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Tooth Wear in Patients Undergoing Sleep Studies: A Blinded Observational Study

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ABSTRACT

Study Objectives: Obstructive sleep apnea (OSA) is a common health problem that remains an underdiagnosed issue. Screening tools and clinical markers are needed from a variety of providers to determine patients at risk for OSA. Tooth wear could be a good potential identifier of patients at risk of having OSA.

Methods: This is an ambidirectional observational cohort. Participants were identified as retrospectively having undergone a sleep study and then tooth wear data was prospectively collected at patients' annual dental exam. The participants also completed an anonymous questionnaire to determine correlations with possible confounding factors.

Results: A total of 107 individuals were included in the analyses. No significant differences in wear were found between participants with Apnea-Hypopnea Index (AHI) <5 and those with AHI ≥5 for any of the teeth examined (all $P > 0.05$). Overall, both groups had median tooth wear scores of 2 (IQR 1). Similarly, no differences in tooth wear were found between participants based on their body mass index (BMI) classification or consumption data (all $P > 0.05$).

Conclusion: Sleep is a complicated entity with many possible confounding factors. There is no correlation between AHI and tooth wear in the selected military cohort. Dentists should screen patients for possible medical and dental conditions whenever tooth wear is detected. Further research is needed to determine if tooth wear could be used as a potential identifier of patients at risk for OSA.

INTRODUCTION

Obstructive sleep apnea (OSA) is associated with an increased risk of many health problems, such as atrial fibrillation, depression, congestive heart failure, stroke, hypertension, coronary artery disease and diabetes.[1] It has been estimated that 82-95% of the population with OSA remain undiagnosed and therefore go without treatment.[2, 3] Screening tools and clinical markers are needed for providers to determine patients at risk for OSA.

The diagnosis of tooth wear is immediate, inexpensive and can be made based on the clinical examination of tooth surfaces. Tooth wear is a consequence of bruxism, or teeth grinding, a symptom which has been frequently associated with obstructive sleep apnea.[4-6] These characteristics make tooth wear a good potential identifier of patients at risk of having OSA.

In a recent review of the literature, two studies regarding OSA and tooth wear specifically (as opposed to bruxism) were found. In 2015, a small prospective study recruited patients (N=30) with various stages of tooth wear and sent them for a sleep study. While the severity of tooth wear was associated with the severity of OSA, in their patient sample, over 80% of patients had lost 10 or more teeth.[7]

Anitua et al retrospectively examined a combination of dental casts and clinical photographs of teeth to evaluate tooth wear in patients who had undergone a sleep study. While the severity of tooth wear was associated with the severity of OSA, they recommended that in future prospective studies, intraoral inspection of the patient should be included.[8]

These outcomes justify the performance of prospective and controlled clinical studies to evaluate the association between tooth wear and OSA, to identify confounders that may influence this association and potentially determine if unexplained tooth wear is an appropriate cause to refer patients for sleep studies.

To our knowledge, no study has prospectively evaluated tooth wear at dental visits in patients with sufficient dental health access, who have already undergone a sleep study.

The incidence of OSA in military personnel has increased over 500% since the early 2000s.[9, 10] Non-adherence is high in this population, especially so in military personnel who have been also been diagnosed with post-traumatic stress disorder.[11, 12] OSA is also a leading cause of US Army aircrew waivers,[13] and of cases newly diagnosed in 2015, 48.1% were diagnosed in the last year of service. This is attributed to medical separation, increased diagnoses in aging, or service members delaying diagnosis to avoid medical separation/permanent profile.[14]

Evidence suggests that service members who are adherent to therapy experience improved sleep quality, energy, emotional well-being and fewer depressive symptoms.[11] Increasing the number and variety of screening tools may allow for undiagnosed patients to be more easily identified and referred for treatment, thereby improving the well-being and health of US service members.

The primary objective of this study is to assess if the severity of tooth wear (as measured by the 5-point Smith and Knight tooth wear index scale) in US service members is associated with the severity of OSA (as measured by the Apnea-Hypopnea Index) in patients who have already undergone a sleep study.

Secondary objectives include adjusting the primary objective for potential confounding factors, such as demographics, comorbidities, diet and current treatments for those patients already with diagnosed OSA.

The purpose is to estimate the severity of tooth wear in patients with obstructive sleep apnea and to assess a potential clinical marker available to dentists in the identification of patients at risk of obstructive sleep apnea syndrome.

The null hypothesis would be that there is no correlation between severity of tooth wear and severity of OSA. An additional null hypothesis would be that there are no associations with OSA and multiple extraneous factors.

MATERIALS AND METHODS

This is an ambidirectional observational cohort. Participants were identified as retrospectively having undergone a sleep study and then tooth wear data was prospectively collected at patients' annual dental exam. The participants also completed an anonymous questionnaire to determine correlations with possible confounding factors at the same time as tooth wear data was collected.

