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STANDARD DURATION INDICATORS OF AN ORTHODONTIST SELF-PLANNING AND TESTING OF JAWS 3D MODELS IN CLINIC

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НОРМАТИВНІ ПОКАЗНИКИ ТРИВАЛОСТІ САМОСТІЙНОГО ПЛАНУВАННЯ І ВИКОНАННЯ ЛІКАРЕМ-ОРТОДОНТОМ 3D-ДРУКУ МОДЕЛЕЙ ЩЕЛЕП В УМОВАХ КЛІНІКИ

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Summary/ Резюме

Along with traditional methods, the widespread introduction of a digital protocols into the orthodontists clinical practice for the provision of appropriate medical care, has led to the necessity to establish standards and time norms for them in the form of conditional labor intensity units (CUL) for full and fair accounting of the specialists' work, calculation of wages fees, cost calculations for patients.

The conducted time-lapse studies of the duration of execution by 12 orthodontists of 24 digital protocols of self-planning and 3D printing of jaw models in clinic conditions (without the dental technician participation) showed that with practically the same time standards for taking impressions of the jaws by digital or traditional methods, the total time of 3D- printing is in favor of the efficiency of 19 % of the jaws intraoral scanning digital protocol application, which is 4.3 CUL in comparison to 5.3 CUL when taking impressions by the traditional way, although with the use of a dispensary impressions mass.

The indicator of the difference of 1 CUL or 60 minutes of the orthodontist's working time is the result that is needed for additional processing of plaster models of the jaws when they are scanned in a stationary scanner.

Keywords: *effectiveness of dental care, dento-maxillofacial anomalies and deformations, condition of the oral cavity, digital protocols, scanning, 3D printing, timing.*

Широке впровадження в клінічну практику лікарів-ортодонтів, поряд з традиційними методами, цифрових протоколів надання відповідної медичної допомоги, призвело до необхідності встановлення на них нормативів і норм часу у вигляді умовних одиниць трудомісткості (УОТ) для повноцінного і справедливого обліку праці фахівців, розрахунку заробітної платні, калькуляції вартості для пацієнтів.

Проведені хронометражні дослідження тривалості виконання 12 лікарями-ортодонтами 24 цифрових протоколів самостійного планування і 3D-друку моделей щелеп в умовах клініки (без участі зубного техніка) показали, що при практично однакових нормах часу на зняття відбитків щелеп цифровим або традиційним способами, загальний час 3D-друку складається на користь ефективності в 19 % застосування цифрового протоколу інтраорального сканування щелеп,, а це 4,3 УОТ проти 5,3 УОТ при знятті відбитків традиційним способом, хоч і із використанням

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диспансеру мас для відбитків.

Показник різниці в 1 УОТ або 60 хвилин робочого часу лікаря-ортодонта є результатом необхідності додаткової обробки гіпсових моделей щелеп при їх скануванні в стаціонарному сканері.

Ключові слова: ефективність надання стоматологічної допомоги, зубощелепні аномалії і деформації, стан порожнини рота, цифрові протоколи, сканування, 3D-друк, хронометраж.

Actuality

Due to the scientific and technical progress in medicine, in many dental clinics of Ukraine, which provides also an orthodontic treatment of dento-jaw anomalies and deformations, has appeared the equipment that is used in modern digital methods, such as scanning the oral cavity with an intraoral scanner, with the help of which it is possible not only to get a digital model of the teeth, but also to provide a 3D assessment of the teeth hard tissues state, 3D printing of jaws models, temporary crowns, navigation templates, aligners without involving the dental laboratories services.

To perform such types of work, are used intraoral and stationary scanners, additive 3D printers, which work according to the principles of layer-by-layer addition of the appropriate material in the form of a special resin, which must harden under such a physical factor as light.

In other words, we are talking about complex technologies of photopolymer printing in dentistry, which have actively began to develop in Ukraine at the beginning of the 20th century and, to date, have achieved quite impressive results in the form of digital protocols for a sufficiently wide range of dental products manufacturing, which have a positive effect not only on the oral cavity condition of a particular patient, but also to improve the provision of dental care in general.

Regarding to the orthodontist's activities, in the conditions of a modern clinic, he can independently perform the same types of 3D printing: the production of physical models from various plastics for planning orthodontic treatment or for the preliminary placement of conventional or lingual braces, temporary plastic crowns, surgical templates for installing orthodontic implants, templates for transferring brackets from the model to the oral cavity, aligners [1-18].

