

Study of hemodynamics of the mucous membrane of the prosthetic area at the stages of treatment of patients with removable dentures according to the improved technique

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Study of hemodynamics of the mucous membrane of the prosthetic area at the stages of treatment of patients with removable dentures according to the improved technique

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Laser Doppler flowmetry is a simple, atraumatic, safe and reliable method of functional diagnosis, so this method is widely used in almost all medical disciplines that require the study of microcirculation in humans.

The aim of the study was to improve the quality of orthopedic treatment of patients with complete adentia by making removable orthopedic structures according to an improved method and under the control of studying the hemodynamics of the mucous membrane of the prosthetic area.

Materials and methods. The study of blood microcirculation in the mucous membrane of the prosthetic area was performed in 20 patients of the comparison group using prostheses made by standard methods and in 20 patients of the study group with prostheses made by advanced methods, before prosthetics and at different times after fixation of constructions: 1 day, 1 month and 1 year.

Results. Our results showed that the microcirculation in the control group before prosthesis significantly ($p < 0,001$) differs from the values obtained after 1 year after use, indicating an increase in vascular perfusion. Regarding the main group – the indicators for this parameter did not differ significantly ($p > 0,05$). The study of flaxmotion index revealed perfusion variability in the control group – from 1.09 to 1.39, but this difference is not significant ($p > 0,05$). In the main group the difference is not significant, $p > 0,05$. Analyzing the indicators of intravascular resistance, we saw a significant ($p < 0,05$) difference in the control group between the initial stage of the study and the last, while in patients of the main group the indicators at the same stages did not differ significantly ($p > 0,05$).

Conclusion. Prostheses made by our improved method have a more favorable effect on the capillary circulation of the prosthetic area throughout the period of use of prostheses on the fabric of the prosthetic area.

Key words: removable dentures, microcirculation, prosthetic area

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Badanie hemodynamiki błony śluzowej okolicy protetycznej na etapach leczenia pacjentów z protezami ruchomymi według ulepszonej techniki

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Laserowa dopplerowska flowmetria jest prostą, atraumatyczną, bezpieczną i niezawodną metodą diagnostyki funkcjonalnej, dlatego znajduje ona szerokie zastosowanie w niemal wszystkich dyscyplinach medycznych, które wymagają badania mikrokrążenia u ludzi.

Celem pracy była poprawa jakości leczenia ortopedycznego pacjentów z całkowitym bezzębiem poprzez wykonanie ruchomych struktur ortopedycznych według ulepszonej metody i pod kontrolą badania hemodynamiki błony śluzowej okolicy protetycznej.

Materiały i metody. Badanie mikrokrążenia w błonie śluzowej okolicy protetycznej przeprowadzono u 20 pacjentów z grupy porównawczej z protezami wykonanymi metodami standardowymi oraz u 20 pacjentów z grupy badanej z protezami wykonanymi metodami zaawansowanymi, przed protezami i w różnym czasie po mocowanie konstrukcji: 1 dzień, 1 miesiąc i 1 rok.

Wyniki. Nasze wyniki wykazały, że mikrokrążenie w grupie kontrolnej przed wszczęciem protezy istotnie ($p < 0,001$) różni się od wartości uzyskanych po 1 roku od założenia, co wskazuje na zwiększenie perfuzji naczyniowej. W grupie głównej wskaźniki dla tego parametru nie różniły się istotnie ($p < 0,05$). Badanie wskaźnika flaxmotion wykazało zmienność perfuzji w grupie kontrolnej – od 1,09 do 1,39, ale różnica ta nie jest istotna ($p < 0,05$). W grupie głównej różnica nie jest istotna, $p > 0,05$. Analizując wskaźniki oporu wewnątrznaczyniowego, zauważyliśmy istotną ($p < 0,05$) różnicę w grupie kontrolnej między początkowym i ostatnim etapem badania, podczas gdy u pacjentów z grupy głównej wskaźniki na tych samych etapach nie różniły się istotnie ($p > 0,05$).

Wniosek. Protezy wykonane naszą ulepszoną metodą korzystnie wpływają na krążenie kapilarne okolicy protetycznej przez cały okres użytkowania protez na tkance obszaru protetycznego.

