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SPIROMETRIC EVALUATION OF RESPIRATORY CAPACITY AT USERS OF TOTAL DENTURES (REVIEW)

СПИРОМЕТРИСКА ПРОЦЕНА НА РЕСПИРАТОРНИОТ КАПАЦИТЕТ КАЈ КОРИСНИЦИТЕ НА ТОТАЛНИ ПРОТЕЗИ

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Abstract

Dental prosthetic appliances will function properly only if aligned with all the other components that comprise the masticatory organ. For a dental prosthesis to be therapeutic, it is expected to restore the effects of lost teeth and establish the function of: mastication, swallowing, phonation, aesthetics, and normal breathing, thus performing prophylaxis of living tissues. The purpose of this literature review is to determine the impact of complete removable dentures on the respiratory capacity of their carriers through spirometry test evaluation. Several authors have performed examinations to see if complete removable dentures have an impact on spirometry test results. **Key words:** Spirometry, edentulism – total tooth loss, removable total dentures.

Апстракт

Протетичкиот додаток правилно ќе да ја врши функцијата само ако е вклопен со сите останати компоненти кои го сочинуваат џвакалниот орган. Се очекува тој да биде терапевтско средство со кое ќе се лечат последиците од изгубените заби и ќе се воспостават функциите на: џвакање, голтање, фонација, естетика и нормално дишење, така што при тоа ќе врши профилакса на живите ткива. Целта на овој литературен преглед е да се одреди влијанието на тоталните протези врз респираторниот капацитет кај нивните носители, преку спирометриска процена. Повеќе автори правеле испитувања за да воочат дали тоталните протези имаат влијание врз спирометарските проценi (тестови). **Клучни зборови:** клучни зборови: спирометрија, беззабност, тотални протези.

Introduction

Over the last few decades, teeth of civilized nations have collapsed rapidly and massively. This problem is generalized around the world. It is present in all nations, regardless of gender and age. On the other hand, people from developing countries are affected proportionally to the extent of their economic development. This shows that there is a growing need for all kinds of dental prosthetic appliances, and dental prosthetics is being given more and more significance.

Dental prosthetics has long been important in terms of oral and general human health, so it was economically necessary to analyze the principles and adopt protocols and procedures for making removable complete dentures. It's all based on science and blends with the contemporary technological capabilities.

In 1903, the famous dental historian Geist - Jakobi claimed that dental prosthetics was a skill and had little to do with medicine. Until World War I, only the extracted tooth was studied. Those understandings changed radically when he began to study the tooth as part of a sophisticated and complex gnatological (masticatory) system.

Further advances in dentistry were related to the knowledge of the temporomandibular joint, its mechanics and kinetics. It was found that there was some relationship between the shape of the teeth and the movement of the joint. It is understood that the teeth, the upper and lower jaw, the skeletal muscles and the temporomandibular joint were an integral part of the single gnatological system and that they all together constituted the functional unit - apparatus mandibulo-maxillaris, known as the stomatogenic system in the new Anglo-

American literature. The understanding of the functional unity of the teeth, the connective tissue connecting them to the jawbone, all soft tissues and glands, the cheek and tongue muscles, and the temporomandibular joint (TMJ), which have become dominant in the science of dental prosthetics, places dental prosthetics equal with medicine.

The gnatological system is a very complicated integral part of the human body, made up of many components. Dysfunction or lack of function of any of its components changes the function of the entire system. With the loss of teeth, only one component of that system is missing, and the prosthetic appliance has to take over all the functions of that component. Prosthetic therapy must take into account all of these relationships. Only this condition enables proper treatment of any defects in the gnatological system, i.e. each treatment should begin with a view of achieving a functional unit, that is to say, known in the literature as oral rehabilitation.