Active duty patients that had undergone an overnight in-lab polysomnogram at Womack Army Medical Center or Cape Fear Valley Medical Center were offered inclusion in the research. Potential participants were reached by telephone within 1 month of their polysomnogram to ask if they would be interested in participating in the research at the same time as their military required annual dental exam. If participants were not interested then they got their annual dental exam at their home dental clinic on Fort Bragg according to standard operating procedure. If they agreed to participate then they got their annual dental exam at the same time as participation in the research.

The investigator was blinded as to what the patient's diagnosis/ Apnea-Hypopnea Index (AHI) score was before their annual exam and participation in the study. All participants presented to the dental clinic within 3 months of having their overnight polysomnogram.

Upon arrival to the dental clinic, the patient was given the consent form and privacy statement and given the option to participate in the study. All patients that presented to the clinic consented to participate in the study.

One dental provider collected all tooth wear data. Anterior tooth wear was scored using Smith and Knight's tooth wear index (see Figure 1).[15] The incisal surfaces were the only ones scored. The incisal surface was scored in the buccal-lingual direction. The incisal wear classification was modified so that dentin wear was consistent with the other surface classifications and could be measured in an objective way. A score of 2 is defined as "Loss of enamel exposing dentin for less than one third of surface" instead of "Loss of enamel just exposing dentin". A score of 3 is defined as "Loss of enamel exposing dentin for more than one third of surface" instead of "Loss of enamel and

substantial loss of dentin". Whether dentin was exposed for more than one third of the surface was determined using a UNC 15 periodontal probe and measuring from the incisal view in the buccal-lingual dimension (see Figure 2). It was measured in the area of greatest dentin exposure. In Figure 2 #9 would be measured as a score of 4, #10 as a score of 2 and #11 as a score of 3. If a tooth was heavily restored or missing and tooth wear data could not be collected it was annotated. #19 and #30 occlusal tooth wear was also included for comparison.

The participants all got their routine annual dental exam according to standard operating procedure. The tooth wear data was recorded during the annual exam. Clinical data was collected in the dental records for treatment purposes as part of standard clinical care. The participants also completed an anonymous questionnaire to determine correlations with possible confounding factors. The short questionnaire asked about confounding factors such as age, sex, stress, gastroesophageal reflux disease (GERD), dietary patterns (diets rich in food or drinks containing a variety of acids, especially citric and phosphoric acids), smoking, alcohol, caffeine, temporomandibular joint issues, sleep position, sleep arousal, headaches, use of an occlusal nightguard and use of a positive airway pressure (PAP) device. Information for the research was collected without any identifiers but each patient was assigned a patient study id for tracking purposes. This concluded the participant's part of the study.

The patient's AHI data and body mass index (BMI) were collected after the annual dental exam and data collection from the patient's medical records. Patients with Apnea Hypopnea Index < 5 serves as a control group. Those with AHI ≥5 were examined as a group as well as stratified by AHI quartile. The CDC's guidelines for BMI were used to pool BMI into categories.[16] All data was compiled and analyzed.

The Shapiro-Wilk test was used to assess the normality of the data distributions. Consequently, measures of central tendency and dispersion for AHI are reported as medians with associated interquartile ranges (IQR). Age and BMI are summarized using means with associated standard deviations. The Kruskal-Wallis test to examine the relationship between tooth wear and AHI. Chi-square tests of independence was used

for pairwise comparisons. Significance was declared at $P < 0.05$ for all tests. All data was analyzed by using SPSS version 25.0 (SPSS, Chicago, IL).

Results

A total of 109 individuals were recruited for this study. Excluded from the analyses were two individuals lacking AHI data, leaving only 107 participants to be included in the analyses. The majority of participants were male (n = 97; 90.7%). The average age of the sample was 36yrs (standard deviation = 7). Participants with elevated AHI were found to be older than the control group (median = 34, standard deviation = 7; and median = 37, standard deviation = 7 respectively), $P = 0.03$. Sample characteristics are summarized in Table 1 by group. There was a positive relationship ($P < 0.001$) between BMI and AHI. BMI and AHI results are plotted on Figure 4.

Teeth were examined in aggregate as well as by location as shown in Table 2. No significant differences in wear were found between participants with AHI <5 and those with AHI ≥5 for any of the teeth examined (all $P > 0.05$). Overall, both groups had tooth wear scores of 2 (IQR 1). Tooth wear and AHI are plotted on Figure 3. Similarly, no differences in tooth wear were found between participants based on their BMI classification, consumption data or self-reported medical conditions (all $P > 0.05$). Consumption information for the sample is summarized in Table 3. Self-reported medical conditions for the sample are summarized in Table 4.

