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DENTISTRY • ORIGINAL ARTICLE

An epidemiological survey of obstructive sleep apnea-hypopnea syndrome among edentulous population based on modified Berlin questionnaire

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Abstract
Purpose This study aims to investigate the percentage of people in high risk of obstructive sleep apnea-hypopnea syndrome (OSAHS) in edentulous population using the modified Berlin questionnaire (MBQ), to identify sex difference in percentage of edentulous people at high risk of OSAHS, and to analyze the occurrence rate of OSAHS-related symptoms that were not included in the MBQ in this group of people.
Methods Five hundred and forty patients (edentulous in mandible or maxilla or both) were recruited to participate in this study. Demographic information, nocturnal denture wearing habit, and sleeping posture were recorded. Meanwhile, subjects completed the MBQ in which participants' snoring behavior, wake-time sleepiness or fatigue, and the presence of obesity or hypertension were investigated.
Results Four hundred qualified questionnaires were obtained. According to the MBQ, about 31 % of the subjects were classified at *high risk of OSAHS*. No significant difference in the percentage of people at high risk of OSAHS was found between male and female groups. *Dry or sore mouth and throat*, *polyuria during sleep*, and *difficult to fall asleep/easy to wake up* showed high occurrence rate equal to or higher than 60 % in the high-risk group.
Conclusions According to the MBQ, about 31 % of the edentulous population was identified as high risk of OSAHS. Equal attention should be given to elderly edentulous female and male since they are at the same level of risk of developing OSAHS.

Keywords Edentulism · Obstructive sleep apnea-hypopnea syndrome (OSAHS) · Modified Berlin questionnaire(MBQ) · Epidemiological survey

Introduction

According to the third Chinese national oral health survey, about 7 % of the Chinese elderly people are edentulous [1]. Edentulism results in loss of vertical dimension of occlusion, and edentulous people suffer from reduction of lower third facial height, rotation of mandible, and lack of facial support. These anatomical changes may have influences on the stomatognathic system [2].

Obstructive sleep apnea-hypopnea syndrome (OSAHS) is a highly prevalent breathing disorder in sleep with high morbidity, severe influence on quality of life, and potential fatality. The etiology of OSAHS is complex, and not yet fully understood, anatomical narrow of the upper airway seems to be the most common and accepted reason [3].

Complete dentures are conventional prostheses for edentulous people. These people are usually instructed to avoid wearing dentures during sleep [4]. Hence the majority of edentulous people sleep without natural teeth or dentures supporting their upper and lower jaw during night, it raises a question whether this condition will cause or exacerbate symptoms of OSAHS. However, there were only a few studies addressing the situation of OSAHS in edentulous population, focusing on comparing polysomnogram (PSG) results with or without dentures in patients' mouth during sleep. So far, no

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sizable-sample epidemiological survey of OSAHS among edentulous population has been conducted. Therefore, this study aims to investigate the percentage of people at high risk of OSAHS in edentulous population using the modified Berlin questionnaire (MBQ), to identify sex difference in percentage of edentulous people at high risk of OSAHS, and to analyze the occurrence rate of OSAHS-related symptoms that were not included in the MBQ in this group of people.

Methods

A total of 540 patients (edentulous in the mandible or maxilla or both) were recruited to participate in this study from August 2012 to December 2013. These patients have received complete denture treatment either in the clinic of Department of Prosthodontics at Peking University School and Hospital of Stomatology (PKUSS) or at Beijing Stomatological Hospital (BJSH). The study protocol was approved by the Biomedicine Ethical Review Board of PKUSS. Researchers in the study team contacted patients via telephone to do the preliminary screening and then sent out mails to patients who were willing to participate. Patient inclusion and exclusion criteria are shown in Table 1.

These patients' complete dentures were delivered by experienced prosthodontists (over 10 years of clinical experience) at PKUSS and BJSH. Demographic information (age, sex, body height, and body weight), nocturnal denture wearing habit, and sleeping posture of all the subjects were collected. Meanwhile, subjects completed the MBQ. The modified Berlin questionnaire was modified from the original Berlin questionnaire in 2006 by Professor S.K. Sharma in Indian and is proved to be more suitable for the eastern people [5]. It has been validated for Chinese population by Chinese scholar Lai Wenjuan and her colleagues [6]. According to the MBQ, these patients were divided into OSAHS high-risk group and OSAHS low-risk group.

