DETERMINATION OF THE EFFECTIVENESS OF THE AUTHOR'S METHOD OF OBTAINING IDENTICAL RASTER IMAGES OF OCCLUSIOGRAMS

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Abstract. Dentists attach great importance to the diagnosis of occlusive contacts, as well as their reproduction. The quality of the treatment depends on the accuracy of the restoration of occlusal contacts. To date, there is no way that would guarantee an accurate, fast, effective result. Therefore, we have developed and patented an author's method for obtaining bitmap images of occlusograms. We conducted a patent search for all similar methods of assessing occlusion and occlusive relationships in the literature sources available to us. Next, we compared our author's method of obtaining bitmap images of occlusograms with other known methods. And as a result of the conducted research, we have proved the effectiveness of the author's method of obtaining raster images of occlusograms in clinical dental practice.

Keywords: occlusography, area of occlusal contacts, flatbed scanner, diagnostics, occlusal fingerprint

ОПРЕДЕЛЕНИЕ ЭФФЕКТИВНОСТИ АВТОРСКОГО СПОСОБА ПОЛУЧЕНИЯ ИДЕНТИЧНЫХ РАСТРОВЫХ ИЗОБРАЖЕНИЙ ОККЛЮЗОГРАММ

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Резюме. Диагностике окклюзионных контактов, а также их воспроизведению стоматологи придают большое значение. Именно от точности восстановления окклюзионных контактов зависит качество проведенного лечения. В настоящее время нет способа, который бы гарантировал точный, быстрый, эффективный результат, поэтому мы разработали и запатентовали авторский способ получения растровых изображений окклюзограмм. Мы провели патентный поиск всех похожих способов оценки окклюзии и окклюзионных взаимоотношений в доступных нам источниках литературы. Далее мы сравнили наш авторский способ получения растровых изображений окклюзограмм с другими известными методами. В результате проведенного исследования нами была доказана эффективность применения авторского способа получения растровых изображений окклюзограмм в клинической стоматологической практике.

Ключевые слова: окклюзография, площадь окклюзионных контактов, планшетный сканер, диагностика, окклюзионный отпечаток

INTRODUCTION

Diagnosis of occlusal contacts, analysis of various lower jaw positions, examination of the condition of muscles and temporomandibular joint are important in dental practice. At stages of examining patients before and after dental treatment, dentists attach great importance to reproduction of occlusal contacts. The quality of treatment depends on the accuracy of the restoration of occlusal contacts [1–3].

Physiological occlusion is provided by occlusal contacts of posterior teeth, which are characterized by the presence of upper and lower fissures and tubercles on chewing surface of the teeth [2, 4].

Restoration of chewing function is one of the main results of high-quality dental treatment, be it orthopedic, orthodontic or, to a lesser extent, therapeutic treatment [1, 7, 13]. Violation or incorrect restoration of occlusal landscape relief [11] leads to increased patient anxiety due to the disruption of vital chewing function [4]. Despite the variety of possible modern dental studies currently available [8, 14], methods for determining chewing efficiency remain the most informative and fully characterize the quality of restoration of chewing function [5, 6, 12]. Accurate restoration of occlusal contacts and near-contact areas during dental treatment is one of the most difficult tasks in dentist's job. To solve it, various devices have been developed that reproduce the movements of lower jaw, as well as various methods for determining and fixing the relationship of jaws have been proposed. There are many ways to record occlusion, there are also several ways to transfer occlusal surface relief to a personal computer and then to a program for determining the area of occlusal surface. However, the problem is still not solved. A.V. Mashkov proposed a method for obtaining bitmap images using a negatoscope, camera and tripod. Occlusogram image was placed on the negatoscope, then photographed and transferred to a personal computer for later analysis [2, 9]. In our opinion, this is inconvenient, requires additional equipment in the form of a negatoscope and high-quality camera and still does not guarantee receiving identical images.

A method of creating occlusal contacts and dentures is known from the literature, using an occlusogram obtained in the oral cavity. According to it, a plane is formed on a plaster model in which contact points lie perpendicular to tooth axis, and the areas of occlusal contacts are created depending on the degree of jaw bone atrophy. In accordance with it, occlusal contacts, their location and the area of occlusal surface of artificial teeth are restored [10, 11]. The disadvantage of this technique is the occlusogram method of determining the location of occlusal contacts when transferring to a plaster model, which is used to obtain a conditional plane with location of contact points. This does not ensure accurate reproduction of occlusal surfaces of artificial teeth and determination of the parameters of interocclusal space of a pair of antagonist teeth. In addition, this method does not allow obtaining accurate parameters of artificial relief of occlusal surfaces of antagonist teeth.