Dental prosthetic appliance can only perform its function properly if it is aligned with all the other components that make up the gnatological system. The modern prosthetist is aware that a dental prosthesis can fit successfully into that system only if the damaged functions of the gnatological system are well known. These data have, over the last decades, led to a significant development of the science of dental prosthetics and conviction that it is not just a mechanical-craft problem, but that every singular prosthetic appliance is a biological and medical challenge. Today, the prerequisite for understanding and solving prosthetic problems requires knowledge from several sciences, such as chemistry, physics, biology, histology, physiology, pathology, bacteriology, hygiene, surgery, and medical psychology. Without the knowledge of all these disciplines, today's modern dental prosthetics cannot be imagined. And so, by applying general medicine and studying how living tissue responds to a foreign body, the underlying biological science of dental prosthetics is gradually evolving.

It was ascertained that removable prosthesis is a therapeutic appliance that restores the effects of lost teeth and that its task was not only to establish masticatory, aesthetic, and phonetic rehabilitation, but also prophylactic to the harmful effects that the removable prosthetic denture can cause on living tissue and mucosa. If we keep in mind the prophylactic properties of the removable prosthetic appliance, the modern prosthetist should also have in mind the basic setting of general medicine, which also applies to dentistry, which is primum non nocere, i.e. with the prosthetic appliance, primarily the patient must not be harmed.

The removable prosthesis is a foreign body, which necessarily causes some tissue damage. The prophylactic task is to minimize the harmful impacts, although today's remedies cannot yet be prevented[1].

In other words, if the dental prosthesis is poorly prophylactic, hygienic or laboratory-made, it will have a harmful effect on the surrounding tissues.

To ensure proper retention and stability of the complete removable dentures, they must be extended to the soft palate in the maxilla and to the retro-mandibular space in the mandible[2,3,4,5]. This means that the volume of the oral cavity is reduced and some crucial functions, such as speech and chewing efficiency, become limited[6,7,8]. Breathing is one of the most important vital functions and can be described as the exchange of gases between the living organism and the atmosphere, which is necessary to carry out the metabolic processes in the body (the living organism) [9]. In the process of breathing through the mouth, oral tissues and existing removable complete prosthesis in the mouth are the first structures to come into contact with the air that passes through the upper airways. It has been found that edentulism causes changes in the pharyngeal muscle[10, 11].

Lung functional tests are appropriate tests for the physiological evaluation of the respiratory system, for the diagnosis of pathological processes and for appropriate clinical management[12]. Spirometry is just one of the diagnostic methods for measuring lung function. It measures static and dynamic pulmonary volumes and flow capacities (vital capacity - VC, forced vital capacity - FVC, 1 second forced expiratory volume – FEV1, Tiffany's index - FEV1 / FVC, top expiratory flow for 25% of FVC - FEF75, forced expiratory flow to 50% of FVC - FEF50, forced expiratory flow to 75% of FVC - FEF25)[13]. The spirometry test has an appropriate quality control protocol and appropriate standards, which is the latest of the current standard for performing spirometry evaluations. These measurements are performed under the same conditions using the same spirometer. Spirometer calibration is daily required due to environmental factors (room temperature, air pressure, relative humidity), which adjusts the BTPS standard[14]. Prior to testing, it is necessary to obtain information on the patient's sex, age, body height, and weight, which are then compared to individual standards (expected values of the respondent). That standard, today, is embedded in the spirometer and does not need to be calculated because the device automatically calculates it. The European Coal and Steel Community Standard (CECA II)[15] is the most commonly used today.

After entering the appropriate patient data into the spirometer, the patient should stand upright and comfortably. The laboratory assistant explains the need and the way to perform the test by demonstrating the correct technique for performing the test. Patients undergo sev-

eral rehearsals until they have mastered the proper technique needed for proper spirometry. The patient should be encouraged to complete the exhalation process. It is important in this procedure to limit the number of trials (rehearsals and actual measurements) to 8 or less, to avoid patient exhaustion and inadequate results.

