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INCREASING THE UPPER AIRWAY SPACE USING ORAL APPLIANCES IN PATIENTS WITH MILD SLEEP APNOEA CAUSED BY STOMATOGNATHIC DYSFUNCTIONS*

POPRAWA TORU ODDECHOWEGO GÓRNEGO ODCINKA UKŁADU ODDECHOWEGO PRZEZ ZASTOSOWANIE WEWNĄTRZUSTNYCH APARATÓW STOMATOLOGICZNYCH W ŁAGODNYCH POSTACIACH BEZDECHU NOCNEGO WYSTĘPUJĄCEGO W DYSFUNKCJACH UKŁADU STOMATOGNATYCZNEGO

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Streszczenie

Wstęp: Podłożem upośledzenia toru oddechowego mogą być wady rozwojowe lub odmienności budowy anatomicznej górnego odcinka układu oddechowego będące podstawową przyczyną niefizjologicznego oddychania człowieka. Zaliczamy do nich schorzenia układu stomatognatycznego, które przyczyniają się w znacznym stopniu do niedostatecznej drożności górnego odcinka układu oddechowego. Leczenie zaawansowanych postaci dysfunkcji układu stomatognatycznego ze względu na wieloprzyczynowość jest trudne i często wieloetapowe. Jednym z bardziej uciążliwych powikłań są bezdechy nocne. Podstawowym postępowaniem stosowanym w terapii jest zmiana przestrzennego położenia żuchwy względem szczęki. Do tego celu wykorzystuje się różnego rodzaju wewnątrzustne aparaty ortopedyczne.

Celem pracy było porównanie wyników zastosowania prostych aparatów ortopedycznych w celu poprawy toru oddechowego górnego odcinka układu oddechowego w łagodnych postaciach bezdechu nocnego występującego w dysfunkcjach układu stomatognatycznego.

Materiał i metody: Badania przeprowadzono w latach 2006–2010 na 92 pacjentach (średnia 42,5 lata) z rozpoznaną zaawansowaną postacią dysfunkcji układu stomatogantycznego. W postępowaniu terapeutycznym zastosowano w 54 przypadkach stomatologiczne aparaty ortopedyczne, natomiast u 22 pacjentów zastosowano skojarzone wieloetapowe postępowanie z wykorzystaniem w I etapie leczenia szyn. Zastosowano dwa typy aparatów, w tym jeden własnej modyfikacji. W postępowaniu oceniano czas ustąpienia objawów bólowych i zmniejszenia się bezdechów nocnych oraz poprawę oddychania przez nos.

Wyniki: Zmiana przestrzennego położenia żuchwy nie tylko zniosła dolegliwości ze strony układu stomatognatycznego, ale również usprawniła tor oddechowy u pacjentów.

Wnioski: Zastosowanie zmodyfikowanych aparatów stomatologicznych skraca czas terapii oraz ma wpływ na lepsze samopoczucie pacjentów. Tym samym może mieć wypływ na leczenie wczesnych postaci bezdechów nocnych.

H a s ł a: zespół bezdechu sennego – aparaty ortodontyczne – układ stomatognatyczny – zespół stawu skroniowo-żuchwowego.

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Summary

Introduction: Abnormal breathing can be caused by developmental malformations or anatomical variations in the upper airways. Stomatognathic diseases may significantly impair the patency of the upper respiratory tract. Treatment of advanced stomatognathic dysfunctions is difficult due to their multifactorial aetiology, and often involves many phases. Sleep apnoea is one of the most bothersome complications. The mainstay therapeutic strategy relies on modifying the position of the mandible against the maxilla, achieved by using different types of oral appliances.

Material and methods: The study was carried out in 2006–2010 on 92 patients (mean age 42.5 years) with diagnosed advanced dysfunction of the stomatognathic system. The treatment relied on the use of an orthodontic appliance (54 patients) or combined multi-phase therapy with splints used in the first phase (22 patients). Two different appliances were used (one of them was modified by the authors). Parameters assessed in the study included time to resolution of pain, reduction in the incidence of sleep apnoea, and improvement in nasal breathing.

