CHEST

Cardiac Troponin Values in Patients With Acute Coronary Syndrome and Sleep Apnea

A Pilot Study

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BACKGROUND: An analysis of cardiac injury markers in patients with OSA who sustain an episode of acute coronary syndrome (ACS) may contribute to a better understanding of the interactions and impact of OSA in subjects with ACS. We compared peak cardiac troponin I (cTnI) levels in patients with OSA and patients without OSA who were admitted for ACS.

METHODS: Blood samples were collected every 6 hours from the time of admission until two consecutive assays showed a downward trend in the cTnI assay. The highest value obtained defined the peak cTnI value, which provides an estimate of infarct size.

RESULTS: We included 89 patients with OSA and 38 patients without OSA with an apnea-hypopnea index of a median of 32 (interquartile range [IQR], 20.8-46.6/h and 4.8 [IQR, 1.6-9.6]/h, respectively. The peak cTnI value was significantly higher in patients without OSA than in patients with OSA (median, 10.7 ng/mL [IQR, 1.78-40.1 ng/mL] vs 3.79 ng/mL [IQR, 0.37-24.3 ng/mL]; $P = .04$). The multivariable linear regression analysis of the relationship between peak cTnI value and patient group, age, sex, and type of ACS showed that the presence or absence of OSA significantly contributed to the peak cTnI level, which was 54% lower in patients with OSA than in those without OSA.

CONCLUSIONS: The results of this study suggest that OSA has a protective effect in the context of myocardial infarction and that patients with OSA may experience less severe myocardial injury. The possible role of OSA in cardioprotection should be explored in future studies.

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KEY WORDS: ACS; cardiac biomarkers; cardiovascular disease; management; OSA; troponin

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ABBREVIATIONS: ACS = acute coronary syndrome; AHI = apnea-hypopnea index; cTn = cardiac troponin; cTnI = cardiac troponin I; CVD = cardiovascular disease; MI = myocardial infarction; PCI = percutaneous coronary intervention; SDB = sleep-disordered breathing; STEMI = ST-elevation myocardial infarction

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Acute coronary syndrome (ACS) affects 1% of the adult global population and is a leading cause of death worldwide, in which one-third of all deaths are due to cardiovascular disease (CVD).[1] OSA is a highly prevalent breathing disorder that affects at least 10% of middle-aged men and 3% of middle-aged women.[1,2] The risk of OSA developing increases with age[3]; moreover, OSA has been associated with major cardiovascular morbidity and mortality and is likely to be an independent risk factor for CVD.[3,4]

Patients with ACS are at an increased risk for fatal and nonfatal cardiac events, and the prevalence of OSA has been reported to be as high as 65.7% in patients admitted for ACS.[5] However, the impact of OSA on ACS severity and prognosis is mostly unknown. Moreover, despite the existence of closely interrelated and detrimental mechanisms that link OSA and CVD, epidemiologic studies suggest that a protective mechanism may exist in patients with OSA.[6] Although such a mechanism may have a pertinent clinical impact, its presence remains under debate. Although several studies described superior postoperative survival in patients with OSA compared with that in patients without OSA[7] along with studies that showed increased survival of elderly patients with mild OSA,[8] other authors described worse postoperative outcomes after an episode of ACS, such as myocardial infarction (MI) in patients with sleep-disordered breathing (SDB), compared with patients without SDB.[9-11]

Cardiac troponin (cTn) is a sensitive marker of cardiac injury and is the preferred clinical biomarker for the diagnosis or exclusion of acute MI in the acute care setting. Thus, cTn has become the biomarker of choice in the assessment and evaluation of myocardial injury.[12] The magnitude of cTn elevation correlates with the extent of myocardial necrosis and is related to the subsequent risk of adverse outcomes, thereby predicting poor prognosis.[13] Recently, more sensitive cTn assays (high-sensitivity cTn) have been developed. Interestingly, studies suggest that high-sensitivity cardiac troponin I (cTnT) is elevated in patients with OSA.[14] A recent study found that based on cTnT levels, patients with OSA had less severe cardiac injury during an acute nonfatal MI than did patients without OSA.[15] The presence of OSA might activate mechanisms with cardioprotective effects, which might be reflected by a change in the expression of cardiac damage markers. An analysis of cardiac injury markers in patients with OSA who sustain an episode of ACS may contribute to a better understanding of the interactions and impact of OSA in subjects with ACS. We sought to investigate the impact of OSA on the extent of myocardial damage according to peak cTnI values, the biomarker of choice in the assessment and evaluation of myocardial injury.[12] We hypothesized that the presence of chronic intermittent hypoxic episodes during sleep in patients with OSA affects cTn expression in patients who sustain an episode of ACS.