Table 1 Inclusion and exclusion criteria

Inclusion criteria
Male and female
60–90 years old
Wearing complete denture for at least half a year
An adequate understanding of written and spoken Chinese
Able to understand and respond to the questionnaires used in the study
Willing and able to accept the protocol and to give informed consent
Exclusion criteria
Unaccustomed to wearing complete denture
Suffering from severe disease of respiratory system
Suffering from uncontrolled internal medicine diseases, such as heart, kidney, or liver failure or any terminal disease
Not in a normal mental state

A chart with several OSAHS-related symptoms that were not included in the MBQ was attached to the questionnaire. These OSAHS-related symptoms included those observed during sleep, i.e., *sweating or nocturnal enuresis*, *polyuria during sleep*, and *difficult to fall asleep/easy to wake up*, and those happened in daytime, i.e., *dizziness*, *nausea*, and *dry or sore mouth and throat*. Occurrence rate of these symptoms in the high-risk and low-risk groups was calculated to identify the most common symptoms related to OSAHS and to support the validity of MBQ.

In order to control the quality of data collected for the questionnaire, we instructed the participants and their families to observe the relevant behaviors in the questions for 1 week before they filled in the questionnaire. Questionnaires were analyzed by one researcher and sampling inspected (10 %) by another researcher. Statistical analysis was performed using SPSS 13.0. A P value of less than 0.05 was considered significant.

Results

A total of 540 participants were asked to finish the questionnaire, and 540 questionnaires were returned, in which 38 participants failed to complete the questionnaire and 102 participants missed some important questions such as snoring behavior or presence of hypertension and were therefore excluded from the study. In the end, 400 completed and qualified questionnaires were obtained. The qualification rate was 74 %. In the 400 patients, 329 (82.25 %) were wearing both upper and lower complete dentures, 51 (12.75 %) were wearing maxillary complete denture, and 20 (5 %) were wearing mandibular complete denture. For the 71 patients who wore single dentures, their opposing dentitions were either natural dentitions or partially edentulous dentitions restored with removable dentures.

Demographics

The average age of the 400 edentulous participants was 74.1 years old. Among them, 40 % were male and 60 % were female. The average body mass index (BMI) was 23.3 kg/m^2. Ninety-four percent of them did not wear dentures during sleep. About 70 % of the participants did not have a settled sleep posture, about 25 % were used to lie on one side, and only 5 % were used to lie supine. The overall repetitive rate of the questionnaire was 83 % (85 % for snoring behavior, 80 % for sleepiness or fatigue, and 100 % for presence of obesity or hypertension).

Data from modified Berlin questionnaire

The modified Berlin questionnaire suggested that 31 % (125 out of 400) of the participants were *at high risk of OSAHS*. There was no significant difference in age and sex distribution between the OSAHS high-risk and low-risk groups even though women outnumbered men in both groups. An average BMI value of 24.6 was detected in the OSAHS high-risk group, and that of the OSAHS low-risk group was 22.7 (Table 2).

Only 26 out of the 400 edentulous patients wore dentures during sleep. No significant difference in nocturnal denture wearing habit and sleeping posture was found between the OSAHS high-risk and low-risk groups (Table 2).

OSAHS-related symptoms that were not included in the MBQ

There were some OSAHS-related symptoms that were not included in the MBQ as identifying items. However, when these symptoms were shown to patients as possible feelings and behaviors during sleep and daily life, significantly higher occurrence rate of some symptoms was found in the high-risk group than in the low-risk group (Fig. 1). Over 70 % of the people in high-risk group had experience of dry or sore mouth and throat as a wake-up symptom, and polyuria during sleep and difficult to fall asleep/easy to wake up were reported by around 60 % of the participants in high-risk group, while the occurrence rates of these symptoms in the low-risk group ranged from 20 to 45 %.

Discussion

Overnight PSG is considered to be the golden standard for diagnosis of OSAHS. However, prohibitive cost of the test and long waiting lists limit its widespread access. Sleep specialists proposed the Berlin questionnaire as a screening tool of OSAHS in 1996 [7]. The questionnaire was made up of three parts: snoring behavior, wake-time sleepiness or fatigue, and presence of obesity or hypertension, with a sensitivity of 86 % and a specificity of 77 %. Sharma modified the questionnaire according to country development and oriental physical status. The modified Berlin questionnaire was proved equally validated to the original one and suitable for oriental with a sensitivity of 86 % and a specificity of 95 % [5]. It has been validated for Chinese population by Chinese scholar Lai Wenjuan and her colleagues [6]. This Chinese version of MBQ was adopted in our survey. Questions from the MBQ have shown high repetitive rate (83 %) in this study, which was similar to that of Chung's study [8]. This was acceptable, considering the observational and subjective nature of data related to snoring behavior, sleepiness, and fatigue.