Results: Change in the protrusion of the mandible not only relieved problems with the stomatognathic system, but also improved breathing in patients. The use of modified oral appliances reduced treatment duration and improved patients' comfort. Therefore, it may be useful in the treatment of patients with mild sleep apnoea.

K e y w o r d s: sleep apnoea – oral appliances – stomatognathic system – dysfunction.

Introduction

Breathing is one of the most important vital signs. It seems uncomplicated and is an integral part of human physiology. We start to breath at birth and our body regulates the breathing process. Everyday activities such as work, physical effort and stress are connected with accelerated breathing. We often do not realize that our breathing is very shallow, and we use very little lung capacity. Thus, any interference to airway space, either in the nose or lungs, can affect respiratory function [1].

Shallow breathing impairs ventilation because the supply of oxygen is insufficient, and the level of carbon dioxide increases in the blood, causing hyperstimulation of the respiratory centre. General hypoxia leads to uneven breathing, sleep disorders, snoring, crying out, and frequent awakenings, followed by morning tiredness, disorientation and mental dullness [2]. Breathing disorders can be caused by developmental malformations, anatomical variations, injuries, and organic factors, but also by ordinary, common and chronic respiratory tract infections [3]. One of the causes for abnormal breathing in humans is impaired patency or complete obstruction of the nasal cavities [2, 3].

Mouth breathing eliminates a number of nasal functions: respiratory, ventilation, filtration, thermal, antibacterial, hydrating, resonating, which may affect human physiology in general [3]. Stomatognathic dysfunctions are among the factors responsible for obstructions in the upper airways, causing mouth breathing, thus leading to a position of the tongue too low to allow air flow to the lungs. The balance of forces in the oral cavity is disturbed, leading to changes in the tone of the soft tissues acting on the facial skeleton. This is manifested by remodelling of the maxillary and mandibular arches, and consequential facial malformations [4]. Abnormal teeth positioning in the maxilla and mandible can also cause disorders of the stomatognathic system. Such disorders stimulate the development of nasopharyngeal obstructions [1, 5].

Functional disorders of the stomatognathic system are becoming an increasingly serious diagnostic and therapeutic problem. This is proven by the number of papers published in dental journals, and also topics addressed at scientific conferences [1, 6, 7, 8]. Symptoms, particularly those experienced by patients with advanced functional disorders of the temporomandibular joint, include pain in the joint region, clicking or popping sounds during mandibular movements, and sleep apnoea [9, 10]. The symptoms are thought to be associated with posterior displacement of the mandible, which may be caused by different factors [7]. One of these is the loss of support zones caused by lowered occlusion or loss of dentition. Posterior displacement of the mandible may also be caused by abnormally high tone of the masseter muscles. Both of these problems are observed in Costen's syndrome [10, 11, 12]. Posterior displacement of the mandible may reduce pharyngeal volume and impair breathing (Fig. 1). The treatment of choice in patients with different functional disorders of the stomatognathic system relies on the repositioning of the mandible using simple orthodontic appliances. Such appliances improve the airway patency in snoring patients or those with obstructive sleep apnoea. The appliances help to eliminate snoring and sleep apnoea, are designed for convenient use by patients with primary and secondary dentition, as well as those with partial or complete loss of dentition [13, 14, 15, 16, 17, 18, 19, 20].

Fig. 1. Acrylic occlusal splint fitted on a plaster model – right side

Material and methods

The study was carried out in 2006–2010 at the Department of Dental Prosthetics of the Pomeranian Medical University in Szczecin on 92 patients aged 35–65 years (mean age 42.5 years), diagnosed with advanced dysfunction of the stomatognathic system. The study included patients who gave informed consent to participate in the necessary diagnostic procedures and accepted the proposed treatment option. The full record of physical examination for each patient included: findings from medical interview with the patient, interview regarding self-reported dysfunctions of the stomatognathic system, and interview focused on pain symptoms. The standard medical interview focused on the general health of each patient, and was based on a questionnaire handed to all patients visiting the clinic. The interview regarding self-reported dysfunctions of the stomatognathic system was carried out by measuring the stage of disorder using the Helkimo index [9].

