0.5 (5.4%)	2.72±0.4*****	2.62±0.5 (5.3%)
K_v		13.8±1.9***** (11.6%)	11.9±1.9 (23.7%)	14.7±1.9***** (6.0%)	13.2±1.9 (15.4%)	15.0±1.9***** (3.9%)	13.2±1.9 (14.1%)

*Differences between the indicators of the first and second groups are statistically significant at the error level of not more than 5% [$P \leq 0.05$].

One month after recovery of the approximal contacts, the gingival fluid amount increases in response to the applied occlusal load in both groups as compared with the previous observation, and exceeds the level typical of the intact periodontium by 25.2-31.4% in the first group, and by 62.4 -64.4% in the second group.

According to LDF data, in the first group of patients, the occlusal load caused a slight increase in blood flow, normally maintained by the microcirculature as far as it increases. No significant changes in vasomotor activity near the stable premolars have been observed. The applied occlusal load leads to functional hyperemia. The level of capillary blood flow in the second group decreases, as compared with the previous observation, but exceeds the

normal by 6.9%. While standard deviation index of erythrocytes flow fluctuations remains lower than the values typical of intact periodontum by 5.3%. A reduced by 14.1% vasomotor activity indicates the occurrence of venous congestion in response to occlusal load in the microvasculature of the premolars with restored interproximal contacts.

Results and Discussion

In our opinion, it is necessary to distinguish two components of tooth stability loss. The first, "reversible" component starts with the reduced consistency of approximal contact, and ends with its loss. The adequacy of approximal contacts causes translational movement of the tooth, when all tooth points move at the same rate in parallel and in contact with the bone, with equal stresses and deformations occuring at each point [14]. In this case, no periodontal hydropreparation or infection occurs. This biophysical state of the system is defined as an intact periodontium, to which the known values of clinical and functional parameters correspond.

Decrease in consistency of the aproximal contacts is accompained by increase in off-axis component of the resultant of the acting force moments. During bolus destruction, the period of tooth rotation time increases. The rotary motion differs from the progressive one by need to account for the force moments. Upon rotational motion, the speed and distance of movement as well as deformities are different and determined by the distance from the center of rotation. Approximal points of the root and the crown move similarly in the radial direction, while in the linear direction their movement is different. Consequently, at the same occlusal loads, the translational and rotational tooth movements are accompanied by different degree of periodontal deformity. From this perspective, there is a need to consider two hydrodynamic aspects of periodontitis:

- high load on some parts of the periodontal tissue generates an increased trophic request and, in the absence of its satisfaction, leads to the development of pre-clinical conditions, reflected in the change of clinical and functional parameters;
- periodontal hydropreparation and infection possible as a consequece of functional overload can lead to the development of the disease, regardless of the level of satisfaction of the increased trophic request.

Another important role in the periodontitis genesis is played by solid deformities. Decrease in consistency of the aproximal contacts is accompained by disappearance of coaxiality of the resultant of acting force moments and the tooth axis.

The chewing load, previously evenly distributed to dental arch periodontium, deforms unevenly the periodontal elements. It activates the pathological process leading to a decrease in the functional value of periodontal tissue and

changes teeth axis accompanied by their convergence. Further effect of occlusal load changes the state of the system from the "reducing consistency of interproximal contacts" into the "loss of approximal contact".

Failure of consistency of approximal contact is the cause of the transition to the "irreversible" component of tooth stability loss. In this case, occlusal loading leads to its rotational movement. Translational movement is possible only when the resultant of acting force moments and the tooth axis coincide. The probability of such coincidence is extremely low, subject to the form of the tooth occlusal surfaces. Rotation results in the destruction of the interdental septum and reduction of intra-alveolar part of the tooth.

Over time, the tooth's center of gravity changes it position to extra-alveolar. At the n-th moment of occlusion, the direction of the resultant of acting force moments approaches to the border, obtained by projecting intra-alveolar part of the tooth on the line parallel to the occlusal plane. Clinical pattern of periodontal disease develops, which severity is demonstrated by the values of clinical and functional parameters, and significantly different characteristics of intact periodontium.

Further reduction of intra-alveolar part of the tooth leads to reduction of its projection. At the same time, the tooth-bearing surface decreases. Therefore, it increases the probability of the resultant of acting force moments to go beyond the contour of the intra-alveolar tooth projection. In this case, the tooth becomes unstable.

