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ORIGINAL ARTICLE

Optimal Body Mass Index Cut-offs for Identification of Patients with Coronary Artery Disease at High Risk of Obstructive Sleep Apnoea

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Background We sought to evaluate the relationship between Body Mass Index (BMI) and obstructive sleep apnoea (OSA) in Chinese patients hospitalised with coronary artery disease, and to determine the optimal BMI cut-off for prediction of OSA.

Methods Consecutive Chinese patients who were hospitalised with symptomatic coronary artery disease were recruited to undergo an in-hospital sleep study.

Results A total of 587 patients were recruited. Using cut-off for Asians, 81.2% of the cohort was overweight (BMI $\geq$23 kg/m^2) and 31.6% was obese ($\geq$27 kg/m^2). A total of 59.5% was diagnosed with OSA, defined as apnoea-hypopnoea index $\geq$15. Body mass index, hypertension and smoking were predictors of OSA. Multiple logistic regression analysis showed that BMI remains an independent predictor of OSA (odds ratio: 1.11 [95% confidence interval: 1.06 to 1.17], $p < 0.001$) after adjusting for smoking and hypertension. Further analysis using BMI and Apnoea-Hypopnoea Index (AHI) as continuous variables showed significant correlation between BMI and AHI (Pearson's r =0.25, P<0.001). In adjusted models, optimal BMI cut-offs to screen for OSA were 27.3 kg/m^2, 23.0-23.9 kg/m^2, and 20 kg/m^2 for patients with neither, either, or both predictors (smoking and hypertension) respectively. The area under the curve for the adjusted and unadjusted models were similar (0.6013 vs 0.6262, $p = 0.118$).

Conclusions Body mass index represents a convenient and readily available tool for bedside identification of patients at high risk of OSA. Body mass index cut-offs to predict risks of OSA in Chinese patients with symptomatic coronary artery disease are defined in this study.

Keywords Cardiovascular • Clinical decision making • Ethnicity • Obesity • Overweight • Prediction

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Introduction

Obstructive sleep apnoea (OSA) is a prevalent but underdiagnosed sleep disordered breathing [1] that is characterised by recurrent episodes of upper airway collapse during sleep, leading to spells of oxygen deprivation [2]. Over the last decade, OSA has garnered interest as a risk factor, and a potential treatment target for adverse cardiovascular events. Patients presenting with acute coronary syndromes were more likely to have underlying OSA [3,4]; those who were diagnosed with OSA were also found to be at increased risk of future adverse events over the following nine months to four years compared to those without OSA [5–8]. Subsequent non-randomised studies suggest that early treatment of OSA with continuous positive airway pressure could ameliorate the associated cardiovascular risk [9–11]. Hence, early diagnosis of OSA in patients with coronary artery disease could facilitate timely treatment and potentially lead to better clinical outcomes.

In-laboratory polysomnography is the gold-standard investigation for the diagnosis of OSA. However, it is time- and labour-intensive, and impractical for the systematic screening of large population groups such as patients who are hospitalised for coronary artery disease. A long waiting time for in-laboratory polysomnography will derail the purpose of *early* diagnosis. While questionnaires such as the Berlin Questionnaire and Epworth Sleepiness Scale have been validated for use in the general population [12,13], they have failed to accurately predict OSA amongst patients presenting with cardiovascular disease [14]. Thus, it is rather remarkable that a handy and inexpensive bedside tool to identify patients presenting with coronary artery disease who are at high risk of OSA has not been clearly established.

Obesity is an important cause of OSA [15,16]. Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults, and a convenient proxy for estimation of body fat percentage [17]. The prevalence of OSA in an Asian population is also likely to be as high as, or higher than Caucasian societies in view of the higher percentage body fat per BMI [18]. We hypothesise that BMI can be used as a bedside screening modality for OSA in Chinese patients presenting with coronary artery disease. In this study, we evaluated the relationship between BMI and OSA in Chinese patients hospitalised with coronary artery disease, and to determine the optimal BMI cut-off for prediction of OSA.

Methods

Study Design

This study was a prospective study conducted at a University-affiliated institution in a multi-ethnic South-East Asian country between December 2011 and April 2014. In this study, adult Chinese patients (age >21 years) who were hospitalised with symptomatic coronary artery disease (stable and unstable angina, non-ST-segment elevation myocardial infarction, and ST-segment elevation myocardial infarction) were eligible. The Chinese ethnicity was based on admission records, which were entered according to the National Registration Identity Card by hospital admission officers.

Exclusion criteria included moderate to severe pulmonary disease, intubation for mechanical ventilation, use of an intra-aortic balloon pump or other haemodynamic support devices, sedation or other muscle relaxant given during hospitalisation, perceived high risk of malignant ventricular arrhythmia, cardiogenic shock (systolic blood pressure < 90 mmHg), clinical heart failure requiring oxygen supplementation, referral for coronary artery bypass surgery, and inability to provide informed consent.

Only patients who satisfied the inclusion requirements and who did not meet any exclusion criteria were considered eligible. After treatment initiation and stabilisation, eligible patients were approached by a research assistant to take part in an overnight sleep study screening before hospital discharge. The research assistant was explicitly informed that patients who were eligible should be systematically approached, irrespective of the presence or absence of obesity, hypertension, and habitual snoring.

Waiting time for an in-laboratory polysomnography at the dedicated sleep laboratory of our institution was approximately four months. Systematic referral of the patients hospitalised for cardiovascular disease to sleep physicians for diagnosis of OSA was also rarely practiced at our institution during the study period. Therefore, there was no selection bias, and the study population was representative of the patients who presented with coronary artery disease.

The study protocol, which was approved by the local institutional review board (Domain Specific Review Board-C), was explained to all patients in detail, and informed consent was obtained. Individual management strategies, including percutaneous coronary intervention and pharmacological therapy, were otherwise left to the discretion of the attending cardiologists and were in accordance with standard practice guidelines.

Overnight Sleep Study

A level III portable diagnostic device (Embletta Gold; Natus Medical Incorporated) was used for all the sleep studies. The device has been validated against in-laboratory polysomnography for diagnosis of OSA [19]. Although limited by the lack of objective measurement of sleep duration and the inability to examine sleep-staging, the reported sensitivity and specificity of the Embletta Gold diagnostic device were from 92-97% and 64-96% respectively [20–22]. Output measures recorded were airflow (nasal cannula), oxygen saturation (pulse oximetry), thoraco-abdominal movements (inductive respiratory bands), snoring episodes (integrated pressure transducer), electrocardiography, and body position (continuous actigraphy).

Sleep Study Analysis

Tracings from the Embletta Gold device were manually scored by a qualified sleep technician, and 50% of the scorings were