Methods

Study Design and Subjects

This observational prospective study of 127 patients admitted to the University Hospital Arnau de Vilanova (Lleida, Spain) (Fig 1) is an ancillary study of the Continuous Positive Airway Pressure (CPAP) in Patients with Acute Coronary Syndrome and Obstructive Sleep Apnea (ISAACC) cohort (NCT01335087). The aim of that multicenter open-label parallel prospective randomized controlled trial[16] was to evaluate the effect of CPAP treatment on the incidence of new cardiovascular events in patients with an episode of ACS and OSA. In this study, we evaluated patients consecutively admitted to the coronary care unit or hospital cardiology room with a diagnosis of ACS. The criteria for inclusion were the detection of a rise or fall, or both, of cardiac biomarker values [preferably cTn] with at least one value greater than the 99th percentile upper reference limit. Additionally, patients were required to have at least one of the following: symptoms of ischemia, new or presumed new significant ST-segment/T wave changes or new left bundle branch block, development of pathologic Q waves on ECG, and imaging evidence of new loss of viable myocardium or new regional wall motion abnormality.[17]

After patients agreed to participate and the consent form was signed, all patients underwent respiratory polygraphy in the first 24 to 72 hours after admission to assess the presence of OSA. Those patients with an apnea-hypopnea index (AHI) of $\geq$ 15 events/h were considered to have OSA and were randomized to conservative treatment or CPAP. Those with an AHI of $<$ 15 events/h were included in the non-OSA group. In the current study, we compared the peak cTnI levels in patients with ACS in the OSA group vs the non-OSA group. The ethics committee of Lleida approved the study (2010-852), and informed consent was obtained from all subjects.

Procedures

Clinical examinations and questionnaires: Demographic and anthropometric characteristics, a medical history, and a detailed medication history were obtained, and questionnaires were administered the day before the sleep study.

Sleep study: The diagnosis of OSA was made according to the guidelines of the national consensus on the apnea-hypopnea syndrome.[18] All participants underwent overnight cardiorespiratory polygraphy with the same model of device (Embletta; ResMed, Bella Vista, Australia).

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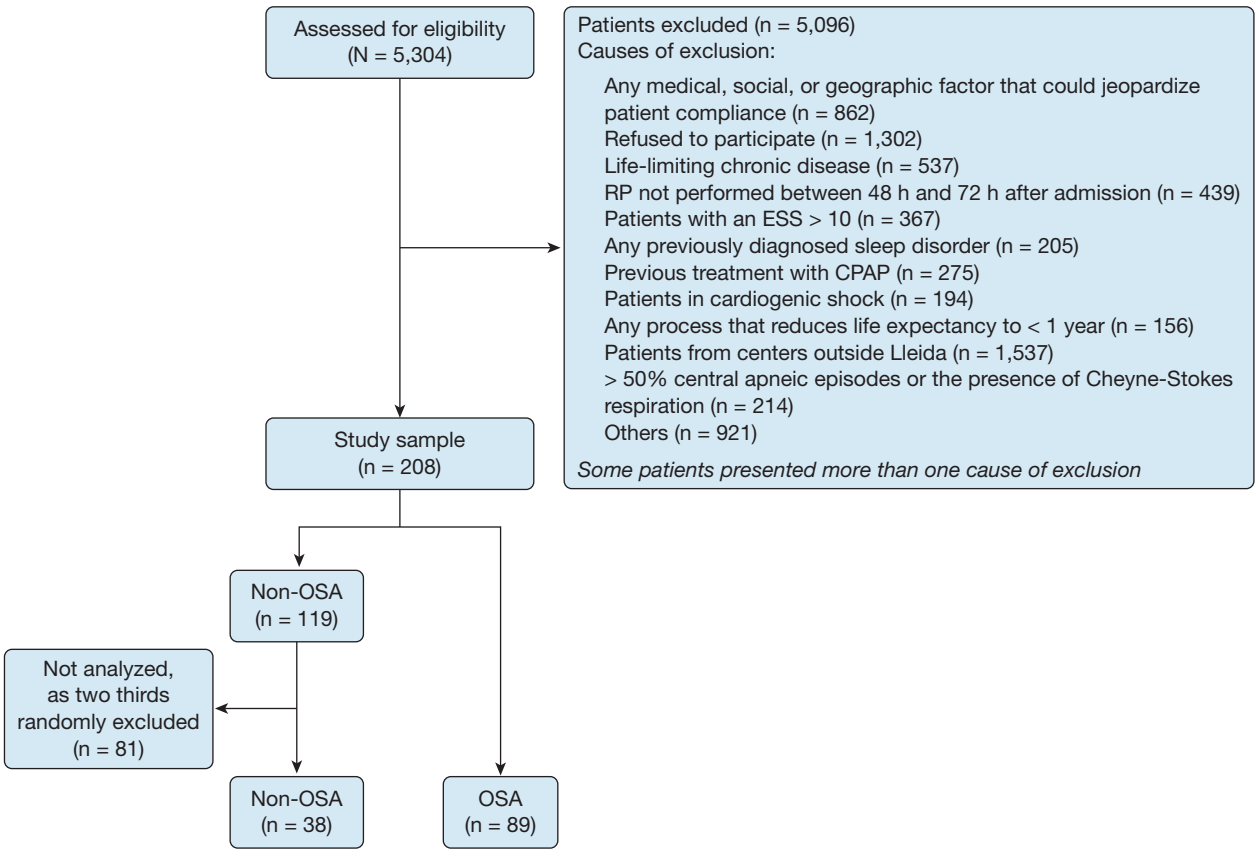