Due to the need for accurate diagnosis and receiving high-quality bitmap images of occlusograms, the author considered that it was necessary to develop a new "Method of obtaining identical bitmap images of occlusograms" [12].

AIM

The aim of the study is to determine the effectiveness of the author's method of obtaining identical bitmap images of occlusograms.

MATERIALS AND METHODS

At the Department of Orthopedic Dentistry with the course in clinical Dentistry of the Volgograd State Medical University, studies were conducted aimed at assessing the efficiency of the "Method of obtaining identical bitmap images of occlusograms" developed by the author of this article [10]. The purpose of these researches was also to test the possibility of using obtained images in the "Program for measuring areas of occlusal contacts using a bitmap image" [12] developed by Mashkov A.V., Chepuryaeva O.S., Shemonaev V.I. and others [12].

Initial data for working in the "Program for measuring areas of occlusal contacts using a bitmap image" are scanned images of patient's occlusograms in centric occlusion. We obtained the occlusogram using a method developed at the Department of Orthopedic Dentistry with a course in clinical Dentistry [2]. Then, in accordance with developed "Method for obtaining identical bitmap images of occlusograms" to identify occlusal contacts, an occlusogram of contact points of the teeth was previously received in the oral cavity. The material used to record occlusal contacts was base wax with thickness of 2.0±0.2 mm in the form of a pink plate with dimensions of 180×90×1.8 mm. Color and optical properties of selected wax made it possible to achieve accurate calibration of plate thickness according to changes in accordance with occlusal surfaces. They also helped to obtain color characteristics for variety of thicknesses on relief imprint of occlusal surfaces of antagonist teeth. To give rigidity, wax plate was fixed on a wire frame bent to the shape of dentition, pressing tightly along edges of wire frame. This structure was then heated in a water bath to an oral temperature of 35.5–37.5 °C, ensuring production of an easily deformable imprint of occlusal surface of antagonist teeth.

The framework with wax plate was inserted into the oral cavity and positioned relative to upper jaw dentition. Then the patient closed the teeth with maximum force in centric occlusion position, in which maximum contraction of masticatory muscles is possible. Resulting occlusogram was removed from the oral cavity, cooled and received a fixed imprint of occlusal surfaces and occlusal contacts of antagonist teeth.

Further operations to fix and study occlusal contacts of antagonist teeth were performed outside the oral cavity, without patient's participation.

You need to create a template to obtain "Identical bitmap images of occlusograms". This is easy to do even at home. You should take a sheet of thick white A4 paper, determine the center of the sheet and draw a cross. Lines must be strictly perpendicular to each other, that is, angles between lines are strictly 90 °. After this, you need to draw a horizontal and vertical line through the center to the edge of the sheet, then step back 50 mm from the center and put dots on horizontal and vertical. Next, you should connect 4 points and get a square with a side of 100 mm.

Then, you need to place previously obtained occlusogram in this square and fix it with transparent adhesive tape. After that, you should place this structure on the glass of flatbed desktop scanner for scanning documents with occlusogram down on glass, and the sheet of white paper should be on top. Then you need to open image scanning software on a personal computer. In our case, we used a Kyocera ECOSYS M2530dn KX flatbed desktop document scanner and ABBYY FineReader 14/FineReader.exe image scanning software, or you can use any available image scanning software. You need to select "Full-color", "Photo" in settings. Next, select "Scan" command and get a "Bitmap identical image of occlusogram" on personal computer screen. Resulting images can be used to diagnose the condition of the teeth and dentitions before, during and after treatment. Wax plate is scanned against the light, as a result of which occlusal contacts on scanned image differ in brightness, which depends on the density of occlusion of antagonist teeth.

The study involved 50 patients of both genders aged 18–35 with intact dentitions, healthy periodontium and proper occlusion. 150 occlusograms were obtained. The average time from the moment of making occlusogram until occlusal imprint was received on personal computer monitor, suitable for analysis in program we developed to determine the area of occlusal surface. Then data were entered into tables and analyzed. Statistical processing of study results was performed using the Statistica and Microsoft Office software packages. Digital data were processed on a personal computer using variation statistics method. We used Student's t-test and Pearson's correlation coefficient (r). The confidence interval with random deviation was no more than 5% (p <0.05). Principles of evidence-based medicine were used in studying research results [2, 6].

