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Prevalence of signs and symptoms of temporo-mandibular disorder in patients with sleep apnea

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Abstract

Purpose The aim of the present study was to detect the prevalence of temporomandibular disorders (TMD) in patients with untreated obstructive sleep apnea (OSA) and to compare the results with healthy controls, matched for sex and age.

Methods Forty-one consecutive patients with OSA were prospectively recruited from the Department of Otorhinolaryngology at the A. Gemelli Hospital prior to undergoing any treatment for OSA and independently of OSA severity. All patients underwent a complete TMD examination according to the diagnostic criteria for temporomandibular disorders (DC/TMD) protocol. The same examination was performed on 41 healthy controls matched for sex and age. Chi-squared test was used to compare results between the two groups.

Results Of the 41 patients with OSA, 21 (51%) presented signs and/or symptoms of TMD compared to 13 of 41 subjects (32%) from the control group. Headache attributed to TMD and disc displacement with reduction were the most common diagnoses, with a statistically significant difference between the two groups ($p<0.05$).

Conclusions The prevalence of TMD signs and symptoms is significantly higher in untreated patients with OSA compared to healthy controls.

Keywords Obstructive sleep apnea, · Sleep disorders, · Sleep-disordered breathing, · Temporomandibular disorders, · Pain, · Drug-induced sleep endoscopy

Introduction

Obstructive sleep apnea (OSA) is a common sleep disorder affecting from 9 to 49% of the general population [1, 2], characterized by intermittent episodes of partial or complete airway obstruction that impairs normal ventilation [3].

Serious consequences are related to untreated OSA including snoring, arousals, diabetes, depression, cardiovascular diseases, and increased risk of mortality [4–6].

A bidirectional relationship has been suggested for poor sleep and pain and a reciprocal relationship has been described between chronic musculoskeletal pain and sleep [7, 8]. Common musculoskeletal conditions are temporomandibular disorders (TMD). They are characterized by pain or dysfunction involving temporomandibular joint (TMJ), masticatory muscles, or both [9]. TMDs are a significant burden for adult population, as they represent the second most common musculoskeletal pain source [10]. The association between TMD pain and sleep fragmentation is still not well understood, but it seems to have a reciprocal influence. In fact, it has been shown that up to 90% of patients suffering from TMD have comorbid sleep disorders [11, 12], but also that patients experiencing OSA signs and symptoms are more likely to present first-onset TMD [13].

TMDs were found to be highly prevalent in OSA patients referred for mandibular advancement device (MAD) therapy

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[14]. Since MAD therapy is mainly suggested for patients with mild to moderate sleep apnea [15], these findings may not be representative of the general OSA population.

The aim of the present study was to observe the prevalence of TMD in untreated OSA patients and to compare the results to healthy controls, matched for sex and age.

Material and methods

We prospectively recruited consecutive patients with OSA from the Department of Otorhinolaryngology at the A. Gemelli Hospital with indications for drug-induced sleep endoscopy (DISE) not yet undergoing treatment for OSA. Subjects were included if they had ≥18 years of age and presented with apnea-hypopnea index (AHI) of ≥5 determined by polysomnographic study (PSG) as recommended by the American Academy of Sleep Medicine guidelines [16]. An apnea event was defined as the cessation of airflow for ≥10 sec; a hypopnea event was defined as a reduction in amplitude of airflow or thoracoabdominal movement to ≤50% of the baseline for ≥10 sec.

Data regarding AHI, minimum oxygen saturation during DISE and site of obstruction observed by DISE were collected.

The control group was selected from the dental clinic at A. Gemelli Hospital, from patients presenting for regular oral hygiene check-ups as they were considered representative of the general population. In order to reduce the risk of including undiagnosed sleep apnea patients in the control group, all patients were asked to fill in both questionnaires related to Epworth sleepiness scale (ESS) [17] and Berlin questionnaire for sleep-disordered breathing [18]. Subjects from the control group were matched for sex and age to OSA patients.

All patients underwent a complete medical and dental examination, during which anthropometric measurements were recorded as well. A complete TMD analysis was performed according to the Italian version of the diagnostic criteria for temporomandibular disorders (DC/TMD) [19], which represents the gold standard for TMD diagnosis for both clinical and research purposes. It consists of several anamnestic questionnaires and a clinical examination, performed by a calibrated clinician. The DC/TMD examination includes records of mandibular movements, TMJ noises during function as well as muscle and TMJ palpation. Both Axis I (clinical examination) and Axis II (psychological effect of pain) are examined. The diagnosis is obtained according to the DC/TMD diagnostic decision tree. The same researcher was responsible for all examinations throughout the study. In order to reduce the risk of bias, OSA patients were examined before the clinician accessed their medical chart and before they underwent DISE.