Figure 1 – *Flowchart of study recruitment. ESS = Epworth Sleepiness Scale; RP = respiratory polygraphy.*

The variables measured included oronasal flow and thoracoabdominal movements, and ECG and pulse oximetry were used for analysis. An obstructive apnea episode was scored when a complete cessation of airflow lasted for ≥ 10 s. An episode of hypopnea was defined as a reduction in airflow for ≥ 10 s associated with a > 4% decrease in arterial oxygen saturation. Cardiorespiratory polygraphy studies were performed without supplemental oxygen.

Cardiac biomarkers: We assessed cTnI expression as a marker of myocardial injury. Blood samples were collected at 6-hour intervals from the time of admission until two consecutive cTnI measurements showed a decrease. The highest value obtained defined the peak cTnI value, which provides a relative estimate of infarct size.[19] The quantitative determination of cTnI levels was performed by chemiluminescence immunoassay (AccuTnI+3 Beckman-Coulter, Unicel Dxl 600 Beckman-Coulter autoanalyzer). Routine biochemical analyses in patients admitted for ACS were performed during the hospital stay.

Coronary artery disease: The severity of coronary artery disease was based on coronary angiography and the number of stents implanted. The number of affected vessels was calculated as the number of vessels with any stenosis > 50% of the lumen.

Statistical Analysis

Continuous variables are presented as the mean (standard deviation) or median (interquartile range [IQR]) for data with a skewed distribution. Participant characteristics were compared using the Student *t* test, analysis of variance, or the nonparametric Mann-Whitney and Kruskal-Wallis tests for skewed data.

A multivariable linear regression model was used to evaluate the independent contribution of the presence or absence of OSA to peak troponin levels after adjusting for age, sex, and type of event (non-ST-elevation MI [non-STEMI] and ST-elevation MI [STEMI]). The peak cTnI values and the area under the cTnI curve were log-transformed to obtain a data distribution closer to normal. Another multivariable linear regression model was built to assess the contribution of the non-OSA, OSA (AHI, 15-32 events/h), and OSA (AHI > 32 events/h) groups to the peak cTnI value and the area under the cTnI curve.

All tests were two-sided, and *P* values < .05 were considered statistically significant. R statistical software, version 3.3.1 (R Project for Statistical Computing) was used for all analyses.

