7. Oliinyk HA, Hryhorieva TH, Suprun OS. Pomylky ta taktyka likuvannia skalpovanykh ran ta defektiv miakykh tkanyn kintsivok. Meditsina Neotlozhnykh Sostoyaniy. 2013; 8: 54-60. [in Ukrainian]
8. Shapovalov VM, Hubochkin NH, Haidukov VM, Lukicheva NP, Miasnikov NY. Rekonstruktyvno-plasticheskiye operatsii pri lechenii bolnykh s defektami pokrovnykh tkaney. Geniy Ortopedii. 2014; 4: 58-61. [in Russian]
9. Miranda BH, Spilsbury ZP, Rosal-Hall A. Hand Trauma: A prospective observational study reporting the diagnostic concordance in the emergency hand trauma that supports centralized service improvements. J Plast. Reconstr. Aeshet Surg 2016; 69: 1397-1402.
10. Naumenko LYu, Ipatov AV, Zub TO, Mametiev AO. Disability status due to upper limb traumas in Ukraine for 2017. Trauma. 2018; 19(4): 11-16.
11. Prasarn ML, Helfet DL, Kloen P. Management of the mangled extremity. Strat Traum Limb Recon. 2012; 7: 57–66.
12. Souza JA, Iglesias AR. Trauma no idoso. Rev Assoc Med Bras. 2002; 48: 79-86.
13. Yang ZNg, Askari M, Chim H. Approach to Complex Upper Extremity Injury. An Algorithm Semin Plast Surg 2015; 29: 5–9.
14. Yang D, Morris SF, TangM, Geddes CR. Reversed forearm island flap supplied by the septocutaneous perforator of the radial artery: anatomical basis and clinical applications. Plastic Reconstractive Surgery. 2003; 112: 1012-1016.

Стаття надійшла 10.01.2020 р.

DOI 10.26724/2079-8334-2021-1-75-171-175
UDC 616.315/315-02:616.314.2-089.28]-022/3-07

Ye.S. Khilinich, M.Ya. Nidzelskiy, V.Yu. Davydenko, G.M. Davydenko, V.V. Kuznetsov
Ukrainian Medical Stomatological Academy, Poltava

CORRELATION BETWEEN TEMPERATURE OF THE MUCOUS MEMBRANE AND SECRETION OF THE HARD PALATE MINOR SALIVARY GLANDS IN DIFFERENT TERMS OF USING THE FULL REMOVABLE DENTURES

e-mail: davydenko.a24@gmail.com

The paper considers correlation between dental structures and the condition of oral tissues, namely: changes in temperature and secretion of the minor salivary glands of the hard palate at different time periods of use of full removable laminar dentures made of acrylic resin. The findings of the studies of temperature rates of the mucous membrane of the hard palate and the condition of secretion of the minor palatine salivary glands show the significant changes in them under the action of the full removable denture base, made of acrylic resin. The increase in temperature beneath the denture base contributes to the phenomena of "greenhouse effect", which causes inflammatory processes of various kinds in the tissues of the prosthetic bed, which can further cause destructive and atrophic changes in the minor salivary glands of the hard palate, which in turn leads to their impaired secretion – hyposalivation. Obviously, there is a directly proportional relationship between the change in temperature of the mucous membrane of the prosthetic bed beneath the denture base and the condition of secretion of the minor palatine salivary glands at different times of use of the full removable dentures.

Keywords: minor salivary glands, full removable dentures, hard palate, secretion, temperature.

Є.С. Хілініч, М.Я. Нідзельський, В.Ю. Давиденко, Г.М. Давиденко, В.В. Кузнецов

ВЗАЄМОЗВ'ЯЗОК ТЕМПЕРАТУРИ СЛИЗОВОЇ ОБОЛОНКИ ТА СЕКРЕЦІЇ МАЛИХ СЛИННИХ ЗАЛОЗ ТВЕРДОГО ПІДНЕБІННЯ У РІЗНІ ТЕРМІНИ КОРИСТУВАННЯ ПОВНИМИ ЗНІМНИМИ ПРОТЕЗАМИ