Słowa kluczowe: protezy ruchome, mikrokrążenie, obszar protetyczny

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Systematic analysis of modern scientific data convincingly proves the leading role of the microcirculatory system in the pathogenesis of many dental diseases. However, the development of pathogenetic mechanisms responsible for the morphofunctional state of the mucous membrane of the prosthetic area in the treatment of patients with removable acrylic prostheses has not been fully studied [1,3,9].

Clinical and functional studies show that patients who use removable dentures have changes in the microcirculatory tract in the oral mucosa. Until now, there are no objective, quantitative characteristics of the parameters of capillary blood flow of the mucous membrane of the prosthetic area of patients who have made removable orthopedic structures, the detection of

which would adequately assess the effectiveness of orthopedic treatment and reduce the risk of complications [2,4,6].

According to most domestic and foreign researchers, Laser Doppler Flowmetry (LDF) is a simple, atraumatic, safe and reliable method of functional diagnosis, so this method is widely used in almost all medical disciplines that require the study of microcirculation in humans [2].

The use of LDF in medicine allows: first, to assess the state and disorders of blood microcirculation, improving the quality of diagnosis of various diseases by recognizing them in the early stages of development; secondly, to form a basis for a deeper understanding of the pathogenesis of emerging disorders of microcirculation; thirdly, to exercise objective control

over the treatment and prevention measures and individual selection of pharmacological agents [8, 10].

In dentistry, LDF is most effective for the quantitative determination of linear and volumetric parameters of the structure of capillary blood flow, as well as the intensity of hemodynamic processes in the tissues of the mucous membrane at the level of the attached gums.

Comprehensive assessment of the results of capillary blood flow by LDF method will allow an objective assessment of topographic features and viability of microcirculatory tissues in the oral mucosa after prosthetics of the patient with removable orthopedic structures, will avoid, at the stage of treatment of prosthetic area structures on the oral mucosa of the patient, obtaining significant results for orthopedic dentistry [5, 11].

The aim of the study was to improve the quality of orthopedic treatment of patients with complete adentia by making removable orthopedic structures according to an improved method and under the control of studying the hemodynamics of the mucous membrane of the prosthetic area.

MATERIALS AND METHODS

The study was conducted on the basis of the Department of Orthopedic Dentistry of the University Dental Center of Kharkiv National Medical University.

Deontological aspects are resolved within the framework of the current legislation in Ukraine, the Law of Ukraine „On Medicinal Products”, 1996, Art. 7, 8, 12, principles of CCI GSP (2008), Order of the Ministry of Health of Ukraine a 690 of 23.09.2009 „On approval of the Rules of clinical trials and examination of clinical trial materials and the Standard Regulations on the Ethics Commission” as amended; Helsinki Declaration of the World Medical Association. The study was performed with minimal psychological loss on the part of patients. Patients were fully informed about the purpose and methods of the study, the potential benefits and risks, as well as possible discomfort during diagnosis and treatment. All ethical requirements are met in accordance with maintaining the confidentiality of information obtained during the study. The work was considered and approved by the Commission on Bioethics of KhNMU of the Ministry of Health of Ukraine.

To study the characteristics of blood flow by the method of Laser Doppler Flowmetry a multifunctional laser diagnostic complex “Lakk-OP” was used [8].

The “Lakk-OP” complex was operated in the LDF + spectrophotometry mode. Before the start of the study, the signal was calibrated according to the manufacturer’s instructions. The study evaluated the rate of microcirculation (PM) of the blood according to the following formula:

$$PM = K \times N_{er} \times V_{av}$$

where: K – the coefficient of proportionality (constant),

N_{er} – the number of erythrocytes in the volume of probed tissue,

V_{av} – the average speed of erythrocytes.

The parameter PM determines the dynamic characteristic of blood microcirculation – the change in blood flow per unit time in the studied volume of tissue about 1 mm³ in relative perfusion units – „p.u.”

Indicators of capillary blood flow were measured in a state of complete physical and mental rest in a room with a temperature of 20-22°C. When recording the Doppler, the patient was in a sitting position, the head was fixed on the headrest. Records were made in the area of the alveolar process on the palatal and lingual sides in the area of the missing incisors, premolars and molars of the upper and lower jaw.