Results

Among the 127 patients enrolled, 89 were found to have OSA (AHI ≥ 15 events/h). The clinical characteristics and demographic variables of the patients are shown in Table 1. No significant differences were observed between patients with OSA and patients without OSA regarding sex, age, or prevalence of cardiovascular risk factors (hypertension, diabetes mellitus, BMI, dyslipidemia, and smoking). Compared with the patients without OSA, the patients with OSA had a higher number of stents placed during percutaneous coronary intervention (PCI) ($P = .007$). The peak cTn

TABLE 1] Anthropometric, Clinical, and Treatment Characteristics of the Non-OSA and OSA Groups

Variable	Group		
	Non-OSA (AHI < 15 Events/h) (n = 38)	OSA (AHI ≥ 15 Events/h) (n = 89)	*P* Value
Age, mean (SD), y	64.4 (13.1)	63.6 (11.5)	.739
Sex, No. (%)			.966
Male	32 (84.2)	73 (82.0)	
Female	6 (15.8)	16 (18.0)	
Apnea-hypopnea index, median (IQR), events/h	4.8 (1.6-9.6)	32.0 (20.8-46.6)	< .001
Oxygen desaturation index > 4%/h, median (IQR)	4.7 (3.5-10.1)	20.2 (6.6-38.1)	< .001
Minimum Sa_{O_2}, %, median (IQR)	87.0 (84.0-89.0)	83.0 (78.0-87.0)	.002
Mean Sa_{O_2}, %, median (IQR)	93.3 (92.1-94.1)	93.0 (91.7-94.2)	.614
Time with Sa_{O_2} < 90%, %, median (IQR)	1.6 (0.2-10.0)	4.20 (0.9-15.6)	.130
Epworth Sleepiness Scale, median (IQR)	3.0 (3.0-4.3)	5.0 (3.0-6.0)	.021
Hypertensive patients, No. (%)	24 (63.2%)	61 (68.5%)	.701
Systolic blood pressure, median (IQR), mm Hg	130 (120-145)	125 (118-137)	.194
Diastolic blood pressure, median (IQR), mm Hg	76.2 (70-82.6)	78.0 (65-85)	.66
BMI, median (IQR), kg/m^2	26.4 (24.6-30.0)	27.7 (25.0-30.1)	.402
Neck circumference, No. (%), cm	42.0 (39.5-43.5)	41.0 (39.5-42.0)	.247
Diabetes mellitus, No. (%)	10 (26.3%)	33 (37.5%)	.312
Dyslipidemia, No. (%)	18 (47.4%)	53 (59.6%)	.284
Peak cTnI, ng/mL	10.7 (1.78-40.1)	3.79 (0.37-24.3)	.04
Area under the peak cTnI	451 (79.8-1,533)	143 (14.8-845)	.049
Type of ACS, No. (%)			.36
Unstable angina	4 (10.5)	9 (10.1%)	
Non-STEMI	15 (39.5)	47 (52.8)	
STEMI	19 (50.0)	33 (37.1)	
First episode of ACS, No. (%)	28 (73.7)	70 (78.7)	.704
Cardiomyopathy, No. (%)	11 (28.9)	28 (31.8)	.912
Stroke, No. (%)	1 (2.7)	3 (3.5)	1
Killip class, median (IQR)	1.0 (1.0-1.0)	1.0 (1.0-1.0)	.98
No. of affected vessels, median (IQR)	1.0 (1.0-2.0)	1.5 (1.0-3.0)	.622
No. of stents, median (IQR)	1.0 (0.0-1.0)	1.0 (1.0-2.0)	.007
Location of lesions undergoing intervention			.29
No lesion	3 (9.68)	5 (13.9)	
Proximal	9 (29.0)	14 (38.9)	
Medial	16 (51.6)	11 (30.6)	
Distal	3 (9.68)	6 (16.7)	
Smoker, No. (%)			0.883
Former smoker	11 (28.9)	24 (27.0)	
No	13 (34.2)	28 (31.5)	
Yes	14 (36.8)	37 (41.6)	
Total tobacco exposure, median (IQR), pack-years	20.0 (15.0-30.0)	28.2 (17.0-43.8)	0.354
Alcohol use, No. (%)			.333
Former alcohol consumption	2 (6.5)	1 (1.56)	
No	24 (77.4)	54 (84.4)	
Yes	5 (16.1)	9 (14.1)	

(Continued)

