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Sleep apnoea and unscheduled re-admission in patients undergoing coronary artery bypass surgery

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ABSTRACT

Introduction: Although it has been recognised as a cardiovascular risk factor, data on sleep apnoea screening before coronary artery bypass grafting (CABG) are scarce. This study sought to determine the prevalence, predictors and effects of sleep apnoea on re-admission in patients undergoing CABG.
Method: We prospectively recruited 152 patients to undergo an overnight sleep study before CABG. Sleep apnoea was defined as an apnoea-hypopnoea index of ≥15 events per hour. Data on unscheduled re-admission due to cardiovascular events were collected.
Results: Among the 138 patients who completed the sleep study, sleep apnoea was diagnosed in 69 (50%). The patients who had sleep apnoea had a lower left ventricular ejection fraction ($p = 0.029$), a larger left atrial diameter ($p = 0.014$) and a larger left ventricular end-systolic dimension ($p = 0.019$) than those who did not. Angiographic SYNTAX and Gensini scores were similar in patients with and without sleep apnoea. The generalised structural equation model revealed that hypertension, a high body mass index and chronic renal failure were independent predictors of sleep apnoea ($p < 0.05$). After an average follow-up of 6 ± 3 months, 12 patients with sleep apnoea (17.3%) and three patients without sleep apnoea (4.3%) were involved in unscheduled re-admission. Patients with sleep apnoea were almost five times more likely to have an unscheduled re-admission due to cardiovascular events (adjusted odds ratio: 4.63, 95% CI: 1.24–17.31, $p = 0.023$) than those without sleep apnoea.
Conclusions: Sleep apnoea was prevalent and predictive of unscheduled re-admissions in patients scheduled for CABG.

1. Introduction

Sleep apnoea, which is characterized by the repetitive cessation of ventilation during sleep due to the collapse of the pharyngeal airway, is a prevalent but under-recognized disorder associated with a diminished quality of life, reduced daytime cognitive function and an increased risk of traffic accidents [1]. Growing evidence has shown that sleep apnoea is also a risk factor and prognostic marker for coronary artery disease [2–4]. Compared with patients without sleep apnoea, those with sleep apnoea have a higher risk of fatal and non-fatal cardiovascular events [5,6]. Several non-randomised studies have shown that treatment with continuous positive airway pressure can mitigate the adverse consequences of sleep apnoea [7–9]. The potential benefits of screening for and treating sleep apnoea in reducing cardiovascular events have been highlighted in a recent European Society of Cardiology guideline [10], and it is conceivable that the demand for sleep apnoea screening among patients presenting with coronary artery disease will increase.

Sleep apnoea has been shown to be a predictor of restenosis and major adverse cardiac events after percutaneous coronary interventions [11–13]. Coronary artery bypass grafting (CABG) is

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preferred to percutaneous coronary interventions for patients with severe or complex coronary artery disease, and evidence from small studies has suggested that sleep apnoea is prevalent in patients undergoing CABG and may be associated with postoperative atrial fibrillation [14,15]. Unscheduled re-admissions after CABG are an important cause of morbidity and escalating healthcare costs. In the USA, recent policy interventions have reduced payments to hospitals with higher than predicted risk-adjusted re-admission rates [16]. Hospital re-admissions after CABG have become a key measure of performance in many centres, and various procedures have been explored to reduce re-admission rates [17]. However, a recent study from New York State reported a 30-day re-admission rate of 16.5%, for which cardiovascular event was an important cause [18]. Therefore, cost-effective strategies to identify this subgroup of patients are of great interest to cardiologists. To the best of our knowledge, there has been no study reporting the association between sleep apnoea and re-admission rate after CABG.

In this study, we performed a sleep study as part of the preoperative evaluation of patients scheduled for an elective CABG. Incorporating detailed clinical, angiographic and echocardiographic parameters, we sought to determine the prevalence and predictors of sleep apnoea, as well as its impact on unscheduled re-admissions following CABG. We hypothesized that sleep apnoea was prevalent and associated with a higher incidence of unscheduled re-admission due to cardiovascular causes.