Стаття присвячена питанню взаємозв'язку стоматологічних конструкцій і стану тканин порожнини рота, а саме: змінам температури та секреції малих слинних залоз твердого піднебіння у різні терміни користування повними знімними пластинковими протезами, виготовленими з акрилової пластмаси. Результати проведених досліджень температурних показників слизової оболонки твердого піднебіння та стану секреції малих піднебінних слинних залоз свідчать про суттєві зміни в них під дією базису повного знімного протезу, виготовленого з акрилової пластмаси. Підвищення температури під базисом протезу сприяє явищам «парникового ефекту», що стає причиною запальних процесів різного характеру у тканинах протезного ложа, які в подальшому можуть бути причиною деструктивних та атрофічних змін у малих слинних залозах твердого піднебіння, що, в свою чергу, призводить до порушення їх секреції – гіпосалівації. Тому можна стверджувати про прямо пропорційний зв'язок між зміною температури слизової оболонки протезного ложа під базисом протеза та станом секреції малих слинних залоз піднебіння у різні терміни користування повними знімними протезами.

Ключові слова: малі слинні залози, повні знімні протези, тверде піднебіння, секреція, температура.

The paper is a fragment of the research project "The effect of dental constructs and material on the prosthetic bed and adaptive abilities of the body", state registration No. 0116U004188.

A specific barrier that is crucial for oral homeostasis is the minor salivary glands, one of the functions of which is the ability to produce antigens for cellular structures involved in the immune response [4]. Moreover, the mucous membrane plays a very important role, through which metabolic processes occur in the oral cavity; hence, changes in the secretory activity of the minor salivary glands can significantly affect the nature and features of pathological processes in this environment [90].

Full functioning of the salivary glands – salivation, promotes intensive cleaning of the oral cavity, leaching of food debris, decay products of food particles and the activity of microorganisms, metabolism both in the dental tissues and in the mucous membrane [3, 14].

In the clinical prosthetic dentistry, the issue on the relationship between dental structures and the condition of the oral tissues is still important and controversial among researchers and clinicians to date. The publications report that dentures and the material from which they are made, can adversely affect the stability of the oral homeostasis [1, 2]. This is especially true of removable dentures made of acrylates [10]. The studies have established that acrylic removable laminar dentures promote first an increase in the secretory activity of the salivary glands, and then its decrease with a acidic shift in the saliva pH [1, 2, 6, 9]. In addition, the state of homeostasis and the occurrence of pathological processes in the tissues of the oral cavity are influenced by bacterial components that have the ability to penetrate into the oral mucosa, including the tissues of the minor salivary glands [14, 15]. One of the factors contributing to this process is the increase in the temperature of the tissues of the prosthetic bed beneath the denture and disorder of heat exchange processes, which are exacerbated by mechanical trauma of rough and inhomogeneous structure of acrylic resin [5].

One of the first objective symptoms of the onset of many diseases is a change in temperature. Temperature reactions, due to their universality, occur in diseases of various etiologies: microbial, viral, allergic, neuropsychiatric and others.

Temperature measurement of organs and tissues is one of the most common methods of diagnosing various pathological conditions that occur in them. In recent years, temperature measurement of the teeth and oral mucosa has become increasingly used in dental practice. Local temperature fluctuations can be an important diagnostic sign and indicate trophic disorders, the degree of blood circulation, depth and nature of the lesion in particular area [11].

Deterioration of salivary gland function is caused by the range of factors – the influence of the pressure of the denture base on the prosthetic bed, changes in the temperature of the mucous membrane beneath the base, the action of residual monomer [5, 7]. The analysis of the publications showed that many researchers have studied the oral homeostasis [8], but few investigators have studied the changes in the temperature of the mucous membrane beneath the removable denture base and the effect of its pressure on the underlying tissues. There is even less data on methods for studying the rate and amount of salivation by the minor salivary glands of the oral cavity, especially in patients who use removable laminar dentures.

After a detailed analysis of the scientific literature on the problem of the effect of the removable dentures on the minor salivary glands, methods of studying its condition, the relationship of secretion with various factors, we concluded that it needs further study and proposed our own approaches and methods to study this issue.

The purpose of the paper was to study relationship between the temperature of the hard palate mucous membrane beneath the acrylic full removable denture base and the condition of the minor salivary glands secretion at different times of using the denture by means of our own proposed methods.