Subjects were excluded if they presented some kind of cognitive impairment, due to difficulties in undergoing TMD examination; if they presented dental problems; if they were assuming medications that would alter pain perception; or if they did not sign the informed consent. Subjects from the control group were excluded also if they were diagnosed with OSA or if they resulted at risk of suffering from sleep apnea from questionnaires.

The ethical committee of the A. Gemelli Hospital approved the protocol with number 7372/18 before starting the trial.

Demographic and polysomnographic data are presented as mean and standard deviation. X-squared test was used to compare results between the two groups. The sample size was calculated assuming a prevalence of 52% TMD in OSA population [14] and between 5 and 33% in the general population [20]. A 95% confidence interval and a power of 0.80 were used. The minimum sample size required was 79 patients total.

Results

Between May 2018 and July 2019, a total of 86 patients were invited to participate in the study. Of the 42 consecutive patients with OSA who were examined, one patient was excluded because of the assumption of pain medication before the examination. Of the 46 controls, 3 patients were excluded because they were considered at risk of suffering from sleep apnea after completing the ESS and Berlin questionnaires for sleep-disordered breathing; and one patient was excluded because she received a positive diagnosis of OSA. As a result, a total of 82 patients were enrolled in the study: 41 patients with OSA and 41 controls matched for sex and age. The sample consisted of 62 men and 20 women; the median age of patients with OSA was 49.7±10.5 and the median age of the controls was 50.3±15.4 years.

The median AHI of patients with OSA was 20.9±12.8 where 15 patients presented with mild sleep apnea (AHI > 5 events per hour); 17 with moderate sleep apnea (AHI > 15 events per hour); and 9 with severe sleep apnea (AHI > 30 events per hour).

The median body mass index (BMI) of patients with OSA was 26.2±3.3 where 25 of 41 patients presented a BMI equal or higher than 25; the median BMI of the controls was 20±2.8 where 4 of 41 subjects presented a BMI equal or higher than 25. Patient characteristics can be viewed in Table 1.

According to the DC/TMD classification, in the OSA group, 21 patients (51%) presented signs and/or symptoms of TMD where 15 patients (36.6%) presented with pain-related TMD and headache and headache attributed to TMD was the most common diagnose. In the control group, 13 patients (32%) presented signs and/or symptoms of TMD where 8 patients (20%) presented with pain-related TMD and headache and local myalgia was the most common diagnose. The difference between groups was statistically

Table 1 Subject characteristics

	OSA group	Control group
Number of patients, N (%)	41 (100%)	41 (100%)
Age (years)	49.7±10.5	50.3±15.4
Male/female, N	31/10	31/10
Apnea-hypopnea index, (N/h)	20.9±12.8	/
Mild OSA, N (%)	15 (37%)	/
Moderate OSA, N (%)	17 (42%)	/
Severe OSA, N (%)	9 (22%)	/
Minimum oxygen saturation, N (%)	82.4±8.8	/
Body mass index (kg/m^2)	26.2±3.3	20±2.8
Signs and/or symptoms of TMD, N (%)	21 (51%)	13 (32%)
Pain-related TMD and headache, N (%)	15 (37%)	8 (20%)
Intra-articular joint disorder or degenerative joint disorder, N (%)	16 (39%)	10 (24%)

N=number; N/h= number of events per hour; OSA=obstructive sleep apnea; TMD=temporomandibular disorders
Values are means ± standard deviation

significant ($p<0.05$). Pain-related TMD diagnosis is shown in Table 2.

As far as clinical diagnosis of intra-articular joint disorder or degenerative joint disorders, 16 patients (39%) presented with some disorder in the OSA group, compared to 10 patients (24%) in the control group. A clinical diagnosis of disc displacement with reduction was the most common diagnose in both groups. The difference between groups was statistically significant ($p<0.05$). Intra-articular joint disorder or degenerative joint disorder is shown in Table 3.

Ten patients (24%) in the OSA group presented with both pain-related and joint disorder compared to 5 (12%) in the control group.