2. Methods

2.1. Study design and patients

This was a prospective observational study conducted in a university-affiliated hospital in Singapore. Between November 2013 and September 2014, we approached patients with severe coronary artery disease who were scheduled to undergo an elective CABG within the next 7 days. The patient list was generated from the Department of Cardiac, Thoracic and Vascular Surgery on a weekly basis, and all of the patients on the list had provisionally consented to CABG. One of the investigators (LPZ) screened and approached the admitted patients, who were waiting for elective CABG, for participation in this research project. The inclusion criteria comprised being listed for CABG and severe coronary artery disease defined as the presence of a >50% diameter stenosis in the left main coronary artery and/or a >50% diameter stenosis in two or three major epicardial arteries. The exclusion criteria comprised moderate to severe pulmonary disease, intubation for mechanical ventilation, known sleep apnoea with regular continuous positive airway pressure therapy, the use of an intra-aortic balloon pump or another haemodynamic support device, a permanent pacemaker implantation, an arterio-venous fistula, sedation or other muscle relaxants given during hospitalization, clinical heart failure requiring oxygen supplementation and the inability to provide informed consent.

After informed consent was obtained, an overnight sleep study was scheduled for the patients in the same night in the cardiology ward. Subsequently, the recruited patients underwent CABG as per standard clinical practice. The team managing the patients were blinded to its results. The study protocol, which was approved by the local institutional review board (Reference number: DSRB-C: 2012-00051), was explained to all patients, all of whom provided informed consent.

2.2. Overnight sleep study

All of the participants were scheduled to undergo an in-hospital overnight sleep study using a wrist-worn portable device (Watch-PAT 200, Itamar Medical, Caesarea, Israel) that was validated by in-laboratory polysomnography [19,20]. Watch-PAT 200 is a four-channel unattended sleep monitoring device that includes peripheral arterial tone (PAT), pulse oximetry, heart rate and actigraphy from a built in actigraph. The arterial pulsatile volume changes of the finger that are regulated by α-adrenergic innervation of the smooth muscles of the vasculature were measured by PAT, which reflects sympathetic nervous system activity. Respiratory events were identified by digital vasoconstriction mediated by α-adrenergic receptors that are sensitive to surges in sympathetic activity. Combined with the PAT signal amplitude, the increase in heart rate and desaturation, the apnoea-hypopnoea index and the respiratory disturbance index were estimated indirectly.

The patients recruited were classified into those with sleep apnoea (apnoea-hypopnoea index ≥15 events per hour) and those without sleep apnoea (apnoea-hypopnoea index <15).

2.3. Measurements and data collection

The demographic and clinical characteristics of the study patients were obtained from hospital case records, and included age, gender, ethnicity, cardiovascular risk factors, alcohol consumption, concomitant medical conditions and medications. Coronary angiography and transthoracic echocardiography were performed as part of the standard clinical procedure for the evaluation of coronary artery disease. The patients' neck circumference, waist circumference, height and weight were measured, and their body mass index was calculated as their weight (in kilograms) divided by the square of their height in meters (square meters). The Berlin Questionnaire was administered and the Epworth Sleepiness Scale was assessed before the sleep study. Notably, data on medication were collected at sleep study and discharge.

2.4. Revascularisation strategy

Despite being listed for CABG, it was anticipated that some patients would change their decision and opt for non-surgical management. Therefore, patients who underwent the sleep study were followed prospectively for the final management strategy: CABG, percutaneous coronary intervention or standalone medical therapy.

2.5. Unscheduled re-admission due to cardiovascular events

All the recruited patients were followed up prospectively until 31st October 2014, at which point the re-admission rates were determined. Data on subsequent unscheduled re-admissions due to cardiovascular events were collected by the investigator from case records, telephone calls and clinic chart reviews, and all of the information was entered prospectively. The investigator who collected the re-admission data was blinded to the sleep study results. The data on re-admission were adjudicated by a senior investigator.

2.6. Statistical analyses

The data analysis was carried out with structural equation model (SEM) in accordance to our hypotheses on how the selected predictors were related. As such, the 20:q rule was applied to determine the sample size [21]. To identify the factors associated with the occurrence of sleep apnoea (sleep apnoea; 0: apnoea-hypopnoea index <15, 1: apnoea-hypopnoea index ≥15) and its relationship with hospital re-admission (0: no, 1: yes), exploratory analyses were performed using independent t-, Mann–Whitney and chi-square tests. The results were applied to conduct a