Moreover, the medical records of treatment and examination for each patient included cephalometric imaging, diagnostic models prepared based on anatomical impressions of the maxilla and mandible, and photographic records of individual phases of treatment.

Minor or advanced functional disorders of the temporomandibular joint, crowding of teeth, or other orthodontic problems contributing to the development of mild sleep apnoea and snoring were diagnosed in 76 patients. In 76 patients with stage 2 or 3 of dysfunction acc. to the Helkimo index therapy involved the use of splints. Group II B was divided into subgroups depending on the type of splint used. Group III C included patients in whom the use of splints was a part of the treatment (Tab. 1).

Maxillary and mandibular impressions, necessary for the preparation of plaster models, and wax occlusal records, were made at the first visit. Then, a dental technician in the

Table 1. **Classification of patients depending on the Helkimo index**

Sex of patients	Group I A	Group II B	Group III C
Female 67 (72.85%)	12 (17.9%)	39 (58.2%)	16 (23.8%)
Male 25 (27.15%)	4 (16%)	15 (60%)	6 (24%)
Total 92 (100%)	16 (17.3%)	54 (58.6%)	22 (24.1%)

Fig. 2. Full acrylic occlusal splint

Fig. 3. Full acrylic occlusal splint fitted in a patient – in occlusion

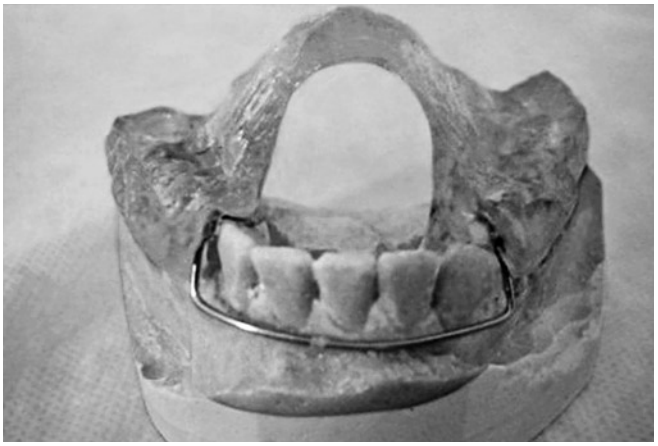

Fig. 4. Modified occlusal splint fitted on a plaster model – front view

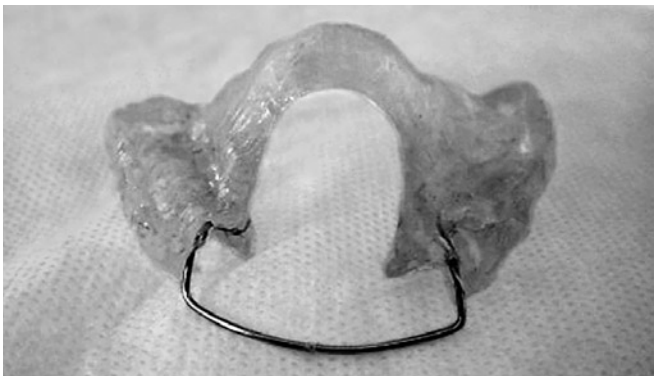

Fig. 5. Modified occlusal splint

Fig. 6. Modified occlusal splint fitted in a patient – in occlusion

laboratory prepared therapeutic occlusal splints corresponding with wax records. On the next visit the appliance was given to the patient, with instruction on use and hygiene, and a schedule for check up visits was agreed.

Occlusal splints, including one modified by the authors, were used in the treatment of patients. Therapeutic occlusal splints should normally cover both dental arches. However, patients using full therapeutic occlusal splints are only able to breathe through the nose (Fig. 1–3). Patients with functional disorders frequently present with a mixed breathing pattern, but mostly breathe through the mouth. Therefore, a full occlusal splint makes breathing during sleep difficult.