TABLE 1] *(Continued)*

Variable	Group		
	Non-OSA (AHI < 15 Events/h) (n = 38)	OSA (AHI ≥ 15 Events/h) (n = 89)	*P* Value
Diuretics, No. (%)	17 (44.7)	26 (29.9)	.161
Anticoagulants, No. (%)	6 (15.8)	16 (18.6)	.902
Antacids, No. (%)	11 (28.9)	35 (40.7)	.295
Hypolipidemic agents, No. (%)	12 (31.6)	36 (41.4)	.403
β-blockers, No. (%)	17 (44.7)	33 (37.9)	.606
Antiplatelet agents, No. (%)	6 (15.8)	15 (17.4)	1
Bronchodilators, No. (%)	3 (7.9)	5 (5.9)	.701
Oral antidiabetic drugs, No. (%)	7 (18.4)	26 (29.9)	.264
Insulin, No. (%)	1 (2.6)	10 (11.8)	.170
Calcium antagonists, No. (%)	2 (5.3%)	20 (23.0)	.032

ACS = acute coronary syndrome; AHI = apnea-hypopnea index (No. of events/h); cTnI = cardiac troponin I; IQR = interquartile range; Sao_2 = arterial oxygen saturation; STEMI = ST-elevation myocardial infarction.

level was not associated with the number of stents (Spearman's rho correlation coefficient, 0.13; $P = .16$). We evaluated the distribution of patients with OSA and patients without OSA by the type of ACS (patients with unstable angina, non-STEMI, or STEMI). The results showed a similar distribution of the type of ACS between the non-OSA and OSA groups ($P = .36$). Moreover, our data showed that the peak cTnI levels in patients with STEMI were significantly higher than those in patients with non-STEMI ($P < .001$). We evaluated the locations of the lesions undergoing intervention. The results showed that the locations of the lesions undergoing intervention did not differ significantly between groups ($P = .29$).

We found that a higher percentage of patients with OSA than patients without OSA were treated with a calcium channel antagonist ($P = .032$), likely due to the known association between OSA and hypertension.[20] Regarding the timing of PCI (before or after the peak cTnI measurement), no difference was observed between the patients without OSA and patients with OSA ($P = .85$).

No significant differences were observed between patients with OSA and those without OSA regarding the mean values for the time of admission (7:17 AM [8 hours 41 min SD] and 8:39 AM [8 hours 26 min SD]; $P = .58$), time of onset of symptoms (10:45 AM [6 hours 24 min SD) and 11:35 AM [6 hours 13 min SD]; $P = .55$) or time to peak cTnI levels (after 9 hours 23 min [8 hours 14 min SD] and after 9 hours 19 min [7 h 35 min SD]; $P = .97$), respectively. The number of cTnI measurements during the hospital stay did not differ significantly between the non-OSA and OSA groups (median, 2.00 [IQR, 2.00-3.00] and median, 2.00 [IQR, 2.00-3.00]; $P = .65$).

The peak cTnI value was significantly higher in patients without OSA than in patients with OSA (median, 10.7 ng/mL [IQR, 1.78-40.1 ng/mL] vs median, 3.79 ng/mL [IQR, 0.37-24.3 ng/mL]; $P = .04$) (Fig 2). Moreover, we estimated the infarct size by calculating the area under the cTnI curve, which was significantly different between the patients without OSA and the patients with OSA (median, 451 [IQR, 79.8-1533] vs median, 143 [IQR, 14.8-845]; $P = .049$) (Fig 3).

To further investigate the impact of OSA severity on peak cTnI levels, we classified the patients with OSA into two groups according to the observed median AHI value (32

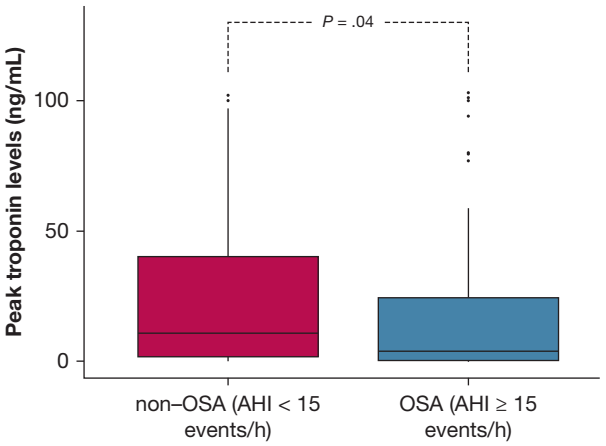

Figure 2 – *Box plots of peak cardiac troponin I levels in patients with and those without OSA. P values were obtained using the Mann-Whitney test.*