The duration of each measurement ranged from 30 to 60 seconds. Each indicator in the subject was determined three times in the same area of the survey, taking into account biometric and chronometric characteristics, and took into account their average value.

The study of blood microcirculation in the mucous membrane of the prosthetic area was performed in 20 patients of the comparison group using prostheses made by standard methods and in 20 patients of the study group with prostheses made by advanced methods, before prosthetics and at different times after fixation of constructions: 1 day, 1 month and 1 year.

An improved method of manufacturing complete removable prostheses was to obtain a functional impression using a specially prepared individual tray and developed by us impression polyvinylsiloxane material [12]. The proposed technique allows to reduce the negative impact of a removable prosthesis on the hemodynamic characteristics of the microcirculatory tract of the tissues of the prosthetic area. In order to maximize the rheological properties of the developed impression polyvinylsiloxane material in the thickness of an individual tray, outlet grooves in the form of a truncated inverted cone were created, which additionally provided the fixation of the impression material.

The formation of a database based on the results of randomized controlled trials was carried out in Microsoft Excel, 2007. Statistical processing of research results was performed using the software package “Statistics v. 8.0”. We calculated the arithmetic mean of the quantitative indicators presented in the text in the form ($M \pm m$), where “M” is the sample mean, «m» is the error of the mean. The results of the description of qualitative indicators (frequency of withdrawal) were expressed as a percentage. In all procedures of statistical analysis, the achieved level of significance (p) was calculated, and the critical level of significance in this study was taken to be 0.05. The hypothesis of equality of general means in the two compared groups was tested using the nonparametric Wilcoxon-Mann-Whitney test for independent samples, and the percentages were performed using the χ -square test [13].

RESULTS

The results of the study of the main indicators and index values of microcirculation in the mucous membrane of the prosthetic area are presented in table 1. As a result of our measurements revealed that the microcirculation in the control group before prosthesis significantly ($p < 0.001$) differs from the values obtained after 1 year after use – 10.11 p.u. and 15.2 p.u. accordingly, indicating an increase in vascular perfusion and a decrease in their tone. Regarding the main group – the indicators for this parameter did not differ significantly ($p > 0.05$) and amounted to 11.15 p.u. at the first stage of control and 11.9 p.u. at the last, which indicates the absence of a negative impact of the prosthesis on the mucous membrane. When comparing the microcirculation between the control and main groups, a significant difference at the level of $p < 0.001$, we found in the fourth stage of the study.

The study of flaxmotion index (IFM) revealed perfusion variability in the control group – from 1.09 to 1.39, but this difference is not significant ($p > 0.05$). In the main group, this indicator also fluctuated slightly (the difference is not significant, $p > 0.05$), but at the final stage of the study reached almost the initial value – 1.16, which indicates the stabilization of the situation. Comparing the results of both groups 1 year after prosthetics, we noted a significant ($p < 0.05$) difference in IFM between the groups – 1.39 and 1.16, respectively.

Analyzing the indicators of intravascular resistance, we saw a significant ($p < 0.05$) difference in the control group between the initial stage of the study, which obtained a result of (3.64±0.25)% and the last, when the resistance was 3.01±0.16)%, while in patients of the main group the indicators at the same stages did not differ significantly ($p > 0.05$) and amounted to (3.51±0.32)% before prosthesis and 3.9±0.28)%, 1 year after prosthetics. At almost equal values between the compared groups at the beginning, after 1 year we found a significant difference at the level of $p < 0.01$, which indicates the stability of the microcirculatory tract when using removable prostheses, which are made by advanced methods and using developed materials.

Table 1. Indicators of microcirculation in the mucous membrane of the prosthetic bed in patients using complete removable prostheses
Tabela 1. Wskaźniki mikrokrążenia w błonie śluzowej łóżka protetycznego u pacjentów stosujących protezy całkowite ruchome