When observing only female patients, in the OSA group, 8 (80%) out of 10 patients presented signs and/or symptoms of TMD, compared to 4 female subjects (40%) in the control group. The difference between groups was statistically significant ($p<0.05$).

Regarding the Axis II examination, 16 OSA patients (39%) presented positivity to one or more questionnaires when compared to 7 subjects (17%) from the control group.

A statistically significant difference was found between the two groups regarding all the examined parameters.

As far as OSA patients, no correlation was found between TMD and other parameters such as severity of OSA measured by AHI, minimum oxygen saturation during DISE, or site of obstruction observed by DISE procedure.

Discussion

The results of the present study show that the prevalence of TMD signs and symptoms is higher in untreated patients with OSA compared to healthy controls.

Our findings are consistent with the idea that sleep deprivation and disruption in sleep structure are associated to

Table 2 Pain-related TMD and headache assessed by DC/TMD

Pain-related TMD and headache	OSA group Total, *n*=41	Control group Total, *n*=41
Headache attributed to TMD	4	1
Myofascial pain	2	/
Myofascial pain with referral	1	1
Local myalgia	2	3
Headache attributed to TMD and myofascial pain	1	/
Myofascial pain with referral and arthralgia	3	1
Local myalgia and arthralgia	2	1
Headache attributed to TMD and arthralgia	/	1

DC/TMD=diagnostic criteria for temporomandibular disorders; OSA=obstructive sleep apnea; TMD=temporomandibular disorders

Table 3 Intra-articular joint disorder or degenerative joint disorder assessed by DC/TMD

Intra-articular joint disorder or degenerative joint disorder	OSA group Total, *n*=41	Control group Total, *n*=41
Disc displacement with reduction	12	7
Disc displacement without reduction with limited opening	2	/
Disc displacement with reduction with intermittent locking	1	3
Degenerative joint disease	1	/

DC/TMD=diagnostic criteria for temporomandibular disorders; OSA=obstructive sleep apnea

musculoskeletal pain, tenderness, and fatigue not only affecting other body sites [21] but also masticatory structures.

The high prevalence of TMDs in patients with OSA referred for oral appliance therapy was already demonstrated by Cunali et al. [14]; and our data allow to expand their results to all patients with OSA independent of the treatment offered and using the new gold standard for TMD diagnosis. To our knowledge, no other such studies have reported TMD prevalence according to the DC/TMD classification in patients with OSA or evaluated this condition independent of the treatment offered.

The distribution of patients suffering from TMDs in the general population shows that female gender is more affected than males [20, 22] and our results indicate that this difference becomes even more evident when observing patients suffering from OSA. This finding suggests that a special attention should be driven when examining women with OSA. It has been reported that the prevalence of TMD pain varies with age with a peak occurring between 30 and 60 years of age [22, 23]. Considering that OSA prevalence tents to increase from the 35 years of age and that it is mainly observed in patients above 50 years of age [2], it creates the likelihood that patients with OSA present also TMD. Considering these data, the presence of a control group becomes even more important. The prevalence of TMDs observed in our control group is consistent with what described by Iodice et al. [22] in the adult Italian population, confirming our findings.

A significant difference between the OSA group and the control group was also observed regarding the psychological effect of pain measured by Axis II. Considering the already known association between OSA and other comorbidities like depression and anxiety [4] as well as the association between these conditions and TMD [24], depression and anxiety could be aggravating factors for TMD prevalence on OSA patients. These data underlie the importance that patients suffering from OSA undergo a complete examination by a multidisciplinary team. Dental sleep specialists have recently gained a role in OSA treatment as they can suspect the presence of the disease and, in some patients, provide therapy by administering MADs and preventing and treating side effects related to their use [25–27]. Another possible aggravating factor is the higher BMI in patients with OSA compared to controls as body fat has been demonstrated to be associated to musculoskeletal pain in healthy subjects [28].

A limitation of the present study is the bias related to the control group as they resulted not at risk of suffering from sleep apnea from questionnaires, but they did not have a PSG to confirm the data. Considering the possibility that patients judged not at risk of suffering from OSA actually have the disease, we may have overestimate TMD prevalence in the control group. As the difference between the study and control group is so significant, we believe that this limitation does not undermine the findings of the study. Among other limitations, we were not able to observe a statistically significant correlation between TMD severity and OSA severity measured by AHI, but a larger sample would have been needed to confirm this finding.