RESULTS AND DISCUSSION

When receiving occlusograms during the study conducted using the author's technique and further processing using the "Method of obtaining identical bitmap images of occlusograms", and subsequent transfer of images obtained to the "Program for measuring areas of occlusal contacts using a bitmap image" [12], an average of 155 seconds were spent. While working according to approach proposed by A.V. Mashkov, an average of 725 seconds were spent on the same work, which is 570 seconds more than obtaining bitmap images of occlusograms using the author's method. At higher speed of work, quality of bitmap images did not suffer and repeatability increased. That is, receiving images using the author's "Method of obtaining identical bitmap images of occlusograms" can increase productivity by 4.7 times compared to other techniques used previously (p <0.001). These include, for example, the method of Associate Professor of the Department of Orthopedic Dentistry with the course in clinical Dentistry of Volgograd State Medical University A.V. Mashkov.

CONCLUSION

As a result of study conducted, the effectiveness of the author's "Method of obtaining bitmap images of occlusograms" for diagnosis of chewing efficiency was proven. Thus, when receiving bitmap images of occlusograms using the technique proposed by the author of this article, time for transferring from a wax reproduction of occlusal surface relief to a digital model is reduced by 570 seconds. This is 4.7 times faster than previously used method. Thus, application of this author's approach increases efficiency of the dentist, reduces time costs. Thanks to this method, work as a whole can become more convenient, cheaper, simpler, more effective, more accessible. In this regard, this "Method of obtaining identical bitmap images of occlusograms" can be recommended for diagnosis of chewing efficiency and use in clinical dental practice.

ADDITIONAL INFORMATION

Consent for publication. Written consent was obtained from the patient for publication of relevant medical information within the manuscript.

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

REFERENCES

1. Dmitriyenko S.V., Chizhikova T.S., Yusupov R.D. i dr. Ball'no-reytingovaya sistema otsenki sostoyaniya okklyuzii u studentov. [Point-rating system for assessing the state of occlusion in students]. Mezhdunarodnyy zhurnal prikladnykh i fundamental'nykh issledovaniy. 2015; 3(4): 584–8. URL: https://applied-research.ru/ru/article/view?id=6675 (date of access: 18.08.2023). (in Russian).

2. Mashkov A.V. Obosnovaniye ortopedicheskogo lecheniya nes"yemnymi zubnymi protezami s uchetom khronoprofilya patsiyenta i individual'no-tipologicheskikh osobennostey rel'yefa okklyuzionnykh poverkhnostey zubov. [Rationale for orthopedic treatment with fixed dentures, taking into account the patient's chronoprofile and individual typological features of the relief of the occlusal surfaces of the teeth]. Avtoref. dis. … kand. med. nauk. Volgogradskiy gosudarstvennyy meditsinskiy universitet. Volgograd; 2013. (in Russian).

3. Mashkov A.V., Shemonayev V.I., Badrak Ye.Yu. Razrabotka issledovatel'skogo modulya dlya analiza biometricheskikh kharakteristik okklyuzionnykh kontaktov i okolokontaktnykh zon antagoniruyushchikh zubov. [Development of a research module for analyzing the biometric characteristics of occlusal contacts and near-contact zones of antagonizing teeth]. Kubanskiy nauchnyy meditsinskiy vestnik. 2015; 1. URL: https://cyberleninka.ru/article/n/razrabotka-issledovatelskogo-modulya-dlya-analiza-biometricheskih-harakteristik-okklyuzionnyh-kontaktov-i-okolokontaktnyh-zon (date of access: 17.08.2023). (in Russian).

4. Mashkov A.V., Shemonayev V.I. Diagnosticheskiye vozmozhnosti metoda okklyuzografii. [Diagnostic capabilities of the occlusion method]. V sbornike: Aktual'nyye voprosy sovremennoy stomatologii. Materialy konferentsii, posvyashchennoy 75-letiyu Volgogradskogo Gosudarstvennogo meditsinskogo universiteta, 45-letiyu kafedry terapevticheskoy stomatologii i 40-letiyu kafedry ortopedicheskoy stomatologii. Pod obshchey redaktsiyey V.I. Petrova. 2010: 151–3. (in Russian).