The spirometry test is performed by deep exhalation, deep inhalation and deep exhalation again through the spirometer pipe. This is repeated three times. The air must not pass through the nose, so a nose clip is used. During each measurement of the spirometry test, the technique of performing should be evaluated for each patient to avoid the appearance of an artefact in the final results. Possible artefacts may include the following: insufficient or incomplete inhalation, lack of labor on inhalation, additional inhalation, insufficient mouth closure, slow onset of exhalation, temporary exhaustion, partial nasal exhalation, coughing during the first second of exhalation etc. Technically, satisfactory spirometry evaluation should be done three times. These three measurements should be consistent (reproducible). Of these, two should not differ more than 100 ml (for FVC and FEV1), i.e. 150 ml from each other. When 3 satisfactory measurements are achieved, those with the highest FVC and FEV1 are selected and used for interpretation (compared to the individual standard), to calculate the percentages of expected values for that person/patient (measured value)/default (expected value x 100%). Thus, the calculated percentage serves for clinical evaluation of spirometry test results[14,16].

Patients with complete tooth loss often face problems while performing spirometry during their regular control of certain diseases, as their vertical dimension is lost. At the same time, rotation and displacement of the lower total denture, which is more mobile than the upper, reduces the posterior pharyngeal space. This is more symptomatic in patients suspected of having extrathoracic airway obstruction, as well as obstructive sleep apnea, parathyroid lymphadenopathy, etc.

Edentulism, also causes increased pharyngeal obstruction with worsening cardio-respiratory symptoms. Some authors recommend that the prosthesis should be in the mouth when performing spirometry, while others recommend removal of the prosthesis during the spirometry procedure[17,18,19].

Objectives

The aim of this literature review was to determine the impact of complete dentures on the respiratory capacity of their carriers through performing a spirometry test.

Materials and methods

The material consists of reviewed articles that examine spirometry test results in patients with complete tooth loss restored with complete removable dentures. The articles were acquired by research in international journals, as well as PubMed and NCBI database. Research was done with reviewed articles.

Discussion

Previous studies have shown that there is a strict relationship between orofacial conditions and the upper respiratory tract[20,21,22,23,24,25]. However, until the end of the 20th century, clinical findings were not used to assess the respiratory functions of various dental conditions, such as partial or total tooth loss. The most significant clinical records of the relationship between the oral condition and the respiratory function appeared only in the late nineties of the twentieth century.

Bucca et al[26] reported that the Apnea-Hypopnea Index (AHI) showed nearly double values during sleep in patients with total tooth loss who did not wear dentures. Patients were 44 years of age and had obstructive sleep apnea (OSA) and chronic obstructive pulmonary disease (COPD), who wore total dentures because of loss and extraction of teeth. Cephalometric analyzes of patients revealed a significant narrowing of the anteroposterior oropharyngeal space from 1.5 to 0.6 cm. Following these striking findings, they expanded their studies to six male toothless patients with obstructive sleep apnea (OSA). The authors observed that removal of total dentures significantly reduced the retropharyngeal space and that sleeping with removed dentures was associated with a decrease in mean and low arterial blood saturation, while increasing the Apnea-Hypopnea index[26]. The authors concluded that removing the complete removable dentures significantly reduces the retropharyngeal distance in patients with obstructive sleep apnea (OSA) during sleep. They advised patients not to remove complete removable dentures while sleeping to avoid the risk of developing obstruction of the respiratory tract[26,27].

In another study for evaluating the impact of complete removable dentures on the Apnea-Hypopnea Index (AHI), 34 patients with obstructive sleep apnea (OSA) were examined. Ariska et al.[28] found that wearing complete removable dentures reduced the Apnea-Hypopnea Index (AHI) in 19 patients, whereas it increased the index in 8 patients during sleep. Interestingly, the improvement of the Apnea-Hypopnea Index (AHI) is not associated with a decrease in apnea score but with a

decrease in hypopnea score. In addition, there was no significant difference between the different prosthetic situations (with and without prosthesis in the mouth) with correlation to the mean and low oxygen saturation index in percentages (SpO_2) and desaturation index.

