Sleep Medicine 37 (2017) 141–146

Contents lists available at ScienceDirect

Sleep Medicine

journal homepage: www.elsevier.com/locate/sleep

Original Article

Association between severity of untreated sleep apnoea and postoperative complications following major cardiac surgery: a prospective observational cohort study

Martina Mason*, Jules Hernández Sánchez, Alain Vuylsteke, Ian Smith

Papworth Hospital NHS Foundation Trust, Papworth Everard, Cambridge, CB23 3RE, UK

ARTICLE INFO

Article history:
Received 27 January 2017
Received in revised form
13 June 2017
Accepted 18 June 2017
Available online 30 June 2017

Keywords:
Sleep apnoea
Cardiothoracic surgery
Postoperative complications

ABSTRACT

Objective: To examine whether untreated sleep apnoea is associated with prolonged Intensive Care Unit (ICU) stay and increased frequency of postoperative ICU complications, in patients undergoing major cardiac surgery.

Patients/methods: Adult patients, undergoing elective coronary artery bypass grafting with or without cardiac valve surgery, between March 2013 and July 2014, were considered. We excluded patients participating in other interventional studies, those who had a tracheostomy before surgery, required emergency surgery or were due to be admitted on the day of surgery. Patients underwent inpatient overnight oximetry on the night prior to their surgery to assess for the presence of sleep apnoea. Since oximetry alone cannot differentiate obstructive from central apnoea, the results are reported as sleep apnoea which was diagnosed in patients with an arterial oxygen desaturation index (ODI) $\geq$ 5/h.

Results: The primary outcome measure was length of stay (LoS) in ICU in days. The secondary outcome was a composite measure of postoperative complications in ICU. Multivariate models were developed to assess associations between ODI and the primary and secondary outcome measures, adjusting for pre-selected predictor variables, relative to primary and secondary outcomes. There was no significant association between ODI and ICU LoS, HR 1.0, 95% CI 0.99–1.02; p = 0.12. However we did find a significant association between ODI and postoperative complications in the ICU, OR = 1.1; 95% CI 1.02–1.17; p = 0.014. The probability of developing complications rose with higher ODI, reflecting sleep apnoea severity.

Conclusions: Acknowledging the limitations of this prospective study, untreated sleep apnoea did not predict an increased length of stay in ICU but we do report an association with postoperative complications in patients undergoing major cardiac surgery.

1. Introduction

Obstructive sleep apnoea (OSA) is partial or complete upper airway occlusion during sleep. Increasing respiratory muscle effort against the obstructed upper airway, in an attempt to maintain air flow, causes arousal from sleep and sleep fragmentation which can be associated with symptoms of un-refreshing sleep and adverse health outcomes [1]. The prevalence of OSA in the adult population has been increasing [2]. Severe OSA has been associated with increased risk of fatal and non-fatal cardiovascular events [3]. OSA shares some risk factors with coronary artery disease [4] and so while the exact prevalence of OSA among people undergoing coronary artery bypass surgery is unknown we might expect it to be higher than in the general adult population.

Association between OSA and postoperative complications in patients undergoing cardiac surgery has previously been reported in retrospective reviews and studies using screening questionnaires to diagnose OSA [5–11]. Two prospective studies reported an association between OSA and postoperative atrial fibrillation and

Abbreviations: AKI, Acute Kidney Injury; CABG, Coronary Artery Bypass Grafting; ESS, Epworth Sleepiness Scale; HR, Hazard Ratio; ICU, Intensive Care Unit; LoS, Length of stay; ODI, Oxygen Desaturation Index; OR, Odds Ratio; OSA, Obstructive Sleep Apnoea.

* Corresponding author. Fax: +44 1480 364161.
E-mail addresses: martina.mason@nhs.net (M. Mason), papworthstats@gmail.com (J. Hernández Sánchez), a.vuylsteke@nhs.net (A. Vuylsteke), ian.smith38@nhs.net (I. Smith).

http://dx.doi.org/10.1016/j.sleep.2017.06.010
1389-9457/

delirium in patients undergoing cardiac surgery, using respiratory polygraphy to diagnose sleep apnoea [12,13]. Two more recent prospective observational studies using recognised sleep diagnostics showed no association between OSA and adverse short term postoperative complications [14,15].

Central sleep apnoea is characterised by pauses in breathing with no apparent occlusion of the airway. There are no published data on its impact on surgical outcomes though it has been implicated in adverse outcomes for patients with cardiac disease [16].

There is currently limited evidence specifically linking OSA or central sleep apnoea, to postoperative complications. Moreover, there are currently no data showing that the application of perioperative continuous positive airway pressure therapy to patients with sleep apnoea reduces the risk of perioperative complications [17]. Despite this lack of robust evidence screening preoperatively for OSA is now the norm in some parts of the United Kingdom, leading to additional National Health Service cost and a potential delay in surgery. We designed a prospective observational study to examine whether untreated sleep apnoea is associated with prolonged ICU stay and increased frequency of postoperative ICU complications, in patients undergoing major cardiac surgery.