5. Mitin N.Ye., Vasil'yeva T.A., Vasil'yev Ye.V. Metodika opredeleniya zhevatel'noy effektivnosti s primeneniyem original'noy komp'yuter-noy programmy na osnove metodov analiza mnogomernykh dannykh. [Methodology for determining chewing efficiency using an original computer program based on multidimensional data analysis methods]. Ros. med.-biol. vestn. im. akad. I.P. Pavlova 2016; 1. URL: https://cyberleninka.ru/article/n/metodika-opredeleniya-zhevatelnoy-effektivnosti-s-primeneniem-originalnoy-kompyuternoy-programmy-na-osnove-metodov-analiza (date of access: 18.08.2023). (in Russian).

6. Narkevich A.N., Vinogradov K.A. Vybor metoda dlya statisticheskogo analiza meditsinskikh dannykh i sposoba graficheskogo predstavleniya rezul'tatov. [Choosing a method for statistical analysis of medical data and a method for graphically presenting the results]. Sotsial'nyye aspekty zdorov'ya naseleniya. 2019; 4(68). URL: https://cyberleninka.ru/article/n/vybor-metoda-dlya-statisticheskogo-analiza-meditsinskih-dannyh-i-sposoba-graficheskogo-predstavleniya-rezultatov (date of access: 20.04.2023). (in Russian).

7. Pichugina Ye.N., Arushanyan A.R., Konnov V.V. i dr. Sposob otsenki okklyuzionnykh vzaimootnosheniy zubov i zubnykh ryadov. [A method for assessing the occlusal relationships of teeth and dentition]. Zdorov'ye i obrazovaniye v XXI veke. 2016; 11. URL: https://cyberleninka.ru/article/n/sposob-otsenki-okklyuzionnyh-vzaimootnosheniy-zubov-i-zubnyh-ryadov (date of access: 18.08.2023). (in Russian).

8. Ryakhovskiy A.N. Opredeleniye ploshchadi i plotnosti smykaniya zubnykh ryadov. [Determination of the area and density of closure of the dentition]. Stomatologiya. 1992; 5: 62–4. (in Russian).

9. Skott Dzh. Tochnaya registratsiya prikusa: povysheniye predskazuyemosti rezul'tata ortopedicheskogo lecheniya. [Accurate bite registration: increasing the predictability of prosthetic treatment outcome]. Sovremennaya ortopedicheskaya stomatologiya. 2013; 20: 11–5. (in Russian).

10. Chepuryayeva O.S. Sposob polucheniya identichnykh rastrovykh izobrazheniy okklyuzogramm. [A method for obtaining identical raster images of occlusograms]. Svidetel'stvo o registratsii izobreteniya. № 2022133779 ot 21.12.22. (in Russian).

11. Chepuryayeva O.S., Klauchek S.V., Shemonayev V.I., Zhivotov D.S. Ekspertnaya otsenka programmno-apparatnogo kompleksa BOS-PUL'S, primenyayemogo v stomatologii. [Expert assessment of the BOS-PULSE hardware and software complex used in dentistry]. Rossiyskaya stomatologiya. 2019; 12(3): 68–9. (in Russian).

12. Chepuryayeva O.S., Petrov V.O., Poroyskiy S.V. i dr. Programma dlya izmereniya ploshchadey okklyuzionnykh kontaktov po rastrovomu izobrazheniyu. [Program for measuring the areas of occlusal contacts using a raster image]. Svidetel'stvo o registratsii programmy dlya EVM № 2012610639 ot 10.01.2012 g. (in Russian).

13. Yatsuk A.V., Sivolapov K.A. Ustroystvo dlya opredeleniya davleniya zubov. [Device for determining the pressure of teeth]. Patentoobladatel' Gosudarstvennoye byudzhetnoye obrazovatel'noye uchrezhdeniye dopolnitel'nogo professional'nogo obrazovaniya Novokuznetskiy gosudarstvennyy institut usovershenstvovaniya

vrachey Ministerstva zdravookhraneniya i sotsial'nogo razvitiya Rossiyskoy Federatsii. RU2496447C12013.10.27. (in Russian).

14. Felicio C.M. Reliability of masticatory efficiency with beads and correlation with the muscle activity. Pro Fono. 2008; 20(4): 225–30.

