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Original Article

The utility of perioperative polygraphy in the diagnosis of obstructive sleep apnea

Ivan Cundrle Jr. [a,b,*], Milos Belehrad [b], Milan Jelinek [a], Lyle J. Olson [c], Ondrej Ludka [b,d], Vladimir Sramek [a]

[a] Department of Anaesthesiology and Intensive Care, St. Anna's University Hospital, Brno, Czech Republic
[b] International Clinical Research Center, St. Anna's University Hospital, Brno, Czech Republic
[c] Division of Cardiovascular Diseases, Mayo Clinic, Rochester, MN, USA
[d] Department of Internal Medicine and Cardiology, University Hospital, Brno, Czech Republic

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ABSTRACT

Objective/Background: Obstructive sleep apnea (OSA) is highly prevalent and often undiagnosed in surgical patients. The aim of this study was to compare polygraphy (PG) performed on sedated patients during surgery to overnight polysomnography (PSG). It was hypothesized that perioperative PG may be used to diagnose OSA.

Patients/Methods: Overnight PSG was performed three days prior to surgery. For surgery, spinal anesthesia and sedation with propofol infusion were used. Sedation depth was monitored by the Bispectral index and maintained for all patients (target level 75). Echocardiography studies were available in three patients, and all were diagnosed with diastolic dysfunction. Relatively high prevalence of CSA in patients with diastolic dysfunction has been previously reported. During surgery, PG recording (Embletta) was performed. Sleep apnea was defined by the type (central/obstructive apnea ≥50%) and by the apnea–hypopnea index (AHI) (events/hour: AHI < 5 no apnea; 5 ≤ AHI < 15 mild apnea; 15 ≤ AHI < 30 moderate apnea; AHI ≥30 severe apnea). Bland–Altman plots were used for analysis, and 2 × 2 decision statistics were calculated for several cut-off values of the AHI. Data were shown as bias with limits of agreement (bias±1.96 standard deviations).

Results: Nineteen subjects were studied: nine (47%) were diagnosed with obstructive, seven (37%) with central sleep apnea, and three (16%) with no sleep apnea by overnight PSG. Perioperative PG bias was 12 (−37; 61) for AHI; 6 (−25; 37) for obstructive apnea; 0 (−4; 4) for central apnea, and 6 (−31; 43) for hypopnea. For the detection of OSA, a PG cut-off value of AHI 5 yielded 89% sensitivity and 60% specificity, AHI 15 yielded 86% sensitivity and 67% specificity, and AHI 30 yielded 100% sensitivity and 71% specificity.

Conclusion: Wide limits of agreement preclude perioperative PG to be used as a diagnostic method; however, it may be useful to screen sedated surgical patients for OSA.

1. Introduction

Obstructive sleep apnea (OSA) is the most common form of sleep-disordered breathing (SDB) in the general population, and is characterized by recurrent upper airway obstruction during sleep [1]. In the surgical population, estimates for prevalence of OSA are higher than in the normal population and range from 10% to 64% in general [2] and up to 91% in bariatric surgery [3]. Obstructive sleep apnea is associated with major comorbidities and high mortality rates [1,4–6].

Although effective therapy is available [7], OSA is not often diagnosed [2,8,9]. Clinical screening and the use of questionnaires continue to pose major challenges [10]. It has been recently shown that anesthesiologists and surgeons fail to diagnose moderate OSA in 65% and 93%, and severe OSA in 53% and 90% of patients, respectively [9]. Therefore, there is a need for improved diagnostic and screening strategies, especially for the perioperative period.

During the perioperative period, signs and symptoms of OSA may become more pronounced due to sleep impairment and use of sedative/analgesic medication [2,9,11,12]. Rabelo et al. compared short in-laboratory polysomnography (PSG) and short PSG with continuous propofol infusion, and showed similar respiratory parameters in patients with OSA, justifying the use of sedation for nasoendoscopic evaluation of the airway obstruction in patients with OSA [13,14]. Furthermore, Gregório et al. showed that midazolam-induced PSG yielded good sensitivity and specificity for the detection

* Corresponding author. Department of Anaesthesiology and Intensive Care, St. Anne's University Hospital in Brno, Pekarska 53, 656 91 Brno, Czech Republic. Fax: +420 543 183 529.
E-mail address: Ivan.Cundrle@seznam.cz (I. Cundrle Jr.).

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of moderate-to-severe OSA [15]. However, whether or not sleep studies performed with continuous sedation may be used to diagnose SDB has not been firmly established.

It was hypothesized that perioperative polygraphy (PG) performed during routine elective surgery could be used to diagnose patients with OSA. Accordingly, the aim of this study was to compare PG obtained from sedated patients undergoing elective knee surgery with standard, in-laboratory, overnight PSG.

2. Methods

2.1. Subject selection

Subjects for investigation were consecutive patients scheduled for total knee replacement surgery. The inclusion criterion was clinically indicated knee surgery. Exclusion criteria were: known OSA, preference for general anesthesia, and contraindication to spinal and/or epidural anesthesia. All participants gave written, informed consent. This study was conducted in accordance with the Declaration of Helsinki, and approved by the local Ethics Committee of the St. Anne's University Hospital in Brno, Czech Republic (No. 67V/2013; 10/07/2013).