The analysis of the relevant legal documents in the field of accounting for the work of dentists in orthodontic practice proved that, at present, in Ukraine there are no objective labor standards in orthodontists for the implementation of modern digital methods of orthodontic care, which, after approval at the level of the Ministry of Health of Ukraine, could become official labor standards in the form of conditional labor intensity units (CUL), as it exists in other branches of local dentistry [19, 20].

Research materials and methods

The purpose of this study is to increase the efficiency of providing dental care to the population of Ukraine by determining the duration of the digital protocol for planning and performing 3D printing of jaw models by an orthodontist.

The first object of the study is dentists providing medical care in the specialty "orthodontics" of various qualifications, working in medical institutions of different ownership in different regions of the country. The subject of the study is the nomenclature of modern types of orthodontic care in Ukraine.

The second object of the study is the duration of the dental orthodontic care provision in Ukraine, and the subject of the study is methodological measures and techniques for determining the duration of digital protocols for planning and performing 3D printing of jaw models personally by

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an orthodontist and establishing standards of time and conventional labor-intensive units for the provision of appropriate care.

Research methods:

- analytical — to determine the structure and nature of the orthodontist's labor costs while scanning the oral cavity with an intraoral scanner and determining the central occlusion;
- timing — to determine the total duration of the relevant clinical stages of the oral cavity scanning by an orthodontist with an intraoral scanner and central occlusion determination;
- mathematical — to determine the departmental standards value of the orthodontist's working time while scanning the oral cavity with an intraoral scanner and the central occlusion determination;
- statistical — for processing research results.

To determine the duration of the relevant clinical stages of scanning the oral cavity by an orthodontist with an intraoral scanner and to determine the central occlusion and establish the CUL, was used the method of determining labor costs in dentistry as modified by V. A Labunets (1999) [15], which was officially approved by the Ministry of Health of Ukraine.

Because of the dentists work process character at the clinical stages of providing specialized care is a clear and consistent performance of certain manipulations consisting of a number of repeated and constant elements of the main operation, the time costs are previously indexed to permanent time costs (Tp), which are not depend on the number of structural elements or specialized actions (example: consulting a patient, taking an impression, scaning) and variable-repetitive time costs (Tvr), which completely depend on these factors (for example digital processing of a certain number of scans, files).

The method of indexing time costs by character and content is as follows: the expert observe the production process first divides into separate technological stages that have logical completion, and then evaluates the content of the work at this stage and determines how these manipulations are correlated with the nature of labor costs.

Based on the obtained data, according to methodological requirements, the summation of Tp and Tvr indicators is carried out, the result of which can be presented as the desired standard of time for certain types of orthodontic care:

TS = Tp + Tvr, where:

TS — time standard;

Tp — permanent time expenditure;

Tzp — variable-repetitive time expenditure.

Statistical processing of timing results consists in determining the weighted arithmetic average, without determining the error of this indicator [19].

Research results

Material support for the implementation of digital protocols for the provision of orthodontic care requires the availability of the following sufficiently high-tech equipment, namely: a computer with appropriate software, an intraoral scanner, an impression material dispenser, a stationary scanner, an additive 3D printer, an ultrasound bath, a photopolymerization module.

Bearing in mind that the intellectual support of the process is performed by the orthodontist personally, his professional competence and ability to work in computer programs for processing the results of scanning, editing, planning, file production and 3D printing are required conditions for obtaining an adequate result.

It is known that 3D printed models of the jaws can be obtained in two ways: by intraoral scanning of the patient's dentition with obtaining digital impressions in the form of an STL file, and based on traditional impressions, followed by the manufacture of plaster models of the jaws, their scanning on a stationary scanner and the creation of an STL file.

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Time-lapse measurements of technological processes of planning and implementation of 3D printing of jaw models were carried out on the basis of medical institutions in the cities of Odessa, Cherkassy, Mykolaiv and Ivano-Frankivsk during 2022-2024.

While the measurements were conducted, were performed and timed 24 processes of 3D printing of jaw models by 12 orthodontists of various qualification.

The results of the time-keeping studies were entered into the specially developed "Time Chart of the Orthodontist's Working Time". Before that, the labor costs of specialists were indexed, according to the applied methodology, to permanent costs of working time of specialists (Tp), which do not depend on the number of jaw models that are simultaneously printed, and variable and repetitive costs of working time (Tvr), which depend entirely on given factors. The final indicators were summarized according to the officially approved formula.