ЛИТЕРАТУРА

1. Дмитриенко С.В., Чижикова Т.С., Юсупов Р.Д. и др. Балльно-рейтинговая система оценки состояния окклюзии у студентов. Международный журнал прикладных и фундаментальных исследований. 2015; 3(4): 584–8. URL: https://applied-research.ru/ru/article/view?id=6675 (дата обращения: 18.08.2023).

2. Машков А.В. Обоснование ортопедического лечения несъемными зубными протезами с учетом хронопрофиля пациента и индивидуально-типологических особенностей рельефа окклюзионных поверхностей зубов. Автореф. дис. … канд. мед. наук. Волгоградский государственный медицинский университет. Волгоград; 2013.

3. Машков А.В., Шемонаев В.И., Бадрак Е.Ю. Разработка исследовательского модуля для анализа биометрических характеристик окклюзионных контактов и околоконтактных зон антагонирующих зубов. Кубанский научный медицинский вестник. 2015; 1. URL: https://cyberleninka.ru/article/n/razrabotka-issledovatelskogo-modulya-dlya-analiza-biometricheskih-harakteristik-okklyuzionnyh-kontaktov-i-okolokontaktnyh-zon (дата обращения: 17.08.2023).

4. Машков А.В., Шемонаев В.И. Диагностические возможности метода окклюзографии. В сборнике: Актуальные вопросы современной стоматологии. Материалы конференции, посвященной 75-летию Волгоградского Государственного медицинского университета, 45-летию кафедры терапевтической стоматологии и 40-летию кафедры ортопедической стоматологии. Под общей редакцией В.И. Петрова. 2010: 151–3.

5. Митин Н.Е., Васильева Т.А., Васильев Е.В. Методика определения жевательной эффективности с применением оригинальной компьютерной программы на основе методов анализа многомерных данных. Рос. мед.-биол. вестн. им. акад. И.П. Павлова. 2016; 1. URL: https://cyberleninka.ru/article/n/metodika-opredeleniya-zhevatelnoy-effektivnosti-s-primeneniem-

6. Наркевич А.Н., Виноградов К.А. Выбор метода для статистического анализа медицинских данных и способа графического представления результатов. Социальные аспекты здоровья населения. 2019; 4(68). URL: https://cyberleninka.ru/article/n/vybor-metoda-dlya-statisticheskogo-analiza-meditsinskih-dannyh-i-sposoba-graficheskogo-predstavleniya-rezultatov (дата обращения: 20.04.2023).

7. Пичугина Е.Н., Арушанян А.Р., Коннов В.В. и др. Способ оценки окклюзионных взаимоотношений зубов и зубных рядов. Здоровье и образование в XXI веке. 2016; 11. URL: https://cyberleninka.ru/article/n/sposob-otsenki-okklyuzionnyh-vzaimootnosheniy-zubov-i-zubnyh-ryadov (дата обращения: 18.08.2023).

8. Ряховский А.Н. Определение площади и плотности смыкания зубных рядов. Стоматология. 1992; 5: 62–4.

9. Скотт Дж. Точная регистрация прикуса: повышение предсказуемости результата ортопедического лечения. Современная ортопедическая стоматология. 2013; 20: 11–5.

10. Чепуряева О.С. Способ получения идентичных растровых изображений окклюзограмм. Свидетельство о регистрации изображения. № 2022133779 от 21.12.22.

11. Чепуряева О.С., Клаучек С.В., Шемонаев В.И., Животов Д.С. Экспертная оценка программно-аппаратного комплекса БОС-ПУЛЬС, применяемого в стоматологии. Российская стоматология. 2019; 12(3): 68–9.

12. Чепуряева О.С., Петров В.О., Поройский С.В. и др. Программа для измерения площадей окклюзионных контактов по растровому изображению. Свидетельство о регистрации программы для ЭВМ № 2012610639 от 10.01.2012 г.

13. Яцук А.В., Сиволапов К.А. Устройство для определения давления зубов. Патентообладатель Государственное бюджетное образовательное учреждение дополнительного профессионального образования Новокузнецкий государственный институт усовершенствования врачей Министерства здравоохранения и социального развития Российской Федерации. RU2496447C12013.10.27.

14. Felicio C.M. Reliability of masticatory efficiency with beads and correlation with the muscle activity. Pro Fono. 2008; 20(4): 225–30.