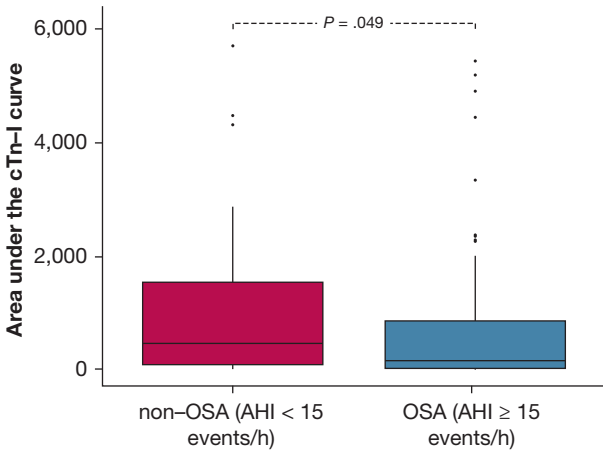

Figure 3 – *Box plots of the area under the cardiac troponin I curve in patients with and those without OSA. P values were obtained using the Mann-Whitney test.*

events/h) (e-Appendix 1). The characteristics and demographic variables of the patient groups are shown in e-Table 1. We observed a trend toward a decrease in cTnI levels as the severity of OSA increased ($P = .058$) (Fig 4). The area under the cTnI curve was not significantly different between the non-OSA (AHI < 15 events/h), mild to moderate OSA (AHI = 15-32 events/h), and severe OSA (AHI > 32 events/h) groups ($P = .08$) (Fig 5).

We used a multivariable linear regression model to evaluate relationships between peak cTnI value and patient group, age, sex, and type of ACS. The presence or absence of OSA significantly contributed to the peak cTnI level. Furthermore, the peak cTnI level was 54% lower in patients with OSA than in patients without OSA. Moreover, in the multivariable linear regression model that categorized patients based on OSA severity, patients with severe OSA had 61% lower cTnI levels than did patients without OSA (Tables 2 and 3). In addition, we used a multivariate linear regression model to evaluate the association between area under the troponin curve and patient group, age, sex, and type of ACS. The results were similar to those obtained for peak cTnI levels (Tables 4 and 5).

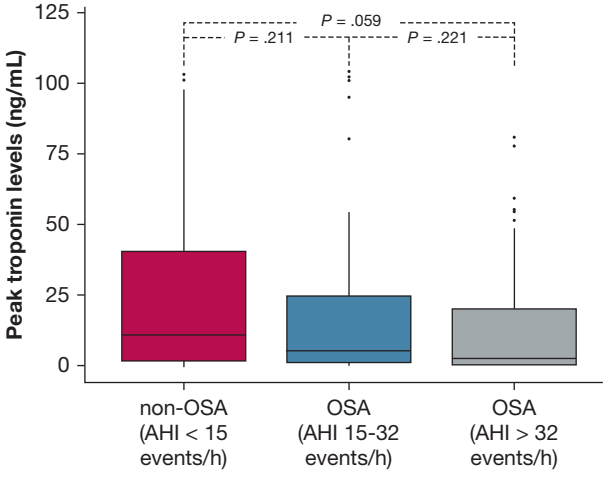

Figure 4 – *Box plots of peak cardiac troponin I levels in patients without OSA or with mild to moderate or severe OSA. The severity of OSA was based on the apnea-hypopnea index. P values were obtained using the Mann-Whitney and Kruskal-Wallis tests.*

Discussion

The results of this observational study suggest that the presence of OSA has an effect on peak cTnI levels in patients with ACS. We found that patients without OSA exhibited higher peak cTnI levels. These results suggest that patients with a higher AHI are significantly more likely to have low cTnI levels than are patients without evidence of OSA, which could imply that patients with an elevated AHI, particularly those with severe OSA, may experience less severe myocardial injury. Finally, these results suggest that OSA has a protective effect in the context of MI.