With both methods of 3D printing of jaw models (taking digital or traditional impressions), the consultation stage is mandatory and its duration was equal to, on average, 36.06 minutes.

Taking digital impressions of the jaws lasted, on average, 39.4 minutes and required the orthodontist to have appropriate skills in using an intraoral scanner and working in a computer program to process the scan results and create an STL file on the basis of which the next 3D printing was carried out, lasting, on average, 116.23 minutes per model, of which: Tp = 51.62 minutes, Tvr = 64.61 minutes.

If we take one patient into account (upper and lower jaw), then the result of the duration of 3D printing will be as follows:

TS of 3D printing = Tp + 2xTvr = 51.62 min. + 2x 64.61 min. = 180.84 min.

Together (consultation, intraoral scanning, 3D printing) per patient:

TS = 36.06 min. + 39.4 min. + 180.84 min. = 256.3 min.

Regarding the process of removing traditional impressions with the help of dispensary masses for impressions, its duration was, on average, 32.77 minutes, which is 6.63 min. less than the time of taking digital impressions due to the absence of the necessity to create an STL file of digital jaws. The duration of scanning plaster models, processing information in computer programs for the purpose of creating STL files and subsequent 3D printing is 146.74 minutes per model, of which Tp = 46.27 minutes, Tvr = 100.47 minutes.

Based on one patient (two models), the time standard for scanning and 3D printing will be as follows:

TS scan. 3D printing = Tp + 2ЧTvr = 46.27 min. + 2Ч 100.47 min. = 247.21 min.

Together (consultation, impression taking, scanning, 3D printing) per patient:

TS = 36.06 min. + 32.77 min. + 247.21 min. = 316.04 min.

Based on the methodological provisions of the official methods of determining labor costs in dentistry, where the volume of medical care provided during 60 minutes of working time is used to calculate the CUL (conditional labor intensive units) of a dentist's work at a clinical appointment, the CUL indicators are calculated according to the following formula:

CUL = TS x 1CUL,

where:

CUL — conventional units of labor intensity (in absolute numbers);

TS — time standard (in minutes);

1CUL is a conventional indicator of one conventional unit of labor intensity (in minutes).

According to the time standards that we've received for these types of orthodontic care, the time standards are as follows:

Consultation stage (as an independent type of assistance) — 0.5 CUL;

- taking digital impressions of the jaws with an intraoral scanner — 39.40 min. or 0.7 CUL;

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- 3D printing of one jaw model with digital impression removal — 116.23 min. or 2 CUL;
- a full cycle for one patient (consultation, digital impressions, 3D printing of two models) — 256.3 minutes. or 4.3 CUL.

2. 3D printing of jaw models when removing traditional impressions:

- consultation stage — 30.06 min. or 0.5 CUL;
- taking traditional impressions — 32.77 minutes. or 0.5 CUL;
- a plastic model scaning and 3D printing of one jaw model — 146.74 min. or 2.5 CUL;
- a full cycle for one patient (consultation, traditional impressions, scanning and 3D printing of two models) — 316.04 minutes. or 5.3 CUL.

Discussion

A careful analysis of the obtained results of time-keeping studies of the duration of 3D printing of jaw models by an orthodontist in clinic conditions showed that with practically the same time standards for taking impressions of the jaws by digital or traditional methods, the total working time is in favor of the effectiveness of using the digital protocol of intraoral scanning 4.3 CUL vs. 5.3 CUL when taking impressions in the traditional way, albeit with the use of a mass dispensary for impressions.

The indicator of the difference in 1 CUL or in 60 minutes of working time of the orthodontist is the result of the need for additional processing of plaster models of the jaws when they are scanned in a stationary scanner (processing of the plinth on the trimmer, filling of undercuts, application of spray for scanning, installation in the scanner, direct scanning, processing scanning, error correction, STL-file production).

Conclusion

In terms of time spent by the orthodontist, the full 3D printing cycle of jaw models when taking digital impressions of the jaws using an intraoral scanner is 60 minutes shorter or 19 % more efficient than the full 3D printing cycle of the same jaw models removal of traditional impressions with the dispensary of masses for impressions.

Despite to the cost of an intraoral scanner, which exceeds the cost of a stationary scanner by 2-3 times, a time saving of up to 19 %, the absence of the need for complicated and dirty work with plaster, the convenience for the doctor and the patient allows us to conclude that the use of digital methods in the work of the doctor is more effective — a dentist in the provision of orthodontic assistance in the treatment and prevention of maxillofacial anomalies and deformations.

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