We modified the therapeutic occlusal splint by uncovering its anterior part, i.e. incisors and canines (Figs. 4–6), thereby preventing airway obstruction, and also allowing for the use of the splint night and day [15].

Patients grouped according to the Helkimo index were evaluated for the time to resolution of pain and sleep apnoea. In group B1 (n = 19) we used an acrylic therapeutic occlusal splint covering both dental arches (Figs. 1–3). In group B2 (n = 35) we used a modified splint covering premolars and molars in the middle of their height, with an integrated 0.9 mm wire arch in the anterior part of the splint, positioned in the oral vestibule (Figs. 4–6).

In the group of C1 and C2 complex proceedings were used. In the first stage of the C1 group (n = 8) were used occlusal splints. The second stage consisted of an exchange of existing permanently attached (*fixed*) and movable prosthetic restorations. Whereas in the first stage of the group C2 (n = 14) modified occlusal splints were used and in the second stage of the C2 group the occlusal plane was changed using existing fixed or movable prosthetic restorations. Then, after a period of adaptation, final prosthetic reconstruction of an occlusion was performed using modified splints.

In all 76 patients we evaluated time to the resolution of acoustic symptoms and pain in temporomandibular joints, and time to improvement or resolution of sleep apnoea. The follow-up period was 12–18 months.

To analyse the correlation between individual variables presented in contingency tables, we carried out χ^2 independence tests. We tested a zero hypothesis, that variables in the table are independent, and an alternative hypothesis on the correlation between the variables. We calculated the values of the verification score for χ^2 and critical values of χ^2_α distribution for the adopted critical significance level $\alpha = 0.05$. For $\chi^2 < \chi^2_\alpha$ there was no reason to reject the hypothesis on the independence of variables, and for $\chi^2 \geq \chi^2_\alpha$, the hypothesis on independence was rejected in favour of the alternative hypothesis.

Summary of results

Groups B1, B2 and C1 + C2 comprised 76 patients (54 women and 22 men). Women accounted for 72.85% and men for 25.15% of the study population (Tab. 1). To analyse the correlation between groups of patients classified acc. to the Helkimo index and sex, data were pooled in contingency tables, and values of the verification score for χ^2 was calculated, including determination of a critical value for each parameter. The distribution of all analysed parameters was normal. The χ^2 test for independent variables confirmed that there were no statistically significant differences between the studied women and men in terms of mean values of the analysed parameters ($p < 0.05$). Because

Table 2. **Groups II B1 and B2**

Sex of patients	Group B1 Occlusal splint	Group B2 Modified occlusal splint
Female	15 (34.1%)	29 (65.9%)
Male	4 (40%)	6 (60%)
Total	19 (35.2%)	35 (64.8%)

Table 3. **Groups III C1 and C2 methods of multi-phase treatment acc. to split used**

Sex of patients	Group C1 Occlusal splint + a therapeutic procedure prosthetic	Group C2 Modified occlusal splint + a therapeutic procedure prosthetic
Female	6 (37.5%)	10 (62.5%)
Male	2 (33.3%)	4 (66.7%)
Total	8 (36.3%)	14 (63.7%)

Table 4. **Use of splints by study groups**

Sex of patients	Occlusal splint group B1 and C1	Modified splint group B2 and C2
Female	21 (35%)	39 (65%)
Male	6 (37.5%)	10 (62.5%)
Total	27 (35.5%)	49 (64.5%)

Table 5. **Duration of pain and sleep apnoea**

Group	< 3 months	3–6 months	6 months
II B1 Occlusal splint	3 (15.9%)	6 (31.5%)	10 (52.6%)
II B2 Modified splint	2 (5.7%)	8 (22.9%)	25 (71.4%)
III C1 Occlusal splint	0 (0%)	2 (28.5%)	5 (71.5%)
III C2 Modified splint	0 (0%)	6 (40%)	9 (60%)
Total	5 (6.6%)	22 (28.9%)	49 (64.5%)