The current literature describes controversial benefits of OSA in cardiovascular events. Although some studies have reported that OSA is associated with cardiovascular morbidity and mortality, others have offered the controversial suggestion that the presence of OSA might be protective against myocardial ischemic injury in the setting of acute MI. As described in the literature and in the present study, we observed a significant contribution of the type of ACS to cTnI levels; the patients with STEMI had the highest cTnI levels. Nevertheless, OSA also independently contributed to the peak cTnI levels. In contrast to our results suggesting that OSA is associated with a decrease in the expression of cTnI as a marker of myocardial injury, Belaidi et al[21] showed that chronic intermittent hypoxia in patients with OSA resulted in the development of enhanced hypertension and an increase in infarct size. Importantly, the patients studied by Belaidi et al were younger that the patients included in our study. It has been suggested previously that SDB in the elderly and SDB in younger people are two distinct conditions. The current literature suggests that SDB consequences depend on the patient's age. Thus, cardiovascular risk has been found to be more likely to be elevated in younger (aged < 65 years) than older participants.[22] Moreover, moderate and severe levels of sleep apnea are moderately associated with an increased risk of all-cause mortality compared with the general population, particularly in men aged < 50 years.[17] Other studies have indicated that in older

TABLE 2] Multivariable Linear Regression Analysis of Peak cTnI levels in non-OSA vs OSA Groups

Variable	β (95% CI)	*P* Value
Age	−0.02 (−0.05 to 0.01)	.23
Sex		
Female	Referent	
Male	1.05 (0.06-2.04)	.04
Group		
Non-OSA	Referent	
OSA	−0.78 (−1.55 to 0.00)	.049
Type of ACS		
Non-STEMI	Referent	
STEMI	2.19 (1.46-2.91)	< .01

Coefficients are expressed as the change in log(peak troponin level) per 1 unit change in the independent variable. See Table 1 legend for expansion of abbreviations.

patients with SDB, OSA was not associated with hypertension,[18] and yet others have indicated that the association between OSA and arterial hypertension was stronger in young and middle-aged patients with OSA (compared with elderly subjects).[19] Finally, other authors concluded that OSA did not appear to be associated with cardiovascular disease or mortality in older populations .[23]

Nakashima et al[24] reported that after PCI in patients with acute MI, patients with OSA had a left ventricular ejection fraction similar to that of patients without OSA. After 21 days, the left ventricular ejection fraction was significantly different between patients with OSA and control subjects (52% vs 59%; $P = .02$). These results suggest that OSA may inhibit the recovery of left ventricular function in patients with acute myocardial infarction. Contrary to the findings of Nakashima et al[24] and according to the observations in our study, Berger et al[6] demonstrated that recurrent episodes of hypoxia/reoxygenation in patients with acute myocardial injury

TABLE 3] Multivariable Linear Regression Analysis of Peak cTnI Levels (Non-OSA vs Mild to Moderate OSA vs Severe OSA)

Variable	β (95% CI)	*P* Value
Age	−0.02 (−0.05 to 0.01)	.23
Sex		
Female	Referent	
Male	1.05 (0.06-2.04)	.04
Group		
Non-OSA	Referent	
Mild to moderate OSA (AHI 15-32 events/h)	−0.63 (−1.50 to 0.24)	.15
Severe OSA (AHI > 32 events/h)	−0.94 (−1.84 to −0.04)	.04
Type of ACS		
Non-STEMI	Referent	
STEMI	2.17 (1.44-2.90)	< .01

Coefficients are expressed as the change in log(peak troponin level) per 1 unit change in the independent variable. See Table 1 legend for expansion of abbreviations.

TABLE 4] Multivariable Linear Regression Analysis of the Area Under the Troponin Curve (Non-OSA vs OSA)

Variable	β (95% CI)	*P* Value
Age	−0.02 (−0.05 to 0.01)	.21
Sex		
Female	Referent	
Male	1.19 (0.20-2.18)	.02
Group		
Non-OSA	Referent	
OSA	−0.75 (−1.536 to 0.30)	.05
Type of ACS		
Non-STEMI	Referent	
STEMI	2.07 (1.34-2.80)	< .01

Coefficients are expressed as the change in the log(area under the troponin curve) per 1 unit change in the independent variable. See Table 1 legend for expansion of abbreviations.

TABLE 5] Multivariable Linear Regression Analysis of the Area Under the Troponin Curve (Non-OSA vs Mild to Moderate OSA vs Severe OSA)

Variable	β (95% CI)	*P* Value
Age	−0.02 (−0.05 to 0.01)	.21
Sex		
Female	Referent	
Male	1.19 (0.20-2.19)	.02
Group		
Non-OSA	Referent	
Mild to moderate OSA (AHI 15-32 events/h)	−0.63 (−1.50 to 0.24)	.16
Severe OSA (AHI > 32 events/h)	−0.88 (−1.79 to −0.01)	.05
Type of ACS		
Non-STEMI	Referent	
STEMI	2.05 (1.32-2.78)	< .01

Coefficients are expressed as the change in the log(area under the troponin curve) per 1 unit change in the independent variable. See Table 1 legend for expansion of abbreviations.