In another study, Bucca et al.10 performed spirometry studies on 76 toothless patients, of whom 36 were asymptomatic, 22 had a chronic obstructive pulmonary disease (COPD) and 18 had a interstitial pulmonary disease (ILD). These studies were performed to determine the effect of total dentures on the respiratory function. In addition, they reported that in asymptomatic patients and ILD patients, lung performance was slightly improved when complete removable dentures were in the mouths of patients. The authors have so far found no significant differences in COPD patients if they wore or didn't wear their dentures. According to Bucca et al.[26], values of maximal expiratory flow rate (MEF), forced expiratory flow rate to 50% (FIF50), forced inspiratory flow rate to 50% (FEF50) were increased in asymptomatic patients, while peak expiratory values flow (PEF) and forced expiratory flow (FEF50) were increased in ILD patients. There was no significant difference in the studies on forced vital capacity (FVC) and excretory volume at 1% (FEV1) in any patient group.

Contrary to previous studies, Almeida et al.[29] performed a polysomnographic evaluation of 23 non-OSA patients. They observed that wearing a complete removable denture during sleep increased the AHI index in mild cases. The results of this study were consistent with those of Almeida et al. However, when compared with a spirometry test, subjects should be considered to have different sleeping positions during polysomnography, as opposed to sitting upright in standard spirometry.

Bucca et al.[30] compared results of PSG (polysomnography) in toothless individuals while sleeping with and without dentures in the mouth, and the results showed that the AHI index and the main oxygen saturation were significantly worse in the nights of toothless, denture-free patients than in patients that wore dentures in the mouth at night.

Bucca et al.[31] with the help of spirometry, reported that toothless patients with prosthesis had improvement in some parameters when performing the spirometry. The quality of sleep parameters, such as: sleep efficiency, sleep 1, sleep 2, sleep 3, REM sleep percentages, AHI index, oxygen saturation and excitement index, may all avoid the Obstructive Sleep Apnea Syndrome (OSAS) when using the prostheses.

According to Bucca et al.[30] attention should be paid to individual toothless patients who sleep with their dentures in order to prevent OSAS problems. Erivigni et al.[32] performed cephalometric analyzes in patients with total dentures and their studies found that wearing dentures encouraged changes in the position of the jaw and the tongue, as well as in the pharyngeal space, which could be used as a useful tip to reduce apnea in total prosthesis carriers.

Pellegrino R, Viegi G, Brusasco V et al.[33] have also found that maximal inspiratory flow (PIF) is significantly reduced during extratoracal air obstruction, since airway pressure (which is approximately equal to atmospheric pressure) cannot resist the negative intraluminal pressure produced by the inspiratory. As a comparison, this has little effect on intratracheal air obstruction.

Toothless patients with obstructive sleep apnea may or may not have dentures in their mouth during spirometry tests during lung function tests to assess intratracheal airway (such as distinguishing obstructive from restrictive lung diseases), but they always have to use prostheses for extrathoracic airway compression (as in cases of obstructive sleep apnea, paratracheal tumors, paratraheal lymphadenopathy and laryngeal inflammation).

Piskin B et al.[34] observed the impact of total dentures on spirometry parameters in toothless patients. A total of 46 carriers of total dentures were included in the study. Respiratory functions were examined in four different oral conditions: no prosthesis, only upper, only lower, and both oral prostheses. Spirometric analyzes used forced vital capacity (FVC), peak expiratory flow (PEF), forced expiratory volume in 1 second (FEV1) and forced expiratory flow between 25% and 75% (FEF 25-75).

Data were analyzed with Friedman, Wilcoxon and T-test. ($p = 0.05$). Results showed that there was a significant difference between the parameters with presence or absence of oral dentures ($p < 0.05$).