Table 6. **Time to resolution of pain and sleep apnoea after use of occlusion and modified occlusal splint**

Group	< 3 months	3–6 months	> 6 months
II B1 Occlusal splint	3 (15.8%)	6 (31.5%)	10 (52.7%)
II B2 Modified splint	25 (71.5%)	8 (22.8%)	2 (5.7%)
III C1 Occlusal splint	2 (22.2%)	5 (66.7%)	1 (11.1%)
III C2 Modified splint	6 (50%)	5 (43.6%)	3 (6.4%)
Total	36 (47.5%)	25 (32.8%)	15 (19.7%)

of the confirmed lack of statistically significant differences between the sexes of the studied patients, further comparative analysis included combined data obtained for men and women. In groups B1, B2 and C1 + C2 treatment relied on the use of therapeutic occlusal splints. In patients from group C1 + C2, with advanced medical conditions, splints were used in the early phase of treatment (Tabs. 2–4). Values of the verification score for χ^2 demonstrated no significant differences in terms of sex between patients from groups B1, B2 and C1 + C2. Moreover, the χ^2 test revealed no statistically significant differences between the duration of pain, functional disorders of the stomatognathic system and sleep apnoea in the studied patients (Tab. 5). However, statistical analysis revealed a significant correlation between the time to resolution of pain and sleep apnoea and the type of splint used. In patients treated with modified splints, the time to resolution of symptoms was significantly shorter, because patients adapted better to the use of the appliance. Therapy relying on the use of modified splints reduced treatment time and significantly improved airway patency (Tab. 6).

Discussion

There are many factors contributing to the development of sleep apnoea coexisting with functional disorders of the stomatognathic system [2, 4, 8, 12]. Snoring is one of the symptoms that occur in patients with misaligned mandible and maxilla. Conservative treatment includes methods improving airway patency. Repositioning therapy relies on controlling the body position during sleep and the choice of position in which airway resistance is lowest. In most cases, sleeping on the back should be avoided. The purpose of diet in the treatment is to normalize body weight, improve sleep hygiene (by avoiding meals before bedtime), and prevent episodes of night-time gastro-oesophageal reflux (by avoiding sweet and fat foods before bedtime [2, 11]. Dental treatment involves the use of different occlusal splints, stress breakers and stabilizing splints, which help to restore and maintain the normal position of articular discs and mandibular heads [14, 16]. Orthodontic appliances can be used as deprogrammers (e.g. NTI splints), or be prepared *ex tempore* during the patient's visit [6, 13].

The comparison of our findings with those by other authors revealed that the use of the modified splint allowed us to achieve better adaptation of patients, and thus reduced treatment duration [14, 15, 17]. The presented method for the treatment of stomatognathic dysfunctions associated with breathing disorders and sleep apnoea is low-invasive, relatively inexpensive, and in a short time brings therapeutic benefits that can be noticed personally by patients. Patients treated with an oral appliance were well-rested after sleep and relaxed, had improved concentration, and performed better at work and school [15].

Treatment of functional disorders of the temporomandibular joints complicated by the occurrence of mild forms of sleep apnea requires a complex treatment. Similar methods of using splint therapy were described in works of *Pihut* and *Jankowska*, *Nitecka-Buchta et al.*, as well as in works of *Kostrzewa-Janicka et al*. Works of *Tomasik*, *Jagucka-Mentel et al.*, and *Nitecka-Buchta et al.*, pointed that specialized diagnostics is essential [19, 20, 21, 22, 23, 24, 25].

Conclusions

1. Modelling of the mandibular position helps to resolve dysfunctions of the stomatognathic system, thus eliminating breathing disorders of the upper respiratory tract.
2. The use of modified occlusal splints in patients with advanced chronic temporomandibular joint disorders reduces the duration of initial treatment before targeted specialist diagnostics and multi-phase therapeutic procedure. Therefore, it may be useful in the treatment of patients with mild sleep apnoea.

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