Summary

In the absence of aproximal contacts, the effect of the applied chewing load leads to an increase in gingival fluid exudation near the teeth with a constant area of the intra-alveolar projection by 42.6-44.9%. The same indicator increased by 96.9-99.2% in the teeth having the intra-alveolar projected area decreasing by 10%. Functional changes in capillary blood flow are also more pronounced in the second group, where the vascular vasomotor activity decreased by 23.7%, and in the first group - by 11.6%.

One month after approximal contacts recovery, the effect of the applied chewing load leads to an increase in gingival fluid exudation of the first group by 25.2-31.4%. According to LDF data, no significant changes in vasomotor activity have been observed in the first group. The applied occlusal load leads to functional hyperemia. The second group had the amount of gingival fluid exudation increasing by 62.4-64.4%. A reduced by 14.1% vasomotor activity indicates the maintenance of venous congestion.

Different response of the periodontal tissue of the teeth with a reduced and constant projection of the bearing surface to the occlusal load after restoring the consistency of aproximal contacts allows us to consider their remodeling as a

mechanism of recovering the "reversible" tooth stability. The “irreversible" tooth stability is characterized by a reduced projection of bearing surface.

References

1. Friedman, P.K., Kaufman, L.B., Steven, L., Karpas, 2014. Oral Health Disparity in Older Adults: Dental Decay and Tooth Loss Dental Clinics, 58 (4): 757–770.
2. Tabeta, K., Yoshie, H., Yamazaki, K., 2014. Current evidence and biological plausibility linking periodontitis to atherosclerotic cardiovascular disease Japanese Dental Science Review, 50 (3): 55–62.
3. Irani, F.C., Wassall, R.R., Preshaw, P.M., 2015. Impact of periodontal status on oral health-related quality of life in patients with and without type 2 diabetes Journal of Dentistry, 43 (5): 506–511.
4. Cotton, G.C., Meledandri, C.J., Schwass, D.R., Tompkins, G., 2015. Topical antibacterial gel for treatment of periodontal disease Dental Materials, 31 (17) :39-42
5. Ziazikov M.D., Stepanov A.G., Dzhalalova M.V., Arutiunov S.D., 2015. Effect of the angle functional load on the bone tissue of the jaw, and tooth armored with transdental implant. Russian Dental Journal, 19 (6): 7-9.
6. Korol D.M., Nikolov V.V., Onipko E.L., Efimenko A.S., 2015. Determination of the intensity of occlusal pressure in patients at orthopedic examination. Modern medicine: current issues, 46-47: 40-46.
7. Tscymbalystov, A.V., Kopytov, A.A., Voytyatskaya, I.V., Trifonov, B.V. 2014. Impact of the provisional splinting on the dynamics of restoration of the clinical-functional status of the incisor parodontium that have lost their stability to different extents. Research Journal of Pharmaceutical, Biological and Chemical Sciences, 5(6): 1406-1409.
8. Harzer, W., 1978. The collection and evaluation of sulcusfluidinthejuvenileperi odontium. Stomatology DDR, 28:164-170.
9. Brill, N., Krasse, B., 1958. The passage of tissue fluid into the clinically bealty gingival pocket. Actaodontology Scand,16:232-245.
10. Barer G.M., Khalitova E.S., Kocherzhinskii V.V., Lukinykh L.M., 1986. Quantitative characteristics of gingival fluid in patients with untreated periodontitis. Dentistry. 5: 24 -26.
11. Kopytov A.A., Riakhovskii A.N., Tsimbalistov A.V., Kopytov A.A., 2011. Method of determining the periodontal disease conditions. Patent RF No. 2435505.

12. Krechina E.K., Maslovf V.V., Rakhimova E.N., Shidova A.V., 2008. Determination of blood circulation in the periodontal tissues using methods of laser and Doppler ultrasound. FSU "Central Research Institute for Dentistry and Maxillofacial Surgery of the Federal Agency for high-tech medical care", P. 27.
13. Belokopytova V.V. Evaluation criteria for the degree of microcirculatory disturbances in periodontal diseases: Ph.D. thesis in Med. Sciences: 14.00.21/ Moscow, 2002 - P. 127.
14. Tscymbalystov, A.V., Kopytov, A.A., Voytyatskaya, I.V., Trifonov, B.V., 2014. Intensity of approximal contacts as a factor which conditions direction of seepage of biologic fluid in a periodontal area Research Journal of Pharmaceutical, Biological and Chemical Sciences, 5 (6): 1410-1414.

Corresponding Author:
Alexander A. Kopytov*,
Email: *kopitov.aleks@yandex.ru*