2.2. Polygraphy and polysomnography

In all subjects, the presence or absence of SDB was assessed by a full-night attended PSG study, and subsequently compared with a multi-channel PG study. All PSGs were performed three days prior to surgery, to minimize the time between PSG and PG measurement, and to avoid possible effects of preoperative stress and premedication on PSG evaluation. The PSG results were blinded to clinicians performing the PG measurements. Prior to PSG study, the STOP-BANG [16] and Epworth questionnaires [17] were given to all subjects.

The PSG studies were performed at the ICRC Cardiovascular Sleep Research Center using the Compumedics Grael Technology (Compumedics, Abbotsford, Victoria, Australia). Multi-channel electroencephalogram, electro-oculogram, electromyogram, respiration via oronasal flow and nasal pressure detection, and respiratory inductance plethysmography, snoring, body position, oxygen saturation, and multi-channel electrocardiogram were recorded simultaneously along with high-definition digital video.

The PG studies were performed using an Embletta MPR PG device (Natus Medical Inc., San Carlos, CA, USA). Respiration via oronasal flow and nasal pressure detection, respiratory inductance plethysmography, snoring, and oxygen saturation were recorded simultaneously in the PG studies.

Both PG and PSG studies were recorded and blindly scored by board-registered polysomnographic sleep technologists using the American Academy of Sleep Medicine criteria [18,19]. Apnea was defined as ≥90% reduction of airflow amplitude for at least ten seconds in duration. The presence of paradoxical rib cage and abdominal excursions, along with the characteristic airflow reduction in upper airways, indicated obstructive apnea, whereas central apnea was defined by the absence of thoracic and abdominal breathing efforts. A mixed apnea was associated with absent inspiratory effort in the initial portion of the event, followed by resumption of inspiratory effort in the second portion of the event. Hypopnea was defined as a reduction in nasal pressure signal amplitude for at least 10 seconds in combination with oxygen (O_2) desaturation of at least 3%. As per published guidelines [18], sleep apnea was defined by the type (central/obstructive apnea ≥50%) and by the apnea–hypopnea index (AHI) (events/hour: AHI < 5 no apnea; 5 ≤ AHI < 15 mild apnea; 15 ≤ AHI < 30 moderate apnea; AHI ≥ 30 severe apnea).

2.3. Sedation and patient care during surgery

The night before surgery, all patients received premedication with a benzodiazepine (Diazepam Slovakofarma 10 mg) and on the morning of surgery, a combination of benzodiazepine (Diazepam Slovakofarma 10 mg) and paracetamol (Paralen 1 g). Spinal and epidural anesthesia were introduced simultaneously, irrespective of the study protocol. Opioids were avoided unless needed for supplementary analgesia. As in the sleep laboratory, patients were allowed to freely position their head and to request additional head support.

During surgery, patients were sedated using a propofol infusion (Propofol 1% MCT/LCT Fresenius inj.eml.). The depth of sedation was monitored by the Bispectral index (BIS) (BIS VISTA™ Monitoring System – Aspect Medical Systems Inc., Norwood, MA, USA) and targeted at a BIS level of 75. Oxygen supplementation was used whenever the O_2 saturation dropped below 70%. This low threshold was chosen because serious short-term nocturnal desaturations are common in OSA patients [20].

2.4. Statistical analysis

The Shapiro–Wilk test was used to evaluate normality. Comparisons between PSG and PG were performed by the paired Student *t*-test or Wilcoxon matched pair test. Differences in proportions were tested by the two-tailed Fisher exact test and statistical dependence by the Pearson or Spearman rank test. Decision statistics (2×2 tables) were calculated for the main cut-off values of AHI. Bland–Altman analysis was used to evaluate the agreement between PSG and PG studies. Bias was presented together with limits of agreement, which were defined as bias ±1.96 standard deviation (SD). Data were summarized as mean (±SD); p-values <0.05 were considered statistically significant. Statistical analysis was performed using Statistica 12.0 (StatSoft Inc., Prague, Czech Republic).

3. Results

Twenty subjects were enrolled in the study. One subject was excluded because of technical difficulties during surgery. Ten (53%) subjects were women; mean age was 71 ± 8 years, and mean body mass index (BMI) 29 ± 4 kg/m. Fourteen subjects (74%) were classified as ASA II, and five subjects as ASA III (26%). Mean scores of the STOP-BANG and Epworth questionnaires were 4 ± 1 and 6 ± 4, respectively. During surgery, mean BIS was 70 ± 5, and mean propofol infusion concentration was 210 ± 90 mg/hour. Supplemental oxygen was necessary in four patients in whom O_2 saturation dropped below 70%. None of the subjects required opioid administration.

The main PSG and perioperative PG parameters are shown in Table 1. There were no significant differences in the severity or frequency of either OSA or central sleep apnea (CSA) between PSG and perioperative PG. The perioperative PG scoring time was significantly shorter than the scoring time of the PSG. There were no significant differences in AHI, or in the number of central, obstructive, and mixed apneas, and hypopneas between perioperative PG and PSG. Both perioperative PG mean and minimal O_2 saturation were significantly lower than the same parameters of PSG.

Bias and limits of agreement for all main PSG and perioperative PG parameters are shown in Table 2. Perioperative PG overestimated AHI, and both obstructive apnea and hypopnea compared to PSG. Mean and minimal O_2 saturations were underestimated by perioperative PG, and there was no systemic bias for central apnea. Limits of agreement were wide for all measured parameters except for central and mixed apnea.

Decision statistics for the perioperative PG diagnosis of OSA and CSA are shown in Table 3 for the main three AHI cut-off values. For the detection of OSA, perioperative PG sensitivity was high for all AHI cut-off values, and specificity increased with AHI. For the