Materials and methods. To achieve this goal, we examined and provided prosthetic treatment for 47 edentulous patients with full removable laminar dentures with their informed consent to such treatment and further participation in the studies and in accordance with the Helsinki Declaration of the World Medical Association on Ethical Principles of Human Medical Research [12]. Removable dentures were made of base acrylic resin “Ftorax” with artificial plastic teeth.

The study of the temperature of the mucous membrane of the hard palate beneath the acrylic full removable denture base was performed using our proposed device for measuring the pressure and temperature of the mucous membrane beneath the denture base [13].

The temperature sensor is a chip DS18B20, calibrated with an accuracy of ± 0.1° C in the temperature range 32° C–42° C. The device is used as follows: temperature and pressure sensors were mounted in the base of the full removable denture of the upper jaw in the palatal area of molars on both sides; the denture is connected to the cable, then connected to the plug, plug in, the denture with the sensor is fixed in the mouth, the power button is turned on. Temperature measurement was performed in two positions – with the mouth open and closed.

The analysis of the rate and amount of salivation of the minor salivary glands of the hard palate was made using filter paper, an individual tray (before prosthetics) and a full removable denture. Electronic scales with an accuracy of ten thousandths were used for weighing the filter paper. The study was performed preprandial in the morning. The forms prepared in advance were cut out of filter paper in the shape of the palatal part of an individual tray or a full removable denture. The optimal time for determining

the rate of salivation was established experimentally: measurements were performed after 30, 60, 180 seconds and after 5 minutes. After 30 and 60 seconds, further saturation of the filter paper was observed, after 5 minutes the filter paper was saturated with saliva and it became impossible to remove it from the denture for weighing. Therefore, optimal time of 180 seconds was established to determine the rate of salivation.

The studies of the above parameters were performed before prosthetics, after 1, 7, 30 days, 3, 6, 12, 24 and 36 months of the use of the full removable dentures. For the reliability of the studies, the results of patients who appeared at all times of observation were taken into account.

Results of the study and their discussion. According to thermometric studies of the mucous membrane of the palate in edentulous patients before prosthetics, it was found that the temperature rates were much lower than in people with intact dentitions. Comparison was made according to the literature data, showing that the temperature in such individuals was 34.4–34.6±0.5° [14]. The findings of the study of the temperature of the mucous membrane of the hard palate at different times of use of the full removable dentures are presented in table 1.

Table 1

Findings of the study on the temperature of the mucous membrane of the hard palate at different times of using full removable dentures

Terms of the study	Temperature rates, C°, M±m	
	with the mouth open (n=13), p<0.05	with the mouth closed (n=13), <0.05
Before prosthetics	32.5±0.02	34.2±0.05
1 day after prosthetics	34.6±0.05	35.8±0.05
7 days after prosthetics	35.7±0.04	36.9±0.03
30 days after prosthetics	35.1±0.02	36.6±0.05
3 months of denture wearing	35.8±0.05	36.7±0.06
6 months of denture wearing	35.5±0.05	36.7±0.04
12 months of denture wearing	35.4±0.02	36.2±0.05
24 months of denture wearing	35.7±0.03	36.2±0.06
36 months of denture wearing	35.2±0.05	36.4±0.02

A decrease in temperature in edentulous patients by 1.5–2° compared to individuals with intact dentition indicates a slowing of trophic processes in the tissues of edentulous jaws due to tooth loss and age.

The resulting data indicate that changes in temperature occur in the dynamics – with the mouth open and closed. The difference in the rates was 1.5–1.7°.

Significant changes in temperature occur after prosthetics. On the first day of denture wear, the temperature increased by 2° with the mouth open, and by 1.5° with the mouth closed. After 7 days, an even greater increase in temperature was noted compared to the pre-prosthetics: by 3.2° with the mouth closed and by 2.7° with the mouth open.

The findings indicate the emergence of the "greenhouse effect" and the inflammatory reaction of the mucous membrane of the prosthetic bed due to the action of the acrylic base of the denture as a foreign body.

On day 30, a slight decrease in temperature in the range of 0.3–0.5° was observed with both mouth open and closed. This indicates some adaptation to the denture, but does not reduce its effect on the underlying tissues.

After 3 months of denture wearing, the temperature increased by 0.5° with the mouth open; with the mouth closed, it remained practically at the same level as on day 30. This indicates the emergence of a phenomenon of permanent "greenhouse effect" beneath the denture base.