In all spirometry parameters, the most significant difference was found between the forced vital capacity in the absence of dentures in the oral cavity, the forced vital capacity in the presence of the lower denture as well as in the forced expiratory volume in 1 second without dentures in the mouth, forced expiratory volume in 1 second with the presence of the upper total denture only.

It has been reported that complete removable dentures can adversely affect spirometry values in toothless patients.

Bucca CB et al.[35] compared the values of FVC, FEV1, PEFR, FEF50%, FIV1 and FIF50% recorded with and without prosthesis in three groups of toothless patients: 36 asymptomatic patients with normal spirometry, 22 patients with chronic obstructive pulmonary disease (COP) and 18 with interstitial pulmonary disease (ILD). In 14 subjects, the retropharyngeal space was examined by cephalometry.

Respondents with normal spirometry and interstitial pulmonary disease showed significantly low prosthesis-

free air flow, while subjects with chronic obstructive pulmonary disease showed no significant difference in spirometry values with or without prosthesis.

The retropharyngeal space was significantly increased by removing the dentures (from 1.52 +/- 0.07 to 1.16 +/- 0.09 cm, SEM, p <0.0001).

These findings indicate that in toothless patients with normal or restrictive pulmonary function, airflow values, with or without prosthesis, have small but significant differences. Also, such differences do not play a role in the results of spirometry analyzes, so toothless patients are recommended to wear the dentures during spirometry analyzes.

Carossa S. et al.[36] have investigated whether toothless patients with an increased pharyngeal muscle will have an impact on spirometry analysis. Spirometry tests were conducted in 58 toothless patients, with and without dental prosthesis, 36 of whom were asymptomatic, with normal pulmonary function, and 22 had chronic obstructive pulmonary disease (COPD).

In 10 patients, the retropharyngeal space with and without prosthesis was measured by cephalometry. In the group of patients with normal pulmonary function, removal of the prosthesis caused a significant reduction in lung volume and air flow values, while in patients with obstructive pulmonary disease, it didn't have any impact.

In both groups, the retropharyngeal space was significantly reduced by removing the dentures.

Loss of teeth, by reducing extratracheal airway calibration, significantly affects spirometric measurements in patients with normal lung function but not in patients with chronic lung disease.

Majumdar S. et al.[37] examined spirometry functions. Patients and controls (n = 10) for each of the groups of males and females were examined by spirometry using a computerized electronic spirometer with tolerance assessed by a modified Harvard step test.

Patients with type 2 diabetes mellitus (n = 4), post-tuberculosis (n = 7), hypothyroid (n = 6), collagen vascular disease group (n = 6) showed restrictive spirometry results, and IHD (ischemic heart disease) patients showed significant limitations in the tolerance values examined.

Many studies suggest that loss of teeth causes decrease in the size and tonus of pharyngeal muscles, which can cause apnea in these individuals[38].

The morphological changes caused by tooth loss consist of a reduced vertical dimension of occlusion, a decrease in the lower third of the face, and anterior rotation of the mandible[39].

Also, loss of teeth causes an unnatural position of the thongue[40].

All of these disorders cause occlusive disorders and airway obstruction[41].

Usually, the purpose of oral appliances (dental prosthesis) is to increase the airflow (to restore the space as much as possible to a more natural position in the presence of teeth) during sleep by repositioning the mandible forward and downward[42].

Bucca et al.[41] compared the results of polysomnography in toothless patients with and without dentures, and showed that the AHI index and the main oxygen saturation were significantly worse at night in patients that slept without dentures than in patients who slept with the dentures.

Bucca et al.[38] also investigated patients with obstructive sleep apnea syndrome (OSAS) using spirometry tests. From the spirometry test results they found that the values improved when patients had prostheses in their mouths.

The quality of sleep parameters, such as sleep efficiency, first phase of sleep, second phase of sleep, third phase of sleep, percentage of REM sleep, AHI index, oxygen saturation and arousal index, could be improved in the OSAS patient group by the use of complete dentures.