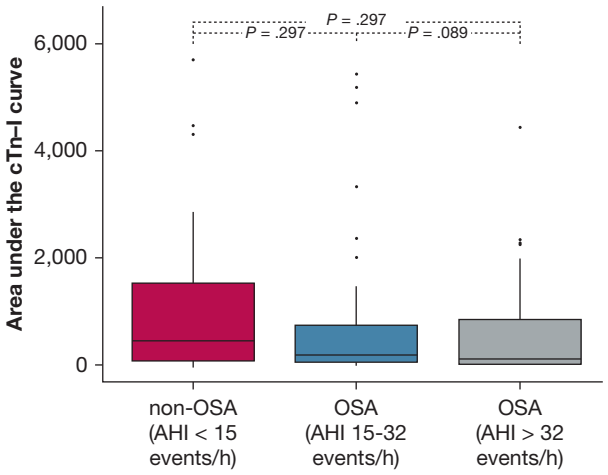

Figure 5 – *Box plots of the area under the cardiac troponin I curve in patients without OSA or with mild to moderate or severe OSA. The severity of obstructive apnea was based on the apnea-hypopnea index. P values were obtained using the Mann-Whitney and Kruskal-Wallis tests.*

with mild to moderate SDB activated adaptive mechanisms that improved endothelial function, providing cardioprotection in the context of acute myocardial injury. These authors also showed that the proliferative and angiogenic properties of endothelial progenitor cells from healthy individuals were increased after exposure to intermittent hypoxia in vitro, implicating the intermittent hypoxia associated with SDB in the alterations of endothelial progenitor cell numbers and functions. Remarkably, both studies have important differences that deserve comment. Nakashima et al[24] studied an Asian population. In addition, Berger et al[6] and the present study included patients with overweight or obesity, whereas in the study of Nakashima et al,[24] the mean BMI was 23 kg/m^2. Therefore, the physiopathologic consequences of the disease could vary between populations with different ethnic origins and different anthropometric characteristics.

In accordance with our results, a previous study[15] that included patients with characteristics similar to those of the patients included in our study suggested that patients with OSA had less severe cardiac injury during an acute nonfatal MI than did patients without OSA. The authors postulated a cardioprotective role of sleep apnea during acute MI through ischemic preconditioning in patients with severe OSA.

One of the major studies suggesting a beneficial effect of OSA was reported by Lavie and Lavie.[8] These authors showed that elderly people with moderate sleep apnea (20-40 events/h) had significantly lower mortality rates than a matched population cohort. In the present study, we observed decreased myocardial injury, as assessed by cTnI levels, in patients with severe OSA (AHI $>$ 32 events/h). However, it is important to note that Lavie and Lavie[8] examined all-cause mortality over a long-term follow-up, an outcome different from the outcome reported in the present study related to myocardial infarct size during ACS. Lavie and Lavie[8] hypothesized ischemic preconditioning as a possible explanation for the declining trend in mortality with age in patients with sleep apnea.

In conclusion, the current literature suggests that a possible cardioprotective effect of OSA could be dependent on age, anthropometric characteristics, and ethnic origin. Moreover, the current evidence highlights the need to clearly identify the deleterious consequences of OSA in each population of patients and the a priori delineation of the optimal candidates who will benefit from CPAP therapy.

Several limitations of this analysis should be noted. First, we excluded patients with more severe ACS, as these patients represented a small proportion of the patient population (3.6% of patients assessed). Second, this study excluded sleepy subjects (Epworth Sleepiness Scale $>$ 10), which could have included patients who exhibited the most severe OSA. However, the number of patients excluded for these causes was relatively low (6.9% of patients assessed). Third, we assessed the extent of myocardial damage according to peak cTnI values, the biomarker of choice in the assessment and evaluation of myocardial injury.[12] No data (eg, from echocardiography) were available to evaluate infarct size.

Conclusions

Patients with ACS and OSA had overall lower peak cTnI levels than did patients without OSA, suggesting that patients with OSA may experience less severe myocardial injury. These findings indicate that OSA has a protective effect in the context of MI. The possible role of OSA in cardioprotection should be explored in future studies.

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