During 6, 12, 24 and 36 months, almost constant temperature was observed with both mouth open and closed, compared to day 30. The difference was only 0.2–0.3°, which is not significant and does not reduce the phenomenon of "greenhouse effect" and indicates the presence of persistent inflammation in the mucous membrane of the prosthetic bed.

The secretion rate of the minor salivary glands of the hard palate was determined by the formula: V=m:t, where *m* is the difference between the weight of the paper after exposure in the mouth (m_2) and the weight of dry filter paper (m_1); *t* is the exposure time (180 s). For a more realistic clinical picture, the secretion rate was first determined in patients with intact dentitions. According to the study, it was 0.006 mg/s. The findings of the study of the secretion of the minor salivary glands at different times of use of the full removable dentures are presented in table 2.

The obtained results of secretion of the minor salivary glands at different times of use of removable dentures show that in edentulous patients the rate of secretion is significantly reduced, almost by three times.

Table 2

Results of the study on the minor salivary glands' secretion of the hard palate at different times of using complete removable dentures (n=13, t=180°C, p<0.05)

Terms of the study	The amount of saliva, mg	The rate of salivation, mg/s
Before prosthetics	0.2748	0.002
1 day after prosthetics	0.7481	0.004
7 days after prosthetics	0.6394	0.004
30 days after prosthetics	0.4285	0.002
3 months of denture wearing	0.4006	0.002
6 months of denture wearing	0.3614	0.002
12 months of denture wearing	0.2731	0.0015
24 months of denture wearing	0.2302	0.001
36 months of denture wearing	0.2221	0.001

On the first day after prosthetics, salivation increases significantly, almost twice compared to pre-prosthetics, since the denture is a significant stimulus and is perceived as a foreign body. This pattern is also observed on the day 7. At this time, a residual monomer acts as an irritant to the mucous membrane of the prosthetic bed, which is released from the denture base and adversely affects the tissues of the prosthetic bed, in particular the minor salivary glands.

30 days after prosthetics, upon completion of the early period of adaptation, the rate of salivation decreased to the level before prosthetics, and the quantitative indicators were almost twice as high.

From the third month of denture wearing, a constant decrease in the secretory activity of the minor palatine salivary glands was noted and by 36 months the rate of salivation twice decreased, compared to the data before prosthetics. This indicates a negative complex effect of the removable denture bases due to residual monomer, increasing the temperature beneath the base, creating a "greenhouse effect", which together leads to acute inflammatory processes in the tissues of the prosthetic bed, which gradually become chronic, lead to destructive and atrophic processes in the minor salivary glands. After 36 months, they become depleted, which is characterized by hyposalivation, which can cause dryness of the mucous membrane of the prosthetic bed.

The resulting data are confirmed by the studies of other researchers [7, 10], who studied the effect of removable laminar dentures, made of acrylates, on the tissues of the oral cavity and concluded that the base of such dentures has a toxic, allergic, traumatic effect on the underlying tissues, leading to inflammation and atrophy. Publications [11] of other researchers emphasizes that the temperature beneath the denture base increases significantly, promotes rapid reproduction of microorganisms, the emergence of inflammatory processes in the mucous membrane of the prosthetic bed.

Other researchers [10] have shown that methyl methacrylate promotes changes in the number and ratio of immunocompetent cells in the minor palatine salivary glands, which leads to disorder of their protective function and secretion.

Conclusion

The findings of the studies of temperature rates of the mucous membrane of the hard palate and the condition of secretion of the minor palatine salivary glands show the significant changes in them under the action of the full removable denture base made of acrylic resin. The increase in temperature beneath the denture base contributes to the phenomena of "greenhouse effect", which causes inflammatory processes of various kinds in the tissues of the prosthetic bed, which can further cause destructive and atrophic changes in the minor salivary glands of the hard palate, which in turn leads to their impaired secretion – hyposalivation. Obviously, there is a directly proportional relationship between the change in temperature of the mucous membrane of the prosthetic bed beneath the denture base and the condition of secretion of minor palatine salivary glands at different times of use of the full removable dentures.