Edentulism is a common condition among elderly people. According to the third Chinese national epidemiological investigation of oral health, 6.8 % of the elderly individuals were edentulous [1]. If the criteria of the investigation were taken into consideration (patients were not classified as edentulism if there was one or more than one tooth left in the mouth, without considering the endodontic or periodontic condition of the remaining tooth/teeth), the actual edentulous population should be much larger. What is more, China is becoming an aged country with its growing elderly population [9]. Therefore, the health care of the aged edentulous population will still be a highly demanding issue at least in the following several decades.

Obstructive sleep apnea-hypopnea syndrome (OSAHS) is a complicated disease due to the obstruction of the upper airway and characterized by sleep anoxia, snoring, and daytime sleepiness. Results of the recent epidemiological investigation

Table 2 Age, sex, BMI, nocturnal denture wearing habit, and sleeping posture in the OSAHS high-risk and low-risk groups

	Total (%)	High risk (%)	Low risk (%)	*P* value
N	400	125 (31.3)	275 (68.7)	
Average age (years)	74.1	74.6	73.8	NS
Sex				
Male	160 (40)	52 (41.6)	108 (39.3)	NS
Female	240 (60)	73 (58.4)	167 (60.7)	
BMI (kg/m^2)	23.3	24.6	22.7	<0.05
Wearing dentures during sleep				
Yes	26 (6.5)	4 (3.2)	22 (8.0)	NS
No	374 (93.5)	121 (96.8)	253 (92.0)	
Sleeping posture				
Lying supine	20 (5)	8 (20.5)	12 (14.8)	NS
Lying on the side	100 (25)	31 (79.5)	69 (85.2)	
Without a settled posture	280 (70)	86 (30.7)	194 (69.3)	

NS not significant

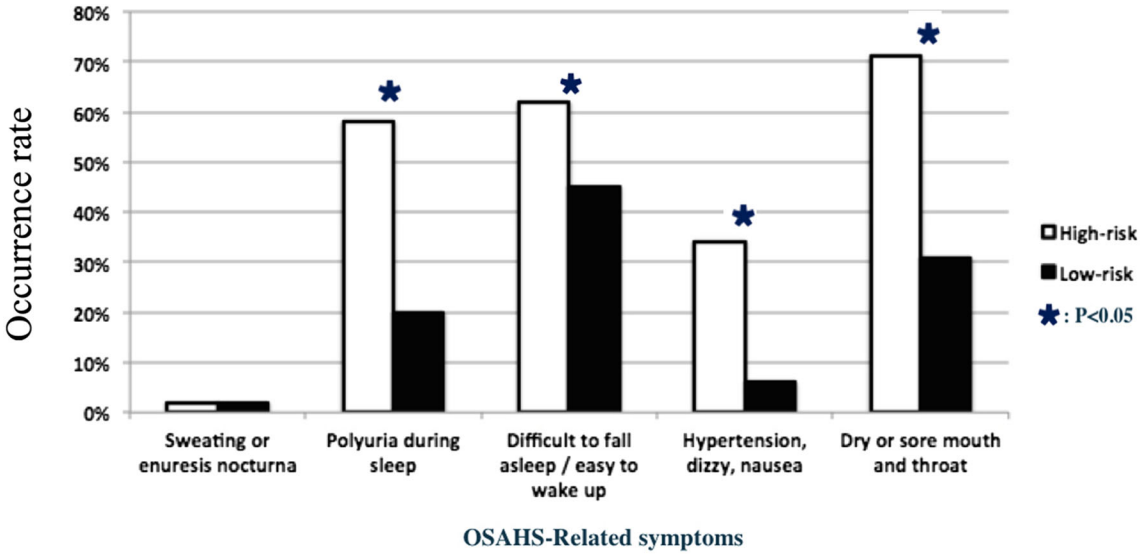

Fig. 1 Occurrence rate of OSAHS-related symptoms in the high-risk and low-risk groups

showed that the OSAHS morbidity rate among Chinese adults was 2–4 % [10, 11]. There were a lot of studies investigating the mechanism and treatment of OSAHS in general population; however, only a few studies addressing OSAHS in edentulous population can be found. When dentures were delivered to patients, dentists usually gave instructions as follows: "Denture should be left out of the mouth at night to provide needed rest from the stresses they create on the residual ridges." [4] A recent study also proved that denture wearing during sleep is associated not only with oral inflammatory and microbial burden but also with incident pneumonia [12]. In our study, 94 % of the patients took off their dentures before they went to bed. This demonstrated that majority of the patients followed dentists' instructions, which raised the questions that when there is no denture supporting upper and lower jaws, will people experience OSAHS during sleep? Will the decreased vertical dimension increase patients' opportunity of developing OSAHS?