Traditionally, dentists advise their patients to sleep without total dentures at night to prevent the risk of overnight oral irritation[43].

According to Bucca et al.[41] special consideration should be given to patients who sleep with total dentures in order to reduce OSAS problems.

Erovigni et al.[44] performed cephalometric analyzes in patients with total dentures. They found that wearing dentures stimulated changes in the TMJ and in the tongue position, as well as in the pharyngeal airflow space, which in turn reduced apnea in patients.

Bucca et al.[45] and Gupta et al.[46] confirmed that removal of dentures significantly reduces the retropharyngeal space, and thus denture-free sleep is associated with a significant decrease in the apnea hypopnea index (AHI) and a decrease in hemoglobin blood saturation. Authors have highlighted that wearing dentures overnight will reduce the effects of OSA.

Carossa et al.[47] described the effect of complete removable dentures and their impact on the reduced pharyngeal space and showed a significant reduction in PAS (posterior airway space). They concluded that wearing dentures induces modifications in the position of the tongue, the TMJ, and the pharyngeal space.

Gupta et al.[48] examined patients with total tooth loss using cephalometry with increasing vertical jaw alignment. They found a significant correlation between PAS and the retropharyngeal space in patients with no teeth in the mouth and in patients with complete dentures. They

concluded that increasing the vertical dimension of the occlusion within the permissible range was advantageous for patients with OSA.

Ariska et al.[49] and Bucca et al.[50] investigated the risk of OSA in total tooth loss with and without total dentures. They concluded that the absence of dentures reduces oxygen saturation and reduces the retropharyngeal space, which in turn results a worsened situation of OSA patients.

In a study by Tsuda et al.[51], it was demonstrated that toothless favors air obstruction during sleep. After all, both the AHI and the main SaO_2 index were significantly worse in patients who slept without dentures than in patients who slept with dentures.

Conclusion

This paper provides research from authors who have worked on the issue of respiratory function in patients wearing complete removable dentures. Their research was done to determine if complete removable dentures have an effect on airflow in the airways.

Patients with obstructive pulmonary disease are advised not to remove their complete removable dentures while sleeping to avoid the risk of upper airway collapse (worsening of results). This data confirms the findings that complete removable dentures in the oral cavity tend to restore the condition in the oral cavity to as normal as possible (vertical dimension and position of surrounding tissues).

On the other hand, in patients who did not use to have respiratory problems, a difference was observed in the results of spirometry depending on the individual.

Spirometry test results in cases who wore the complete removable dentures had an impact in some individuals, while that wasn't the outcome with other examined subjects.

This data cannot confirm with certainty whether patients should remove prostheses during examinations and overnight sleep, as some tests have shown no changes, while other have shown improvement in performing spirometry with oral prostheses.

Some individuals who have difficulties getting used to new conditions, do not fully accept the prostheses and this interferes while performing spirometry tests and wearing them at night while sleeping.

As mentioned earlier, for a complete removable denture to be appropriately accepted by the patient (its user), it must be maximally extended, thereby reducing the volume of the oral cavity and impeding the oral function. Therefore, it is traditionally accepted by dentists to advise their patients to sleep without the complete removable dentures in the mouth at night in order to prevent the risk of oral irritation.

From dental point of view, as a rule for the use of complete removable dentures, it should be noted that prosthesis should be removed from the oral cavity at a certain time of the day to avoid the risk of oral irritation. This period is usually overnight, because the person is inactive, with all the functions reduced to a minimum and can be easily applicable. For people active during the day, removing dentures from the oral cavity for tissue rest would be an additional obligation that can be overlooked by other daily tasks.

In patients with a clinical history of airway obstruction, it should be noted that for better results, dentures may be worn at night if it's not in another way problematic for them, but note that the break from wearing the prosthesis intended for rest of the oral tissues should not be neglected and should be practiced at other parts of the day.

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