Prospects of further research are the following. The full removable laminar dentures, in addition to the above factors (residual monomer, temperature), create a certain pressure on the tissues of the prosthetic bed, which to some extent can affect the condition of the mucous membrane of the prosthetic bed and the minor salivary glands, in particular. Therefore, it will be promising to investigate the parameters of the pressure acting on the mucous membrane of the hard palate, and to study their effect on the condition of the minor salivary glands of the hard palate.

References

1. Bykov IM, Akopova LV, Skorikova LA. Biokhimicheskiye pokazateli gomeostaza i biotsenoza polosti rta u patsiyentov s proteznym stomatitom. International Journal of Applied and Basic Research. 2015; 3:517–23. [in Russian]
2. Gizey EV, Korochanskaya SP. Izmeneniye fiziko-khimicheskikh pokazateley rotovoy zhidkosti pri chastichnoy i polnoy adentii. Topical issues in the theory and practice of dentistry: collection of scientific papers. Moscow; Krasnodar, 2013. p. 151–155. [in Russian]
3. Vavilova TP. Biokhimiya tkaney i zhidkostey polosti rta. Moskva: GEOTAR–Media; 2011. 257 s. [in Russian]
4. Mamadzhonova ShG, Galchinskaya PS, Bogdanova SE, Stukov NV, Ulyanovskaya SA. Vozrastnyye osobennosti slyunnykh zhelez cheloveka. International Journal of Experimental Education. 2016; 5(3):388–89. [in Russian]
5. Nesterko YeE, Butova MV. Primeneniye polimernykh materialov v sovremennoy stomatologii. Young scientist. 2015; 24(1): 49–51. [in Russian]
6. Orekhov SN, Matveyev SV, Karakyan AE, Ibragimova EZ. Prichiny narusheniya sekretsii slyunnykh zhelez i sposoby lecheniya. Scientific Review. Medical sciences. 2017; 4:58–64. [in Russian]
7. Paliychuk IV. Analiz vykorystannya riznykh vydiv ortopedychnykh konstruktsiy ta yikh vplyv na slyzovu obolonku porozhnyny rota. Dentistry news. 2015; 2:13–16. [in Ukrainian]
8. Pervov YuYu. Vliyaniye syemnykh akrilovykh zubnykh protezov na immunnyy gomeostaz slizistoy obolochki polosti rta v zavisimosti ot primenyayemykh materialov i konstruktsiy. Kazan Medical Journal. 2012; 93(2):227–30. [in Russian]
9. Senchakovych YuV, Yeroshenko GA, Kazakova KS, Bilash SM. Vplyv metakrylatu na funktsiyu slynnykh zaloz. World of medicine and biology. 2014; 1(43):181–85. [in Ukrainian]
10. Sokolovskaya VM, Nidzelskiy MY, Dudchenko MO. Vliyaniye akrilovykh plastmass na slizistuyu obolochku polosti rta. Dermatovenereology. Cosmetology. Sexopathology. 2015; 3–4: 212–15. [in Russian]
11. Sokolovskaya VM. Laboratorno-klinichne obhruntuvannya ultrazvukovoyi tekhnolohiyi obrobky polimernykh materialiv pry vyhotovlenni stomatolohichnykh proteziv. [dysertatsiya]. Poltava: UMSA; 2009. 18 s. [in Ukrainian]
12. Helsinska deklaratsiya Vsesvitnyoyi medychnoyi asotsiatsiyi "Etychni pryntsypy medychnykh doslidzhen za uchastyu lyudyny u yakosti obyekta doslidzhennya", Seoul, 2008. [in Ukrainian]
13. Khilinich YeS, Nidzelskyy MYa, Kuznetsov VV, Davydenko YuO, Davydenko VYu, vynakhidnyky; "Ukrayinska medychna stomatolohichna akademiya", patentovlasnyk. Prystriy dlya doslidzhennya temperatury ta tysku pid znimnymy protezamy v porozhnyni rota. Patent Ukrayiny N 134207. 2019 Tra 10. [in Ukrainian]
14. Shabashova NV, Danilova EYu. Mestnyy immunitet i mikrobiota rotovoy polosti (obzor). Problems of medical mycology. 2015; 17(4):4–13. [in Russian]
15. Yanishen IV, Sokhan NV, Fedotova EL, Sokhan MN. Microecology of the oral cavity in the period of adaptation to removable dentures. World Science. 2017; 4(20) 6:13–17.

Стаття надійшла 12.03.2020 р.