Groups of patients	Control group standard methodology (n=20)				Main group improved methodology (n=20)			
	Before over-laying	1 day	1 month	1 year	Before over-laying	1 day	1 month	1 year
Microcirculation index, M, p.u.	10,11±0,16 ^a	13,9±0,43 ^d	14,8±0,92 ^e	15,2±0,17 ^{ac}	11,15±0,21 ^b	14,7±0,82 ^d	14,1±0,75 ^e	11,9±0,35 ^{bc}
Flaxmotion index IFM	1,09±0,1 ^b	1,13±0,09 ^e	1,21±0,06 ^g	1,39±0,08 ^{bf}	1,12±0,16 ^d	1,21±0,03 ^e	1,27±0,01 ^g	1,16±0,08 ^{df}
Intravascular resistance, R (%)	3,64±0,25 ^f	3,42±0,43 ^d	3,19±0,47 ^g	3,01±0,16 ^h	3,51±0,32 ^b	4,52±0,42 ^d	4,63±0,51 ^g	3,9±0,28 ^{bh}
Vascular tone, VT (%)	93,58± 2,76 ^b	88,1±2,71 ^f	82,1±4,71 ⁱ	80,5±3,02 ^{ha}	96,32± 2,13 ^b	95,6±2,55 ^f	96,1±2,91 ⁱ	96,0±2,91 ^{ba}

Note:

a – differences are significant at $p<0,001$ for indicators of the compared groups; b – differences are not significant at $p>0,05$ for indicators of the compared groups; c – differences are significant at $p<0,001$ for indicators of the compared groups; d – differences are not significant at $p>0,05$ for indicators of the compared groups; e – differences are not significant at $p>0,05$ for indicators of the compared groups; f – differences are significant at $p<0,05$ for indicators of the compared groups; g – differences are not significant at $p>0,05$ for indicators of the compared groups; h – differences are significant at $p<0,01$ for indicators of the compared groups; i – differences are significant at $p<0,05$ for indicators of the compared groups.

Regarding vascular tone, it was gradually reduced in patients of the control group from stage to stage – from (93.58±2.76)% to (80.5±3.02)% with a significant difference at the level of $p<0,01$. At patients of the main group fluctuations of indicators on this parameter are practically absent and in 1 year after prosthetics the value (96.0±2.91)% that reliably does not differ from initial size is fixed. A significant difference (at the level of $p<0,05$) between measurements in patients of the control and main groups, we found at the first stage of the study – (88.1±2.71)% and (95.6±2.55)%, respectively, and after 1 year the difference between the groups was already at the level of $p<0,001$ – (80.5±3.02)% and (96.0±2.91)%.

DISCUSSION

The application of the unloading or compression method to obtain prints is debatable. Thus, *Rumpel, Spreng, Goipl* believe that the mucous membrane of the oral cavity should be in anatomical conditions both during fingerprinting and when using a prosthesis. They consider it appropriate to obtain compression impressions. They are contradicted by *Kemeny and Wild*, who believe that prostheses made from compression impressions create constant pressure on the tissues of the prosthetic bed, which causes their atrophy. Other scientists (*Bethelmann, Oxman*) do not prefer any of the methods. They believe that the choice depends entirely on the conditions of the oral cavity [10]. Clinical studies of many domestic and foreign scientists (*IV Shakhnovsky, RA Kotelevsky, AE Kryzhanovsky, I. Hayakawa, S. Hirano*) showed that removable prostheses of different designs have a bad effect on the tissues of the oral cavity. The use of removable prostheses for a long time causes diseases of local and, in some cases, general nature [8]. Thus, the work of *OO Fastovets* and co-authors showed the negative impact of complete removable plate prostheses made by standard methods during the first 6 months of their use – the intensity of blood circulation decreased, which contributed to reduced metabolism and renewal of cellular structures. We have proved that the application of our improved technique together with the developed material has a reliably better result, because the masticatory pressure is automatically distributed differently depending on the type of mucous membrane.

CONCLUSION

Thus, the use of LDF is a very informative and non-invasive method of recording capillary blood flow in the oral mucosa. It allows to give an objective, reliable, scientifically sound assessment of microcirculatory disorders, as well as to assess the dynamics of pathological processes and the effectiveness of treatment and prevention measures aimed at pathogenetic correction of these disorders.

The results of our study clearly demonstrate the impact of the quality of the received impression on the microcirculation of the vessels of the prosthetic area – we can safely say that prostheses made by our improved method have a more favorable effect on the capillary circulation of the prosthetic area throughout the period of use of prostheses on the fabric of the prosthetic area. Therefore, further research will focus on ways to improve the masticatory efficiency of patients with complete adentia to improve quality of their life.

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