To check whether the non-significant difference in tooth wear could be due to a lack of statistical power, a post hoc power analyses was performed with power ($1 - \beta$) set at 0.80 and a two tailed $\alpha = 0.05$. Results of this analysis showed us that sample sizes would have to increase from our existing sample size of 107 to 4,676 in order for group differences to reach statistical significance at the .05 level. Thus, it is unlikely that our negative findings can be attributed to a limited sample size and thus in fact represent a true lack of relationship between AHI and tooth wear.

Discussion

The null hypothesis that there is no correlation between severity of AHI and severity of tooth wear was accepted. The additional null hypothesis that there are no associations with OSA and multiple extraneous factors was also accepted.

This patient population could be at higher risk for tooth wear. These participants had already undergone a sleep study. All had a reason for undergoing the sleep study in the first place. This could range from poor sleep quality to history of traumatic brain injury (TBI) or other medical reason. Bruxism is more frequently observed in depressed, anxious and emotionally stressed individuals.[17] Military personnel are at high risk of exposure to traumatic events with subsequent associated psychological distress and mental health problems including depression, family violence, substance abuse, and post-traumatic stress disorder (PTSD) which may threaten occupational functionality.[18] Only 38-41% of people in this study reported that they don't think they have PTSD, anxiety or frequent headaches (see Table 4).

This study has the benefit of direct observation of the teeth when scoring tooth wear. Anitua et al only used photos and casts.[8] Due to minor color or surface changes between dentin and enamel on some patients it would be difficult to fully measure or detect the changes without direct observation in the mouth. Many people classify tooth wear as mild, moderate or severe without quantifying these measurements. By using Smith and Knight's tooth wear index we were able to quantify the tooth wear in a repeatable way. Each tooth must be scored in order to determine an average or a generalized tooth wear score. We were only looking at anterior tooth wear because it has been hypothesized that bruxism and protruding the mandible are protective functions during sleep.[19] Prospective evaluations and case studies of sleep bruxism and apnea indicate that bruxism events may be directly correlated to apnea episodes.[20] While a causal relationship cannot be made, OSA has been called the highest risk factor for tooth grinding during sleep.[21] Many people do not have anterior tooth guidance in excursive movements or can have an open bite that will minimize any tooth wear. This was not controlled for in this study.

It is not known whether tooth wear observed in this population was due to sleep bruxism or some other etiology. There are three broad categories of wear etiology: functional, erosive and parafunctional.[22] Tooth structure can also be missing due to trauma, caries, resorption or genetic defects. The etiology of tooth wear or missing tooth structure was not investigated in this study.

All of the participants in this study are required to get dental care on an annual basis. The overall health of the teeth were excellent. None of the participants were missing any anterior teeth. None of the patients had more than 3 anterior teeth that could not get an incisal wear score due to being heavily restored.

There was a positive correlation ($P < 0.001$) between BMI and AHI in this study. No differences in tooth wear were found between participants based on their BMI classification ($P > 0.05$). Only 3 patients had an AHI greater than 30. The active duty military population in this study is overall a healthy, physically fit group. This could explain the lack of severe AHI patients and the lack of correlation between tooth wear and AHI in this study. It is possible for an individual to have an elevated BMI due to increased muscle mass instead of body fat. Service members with high standards of fitness and physical readiness may be classified as overweight or obese according to BMI despite having healthy or even low levels of body fat. A study of service members by Heinrich and colleagues,[23] showed that non-obese military men can be misclassified as obese using the BMI categories compared to using body fat testing. However, Heinrich's study showed that categorizing obesity based on measured BMI actually underestimated the prevalence of obesity.

A suggested format for a future study could be screening patients based off tooth wear and then sending them for a sleep study like the pilot study done by Durán-Cantolla et al.[7] Standard operating procedure in the military health care system precluded this study design without further research.

Conclusion

Sleep is a complicated entity with many possible confounding factors. There is no correlation between AHI and tooth wear in the selected military cohort. Dentists should screen patients for possible medical and dental conditions whenever tooth wear is detected. Further research is needed to determine if tooth wear could be used as a potential identifier of patients at risk for OSA.

Author Contributions

R. Allred, contributed to conception, design, data acquisition, analysis, and interpretation, drafted and critically revised the manuscript; D. Shaha, contributed to design, data acquisition and critically revised the manuscript; T. Beltran, contributed to design and data interpretation, drafted and critically revised the manuscript; L. Stanford, contributed to conception, design, data acquisition and critically revised the manuscript. All authors gave final approval and agree to be accountable for all aspects of the work.

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Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. The views expressed herein are those of the author and do not necessarily reflect the official policy of the Department of the Army, Department of Defense, or the US Government.

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Titles of Figures and Tables

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