No correlation between type or anatomical location of obstruction and TMD was observed. Further studies are needed to evaluate if an association is present between sites of obstruction and sleep bruxism [29]. It has been suggested that sleep dysfunction might be not only a consequence of pain but also pathogenic [30]. Future studies are needed to assess whether OSA therapy may provide some effects also on TMD signs and symptoms.

Conclusion

The present study has shown that the prevalence of TMD signs and symptoms is significantly higher in untreated patients with OSA compared to healthy controls. These findings suggest that sleep specialists should be aware of comorbidities in orofacial area not only when administering MAD therapy but also when approaching patients with OSA with other therapies, suggesting the need of a strong collaboration between sleep physicians and dental sleep specialists.

Abbreviations AHI, Apnea-hypopnea index; BMI, Body mass index; DC/TMD, Diagnostic criteria for temporomandibular disorders; DISE, Drug-induced sleep endoscopy; ESS, Epworth sleepiness scale; MAD, Mandibular advancement device; OSA, Obstructive sleep apnea; PSG, Polysomnographic study; TMD, Temporomandibular disorders; TMJ, Temporomandibular joint

Author contributions All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by all authors. The first draft of the manuscript was written by

Anna Alessandri-Bonetti and all authors commented on the previous versions of the manuscript. All authors read and approved the final manuscript.

Declarations

Ethics approval All procedures in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the ethical committee of the A. Gemelli Hospital with number 7372/18.

Consent to participate Informed consent was obtained from all individual participants included in the study.

Conflict of interest The authors have no conflict of interest to declare that are relevant to the content of this article.