2. Materials and methods

2.1. Design

This prospective observational cohort study recruited patients who were undergoing elective coronary artery bypass grafting (CABG) with or without cardiac valve surgery at Papworth Hospital, a specialist cardiothoracic centre. Patients were screened for sleep apnoea the night before their surgery. The primary aim of the study was to assess whether sleep apnoea was associated with a prolonged stay in ICU.

Ethical approval was granted by The National Research Ethics Service East Midlands Northampton Proportionate Review Subcommittee on 20 December 2012 (12/WM/0433). All participants who agreed to enter the study gave signed, informed consent.

2.2. Recruitment

We recruited patients over 18 years of age undergoing elective cardiac surgery and excluded patients who were participating in other interventional studies, those not able to give informed consent or comply with the protocol and patients with a tracheostomy before surgery. Moreover, patients requiring emergency CABG/valve surgery and those admitted on the day of surgery (thereby not allowing in hospital overnight oximetry the night before surgery) were excluded. Some patients were subsequently excluded as intraoperative events or findings led them to have a different operation which did not meet our entry criteria (Fig. 1).

2.3. Data collection

Patients underwent inpatient overnight oximetry (Konica-Minolta PULSOX-300i) while self-ventilating in room air on the night prior to their surgery. The oximetry results were automatically analysed (Visidownload, Stowood Ltd, Oxford UK) and reviewed by a sleep physician, blinded to all clinical data. The anesthetic and surgical teams had no access to the results of preoperative nocturnal oximetry. Since oximetry alone cannot differentiate obstructive from central apnoea, the results are reported as sleep apnoea, which was diagnosed in patients with an arterial oxygen desaturation index (ODI) $\geq$ 5. The ODI was defined as the number of dips in oxygen saturations of greater than 4% relative to the moving average, per hour of sleep. The oximeter was programmed to average measurements over 1 s. As per our usual clinical practice, oximetry records without at least 4 h of adequate data were excluded. Demographic variables, co-morbidities and the Epworth Sleepiness Scale (ESS) score [18] were recorded on the night of admission for surgery. The EuroSCORE, a mortality risk score developed for patients undergoing cardiac surgery, was calculated for all patients [19]. Data regarding postoperative complications were collected from the digital Clinical Information System in the ICU.

2.4. Outcomes

The primary outcome was length of stay (LoS) in ICU (days) a key performance indicator for assessing impact on resources. The secondary outcome was a composite measure of postoperative complications in ICU that included: use of continuous positive airway pressure/bi-level positive pressure ventilation via a mask after extubation, re-intubation, occurrence of new arrhythmias necessitating drug treatment or intervention, need for additional organ support (intra-aortic balloon pump/haemofiltration), major organ complication (defined as those requiring treatment or intervention for cardiovascular, respiratory, renal, neurological, hepatic, coagulation issues), readmission to ICU and 30 days mortality.

2.5. Predictor variables

The primary predictor in all models was ODI analysed as a continuous variable. In view of its clinical relevance, sleep apnoea was divided into categories according to the ODI: mild if ODI $\geq$ 5 but <15, moderate if ODI was $\geq$15 but <30 and severe when ODI $\geq$30. Additional predictor variables thought to be risk factors relevant to the outcomes included EuroSCORE, age, body mass index, surgery type, administration of intravenous opioid analgesia (either intravenous morphine sulphate or fentanyl) during the ICU stay, comorbidities and mean nocturnal oxygen saturations. Although the euroSCORE has been reported to be the best predictive score of mortality for patients undergoing cardiac surgery, certain risk factors within the euroSCORE may have different statistical weight for predicting morbidity and thus individual components of the euroSCORE were used as additional predictor variables [20]. Administration of opioids was selected as a predictor due to previously reported effects including suppression of ventilatory drive and reduction of upper airway dilator muscle activity, potentially exposing patients with sleep apnoea to additional risk [21].

2.6. Sample size

Through discussion with the Critical Care Team we determined a watershed LoS in ICU at 36 h. Unpublished historical clinical data showed LoS <36 h for approximately 75% of patients. The null hypothesis was that patients with sleep apnoea (ODI $\geq$5) did not remain on ICU for >36 h more frequently than patients without sleep apnoea. Fifty seven patients with sleep apnoea, and the same number without, were required to achieve 80% power at 5% significance with a two-sided test for proportions, assuming the proportion of individuals staying longer than 36 h at ICU was 40% in the presence of sleep apnoea compared to 15% in its absence (based on unpublished internal preliminary data).

2.7. Statistical analyses

A parametric accelerated failure time model (Weibull regression) was used to analyse LoS as a continuous response to preselected predictor variables.