As mentioned above, only a few studies have been conducted addressing the relationship between edentulism and OSAHS. In 1999, Bucca [13] reported a male OSAHS patient suffered clinical exacerbation after having all his teeth extracted. A few self-control PSG studies have also demonstrated significantly higher AHI in edentulous people when they slept without denture compared to the situation when they slept with denture [14, 15]. However, some other researchers got paradoxical results [16, 17]. No sizable survey of obstructive sleep disorder in edentulous population has been reported.

Researchers supporting that edentulism can aggravate OSAHS symptoms pointed out that, due to decreased vertical dimension of occlusion (VDO) caused by missing dentition, edentulous individuals could experience prominent anatomical changes such as reduction of lower face height and mandible rotation. These anatomical changes could negatively influence the dimension and function of the upper airway [2]. X-ray cephalometry was adopted to compare supine posterior airway space (PAS) with and without dentures in edentulous individuals. Some researchers found that PAS was prominently narrower without dentures [13, 14] Gassino et al. [18] also found that inadequate VDO was closely associated with the risk of OSAHS in a Berlin questionnaire study.

Sforza [19] investigated 643 elderly participants from the general population with the Berlin questionnaire in France during 2010. The result showed that 31.4 % (202 out of 643) of the participants were in the OSAHS high-risk group. In our study, the percentage of the edentulous people who were at high risk of OSAHS was 31 %, which is quite similar to that of Sforza's findings. However, OSAHS morbidity varies in different races and we cannot simply draw the conclusion that the rate of OSAHS in edentulous population in China is similar to that of the general population of matched age in France from the above data. So far, there is no sizable-sample epidemiological survey using the Berlin questionnaire among the general population in Asia available for reference.

Only one article on epidemiological investigation of sleep-disordered breathing (SDB) in edentulous people can be traced. In this article, Tsuda [20] reported the SDB high-risk rate in a group of edentulous people as 40.3 %, which was significantly higher than that in the general population and in our study (31 %). He also reported that the average BMI in both high-risk and low-risk groups was 29.3 and 26.7, which were over 25 and could be classified as overweight. The average BMI in our study was 24.6 and 22.7 in high-risk and low-risk groups, respectively. The difference in average BMI may explain the different OSAHS high-risk rates between Tsuda's study and ours, and the difference between oriental

and western figure may be a reasonable explanation to the different BMIs. There were only 62 participants in Tsuda's study, and the small sample size may limit the power of the result. Tsuda reported the rate of nocturnal denture wearing habit as 20 and 29.7 % in high-risk and low-risk groups, respectively, and we found it to be 3.2 versus 8 % in high-risk and low-risk groups. It seemed that in both studies, there was less percentage of people wearing denture during sleep in the high-risk group. However, the difference between the two groups was not significant in both Tsuda's and our study. It is also notable that our group of edentulous people was more willing to take off their dentures than that in Tsuda's study did.

No significant difference in the percentage of people at high risk of OSAHS was found between male and female in this group of subjects. This finding was different from that of other epidemiological surveys [21, 22], in which being male was an acknowledged risk factor for OSAHS. However, the female participants in our study were over 60 years old. It was reported that OSAHS was much more common among postmenopausal women than among their premenopausal counterparts, possibly because of declining levels of estrogen and progesterone [23]. Besides, more middle-aged male than female suffered severe OSAHS [20], which might lead to other serious systematic diseases in their early life. As a result, these groups of male edentulous OSAHS patients might be unable to visit stomatological hospitals, hence might be excluded from our survey.

In our study, we found that among OSAHS-related sleeping and wake-up symptoms which were not listed in the MBQ as identifying items, the high-risk group showed a significantly higher incidence rate in the following items: polyuria during sleep, difficult to fall asleep/easy to wake up, hypertension, dizziness, nausea, and dry or sore mouth and throat. These items supported the results of MBQ and can be used as references in diagnosing OSAHS in edentulous population. Among them, dry or sore mouth and throat, polyuria during sleep, and difficult to fall asleep/easy to wake up showed high occurrence rate equal to or higher than 60 % in the high-risk group and should be paid more attention to during the OSAHS screening process. It should be noted that the symptom dry or sore mouth and throat could also be related to not wearing dentures, since the stimulation of saliva due to foreign objects such as dentures may relieve this symptom of dry mouth.

Conclusion

According to the modified Berlin questionnaire, about 31 % of edentulous population was identified at high risk of OSAHS. Equal attention should be given to elderly edentulous female since they are at the same level of risk of developing OSAHS. More evidence and further studies are needed to determine the correlation between edentulism and OSAHS.

Conflict of interest All the authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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