References

1. Seneratna CV, Perret JL, Lodge CJ, Lowe AJ, Campbell BE, Matheson MC, Hamilton GS, Dharmage SC (2017) Prevalence of obstructive sleep apnea in the general population: a systematic review. Sleep Med Rev 34:70–81
2. Heinzer R, Vat S, Marques-Vidal P, Marti-Soler H, Andries D, Tobback N, Mooser V, Preisig M, Malhotra A, Waeber G, Vollenweider P, Tafti M, Haba-Rubio J (2015) Prevalence of sleep-disordered breathing in the general population: the HypnoLaus study. Lancet Respir Med 3:310–318
3. Yaggi HR, Strohl KP (2010) Adult obstructive sleep apnea/hypopnea syndrome: definitions, risk factors, and pathogenesis. Clin Chest Med 31:179–186
4. Edwards C, Mukherjee S, Simpson L, Palmer LJ, Almeida OP, Hillman DR (2015) Depressive symptoms before and after treatment of obstructive sleep apnea in men and women. J Clin Sleep Med 11:1029–1038
5. Sanchez-de-la-Torre M, Campos-Rodriguez F, Barbé F (2013) Obstructive sleep apnoea and cardiovascular disease. Lancet Respir Med 1:61–72
6. Young T, Finn L, Peppard PE, Szklo-Coxe M, Austin A, Nieto J, Stubbs R, Hla KM (2008) Sleep disordered breathing and mortality: eighteen-year follow-up of the Wisconsin sleep cohort. Sleep 31:1071–1078
7. Almoznino G, Benoliel R, Sharav Y, Haviv Y (2017) Sleep disorders and chronic craniofacial pain: characteristics and management possibilities. Sleep Med Rev 33:39–50
8. Creed F (2020) A review of the incidence and risk factors for fibromyalgia and chronic widespread pain in population-based studies. Pain 161:1169–1176
9. De Leeuw R, Klasser GD (eds) (2013) Orofacial pain: guidelines for assessment, diagnosis, and management, 5th edn. Quintessence Pub. Co, Chicago
10. National Institute of Dental and Craniofacial Research (2017) Prevalence of TMJD and Its Signs and Symptoms
11. Sener S, Guler O (2012) Self-reported data on sleep quality and psychologic characteristics in patients with myofascial pain and disc displacement versus asymptomatic controls. Int J Prosthodont 25:348–252
12. Rener-Sitar K, John MT, Pusalavidyasagar SS, Bandyopadhyay D, Schiffman EL (2016) Sleep quality in temporomandibular disorder cases. Sleep Med 25:105–112
13. Sanders AE, Essick GK, Fillingim R, Knott C, Ohrbach R, Greenspan JD, Diatchenko L, Maixner W, Dubner R, Bair E, Miller VE, Slade GD (2013) Sleep apnea symptoms and risk of temporomandibular disorder: OPPERA cohort. J Dent Res 92(7 suppl):70S–77S
14. Cunali PA, Almeida FR, Santos CD, Valdrighi NY, Nacimento LS et al (2009) Prevalence of Temporomandibular disorders in obstructive sleep apnea patients referred for oral appliance therapy. J Orofac Pain 23:339–344
15. Epstein LJ, Kristo D, Strollo PJ, Friedman N, Malhotra A et al (2009) Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults. J Clin Sleep Med 5:263–276
16. Kapur VK, Auckley DH, Chowdhuri S, Kuhlmann DC, Mehra R, Ramar K, Harrod CG (2017) Clinical practice guideline for diagnostic testing for adult obstructive sleep apnea: an American academy of sleep medicine clinical practice guideline. J Clin Sleep Med 13:479–504
17. Johns MW (1991) A new method for measuring daytime sleepiness: the Epworth sleepiness scale. Sleep 14:540–545
18. Netzer NC, Stoohs RA, Netzer CM, Clark K, Strohl KP (1999) Using the Berlin questionnaire to identify patients at risk for the sleep apnea syndrome. Ann Intern Med 131:485–491
19. Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, Goulet JP, List T, Svensson P, Gonzalez Y, Lobbezoo F, Michelotti A, Brooks SL, Ceusters W, Drangsholt M, Ettlin D, Gaul C, Goldberg LJ, Haythornthwaite JA, Hollender L, Jensen R, John MT, de Laat A, de Leeuw R, Maixner W, van der Meulen M, Murray GM, Nixdorf DR, Palla S, Petersson A, Pionchon P, Smith B, Visscher CM, Zakrzewska J, Dworkin SF, International RDC/TMD Consortium Network, International association for Dental Research, Orofacial Pain Special Interest Group, International Association for the Study of Pain (2014) Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for clinical and research applications: recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group. J of Oral & Facial Pain and Headache 28:6–27
20. Cooper BC, Kleinberg I (2007) Examination of a large patient population for the presence of symptoms and sings of temporomandibular disorders. Cranio 25:114–126
21. Lautenbacher S, Kundermann B, Krieg JC (2006) Sleep deprivation and pain perception. Sleep Med Rev 10:357–369
22. Iodice G, Cimino R, Vollaro S, Lobbezoo F, Michelotti A (2019) Prevalence of temporomandibular disorder pain, jaw noised and oral behaviours in an adult Italian population sample. J Oral Rehabil 00:1–8
23. Gesch D, Bernhardt O, Alte D, Schwahn C, Kocher T, John U, Hensel E (2004) Prevalence of signs and symptoms of temporomandibular disorders in an urban and rural German population: results of a population-based study of health in Pomerania. Quintessence Int. 35:143–150
24. Dıraçoğlu D, Yıldırım NK, Saral İ, Özkan M, Karan A, Özkan S, Aksoy C (2016) Temporomandibular dysfunction and risk factors for anxiety and depression. J Back Musculoskelet Rehabil 29:487–491
25. Bartolucci ML, Bortolotti F, Martina S, Corazza G, Michelotti A, Alessandri-Bonetti G (2019) Dental and skeletal long-term side effects of mandibular advancement devices in obstructive sleep apnea patients: a systematic review with meta-regression analysis. Eur J Orthod 41:89–100
26. Alessandri-Bonetti G, Bortolotti F, Bartolucci ML, Marini I, D'Antò V, Michelotti A (2016) The effects of mandibular advancement device on pressure pain threshold of masticatory muscles: a prospective controlled cohort study. J Oral Facial Pain Headache 30:234–240

27. Alessandri-Bonetti A, Bortolotti F, Moreno-Hay I, Michelotti A, Cordaro M, Alessandri-Bonetti G, Okeson JP (2019) Effects of mandibular advancement device for obstructive sleep apnea on temporomandibular disorders: A systematic review and meta-analysis. Sleep Med Rev 48:101211
28. Walsh TP, Arnold JB, Evans AM, Yaxley A, Damarell RA, Shanahan EM (2018) The association between body fat and musculoskeletal pain: a systematic review and meta-analysis. BMC Musculoskelet Disord 19:233
29. Manfredini D, Guarda-Nardini L, Marchese-Ragona R, Lobbezoo F (2015) Theories on possible temporal relationships between sleep bruxism and obstructive sleep apnea events. An expert opinion. Sleep Breath 19:1459–1465
30. Choy EHS (2015) The role of sleep in pain and fibromyalgia. Nat Rev Rheumatol 11:513–520