Archives of Cardiovascular Disease (2016) 109, 494—503

Available online at ScienceDirect www.sciencedirect.com

Elsevier Masson France EM|consulte www.em-consulte.com/en

REVIEW

Consequences of obstructive sleep apnoea syndrome on left ventricular geometry and diastolic function

Conséquences du syndrome d'apnées du sommeil obstructif sur la géométrie et la fonction diastolique ventriculaire gauche

Diane Bodez[a], Thibaud Damy[a], Laurie Soulat-Dufour[b], Catherine Meuleman[c], Ariel Cohen[b,*]

[a] *Department of Cardiology, Henri-Mondor University Hospital, Université Paris-Est-Créteil, 51, avenue du Maréchal-de-Lattre-de-Tassigny, 94010 Créteil cedex, France*
[b] *Department of Cardiology, Saint-Antoine University and Medical School, Université Pierre-et-Marie-Curie, 184, rue du Faubourg-Saint-Antoine, 75571 Paris cedex 12, France*
[c] *Department of Cardiology, Rhône Durance Clinic, 1750, chemin du Lavarin, 84000 Avignon, France*

Received 26 May 2015; received in revised form 25 January 2016; accepted 4 February 2016
Available online 22 June 2016

KEYWORDS
Obstructive sleep apnoea syndrome;
Arterial hypertension;
Left ventricle

Summary Obstructive sleep apnoea syndrome (OSAS) is a frequent sleep disorder that is known to be an independent risk factor for arterial hypertension (AHT). Potential confounding factors associated with both OSAS and AHT, such as age, diabetes mellitus and obesity, have been explored extensively, and are considered as independent but additive factors. However, these factors are also contributors to left ventricular (LV) hypertrophy (LVH) and LV diastolic dysfunction, both of which are important causes of cardiovascular morbidity, and have been reported to be associated with OSAS for decades. In this review, we present an overview of how OSAS may promote changes in LV geometry and diastolic dysfunction through its best-known cardiovascular complication, arterial hypertension. We also summarize the epidemiological links

Abbreviations: AHI, apnoea hypopnoea index; AHT, arterial hypertension; BMI, body mass index; BP, blood pressure; BSA, body surface area; CPAP, continuous positive airway pressure; E/A ratio, ratio between early and late diastolic mitral peak flow velocities; E/e' ratio, ratio between early diastolic mitral peak flow velocity and annular velocity; IVRT, isovolumic relaxation time; LV, left ventricular; LVH, left ventricular hypertrophy; LVM, left ventricular mass; LVMi, left ventricular mass index; nCPAP, nasal continuous positive airway pressure; OSAS, obstructive sleep apnoea syndrome.

* Corresponding author.
E-mail address: ariel.cohen@aphp.fr (A. Cohen).

http://dx.doi.org/10.1016/j.acvd.2016.02.011

between OSAS and LVH, outline diastolic dysfunction in OSAS patients, and try to highlight the mechanisms responsible, focusing on the effect of confounding factors.

MOTS CLÉS
Syndrome d'apnée du sommeil obstructive ;
Hypertension artérielle ;
Ventricule gauche

Résumé Le syndrome d'apnées du sommeil obstructif (SASO) est un trouble du sommeil fréquent, et un important facteur de risque d'hypertension artérielle (HTA). Les potentiels facteurs confondants associés au SASO ainsi qu'à l'HTA, comme l'âge, le diabète, et l'obésité, ont été largement explorés et sont aujourd'hui considérés comme des facteurs indépendants mais additionnels. De plus, ces facteurs contribuent à la survenue d'hypertrophie ventriculaire gauche et de dysfonction diastolique, deux conditions associées à une forte morbi-mortalité cardiovasculaire et associées au SASO depuis des décennies. Cette revue présente une vue d'ensemble des effets du SASO sur la géométrie ventriculaire gauche et sa fonction diastolique par sa principale complication cardiovasculaire qu'est l'HTA. Nous résumons les liens épidémiologiques entre SASO et HVG, décrivons la fonction diastolique dans le SASO, et présentons les mécanismes physiopathologiques impliqués en tenant compte des facteurs confondants.

Background

Obstructive sleep apnoea syndrome (OSAS) is characterized by repetitive episodes of partial or complete collapse of the upper airway during sleep; this usually terminates in arousal, leading to sleep fragmentation. These periods of obstructed breathing result in intermittent hypoxaemia with underlying sympathetic nerve activity and increases in heart rate and blood pressure (BP). Diagnosis and severity of OSAS are determined by the apnoea hypopnoea index (AHI). The American Academy of Sleep Medicine sets a threshold of five events per hour of sleep, predominantly obstructive, with symptoms such as daytime sleepiness, insomnia or snoring, for the diagnosis of OSAS [1].

OSAS is a frequent sleep disorder that affects 2% of middle-aged women and 4% of men [2]. Prevalence has reached 20% in some studies [3], increasing with age [4] and the growing rate of obesity [3]. However, more than 80% of OSAS patients stay undiagnosed, especially women and those with a lower body mass index (BMI) [5]. OSAS is a well-known independent risk factor for arterial hypertension (AHT) [6—8], the prevalence of which reaches 50% in this population [9]. Reciprocally, the reported prevalence of OSAS among hypertensive populations ranges from 20% to 40% [10—12], and up to 70% [13]. AHT in OSAS patients is more likely to affect diastolic BP in young people than systolic BP in the elderly [14]; typically, it has a non-dipper or a riser (higher sleep BP than awake BP) pattern [15—18] that leads to a higher frequency of masked hypertension (around 30% of cases) [19,20], and both of these conditions are known to be associated with even worse outcomes [21]. OSAS is also a recognized cause of resistant AHT [22,23], where the prevalence of OSAS exceeds 80% [24]. Potential confounding factors associated with both OSAS and AHT, such as age, diabetes mellitus and obesity, have been explored extensively, and are considered as independent but additive factors [4,7,8,14,25,26]. However, those factors are also contributors to left ventricular (LV) hypertrophy (LVH) and LV diastolic dysfunction, both of which are important causes of cardiovascular morbidity [27,28], and have been reported to be associated with OSAS for decades [29,30].

In this review, we present an overview of how OSAS may promote changes in LV geometry and diastolic dysfunction through its best-known cardiovascular complication, arterial hypertension. We also summarize the epidemiological links between OSAS and LVH, outline diastolic dysfunction in OSAS patients and try to highlight the mechanisms responsible, focusing on the effect of confounding factors.

LV geometry and OSAS

Description of LVH and remodelling in OSAS

In 1990, Hedner at al. [30] conducted a case-control study comparing 61 OSAS and 61 control patients. The interventricular septum and LV posterior wall were thicker, and so the LV mass (LVM) and LVM index (LVMi) were significantly higher in OSAS patients. In 1995, Noda et al. [31] provided the first prevalence of LVH in OSAS patients, defined by LV wall thickness $\geq$ 12 mm. LVH was reported in 42% of the whole cohort (n = 51), in 31% when the AHI was < 20 and in 50% when the AHI was $\geq$ 20. Using the same criteria for LVH, Cloward et al. [32] reported a prevalence of LVH of 88% among 25 obese and severe OSAS patients. A dose-response relationship was also observed between the severity of OSAS and the prevalence of LVH, using LVMi (normalized by height) for LVH assessment [33,34]. The largest cross-sectional study, including more than 2000 subjects (the Sleep Heart Health Study) [35], confirmed that LVMi (height) was significantly associated with both the AHI and the hypoxaemia index, even after adjustment for age, BMI, systolic BP and diabetes, with an