Risk factors of sleep disturbances in elderly patients after thoracic surgery: a preliminary clinical trial

Bing Li (✉ 540026341@qq.com)
Department of Anesthesiology, Henan Provincial People’s Hospital; People’s Hospital of Zhengzhou University

Yao Liu
Department of Anesthesiology, People’s Hospital of Zhengzhou

Jia Jia
Department of Anesthesiology, Henan Provincial People’s Hospital; People’s Hospital of Zhengzhou University

Fudong Tang
Department of Anesthesiology, Henan Provincial People’s Hospital; People’s Hospital of Zhengzhou University

Wei Zhang
Department of Anesthesiology, Henan Provincial People’s Hospital; People’s Hospital of Zhengzhou University

Jiaqiang Zhang
Department of Anesthesiology, Henan Provincial People’s Hospital; People’s Hospital of Zhengzhou University

Research Article

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Abstract

Background

To identify the risk factors of sleep disturbances in elderly patients after thoracic surgery.

Methods

We enrolled 200 patients, all aged > 65, who underwent elective thoracic surgery and had American Society of Anesthesiology physical status II–III. We recorded general information, surgical diagnosis, type of operation, surgical duration, bleeding, nerve block, and dexmedetomidine dose given by controlled intravenous analgesia (PCIA). We used the Pittsburgh Sleep Quality Index (PSQI) at the end of PCIA to evaluate subjective sleep quality; we also recorded postoperative pain, nausea, and vomiting. We divided patients into a non-sleep disturbances group and a sleep disturbances group with PSQI ≥5 as the cutoff.

Results

A total of 76 (45%) of the patients had sleep disturbances after thoracic surgery. There were significant differences between groups in terms of chronic insomnia, hypertension, diabetes, BMI, age, surgical diagnosis, type of operation, surgical duration, bleeding, nerve block, and dexmedetomidine dose in PCIA. Logistic regression analysis revealed that chronic insomnia, BMI, diabetes, surgical diagnosis, type of operation, surgical duration, bleeding, and postoperative pain were independent risk factors of postoperative sleep disturbances. This analysis also showed that nerve block and dexmedetomidine dose in PCIA were significant protective factors of postoperative sleep disturbances.

Conclusion

Chronic insomnia, BMI, diabetes, surgical diagnosis, type of operation, surgical duration, bleeding, and postoperative pain are independent risk factors of postoperative sleep disturbances in elderly patients. Nerve block and the dose of dexmedetomidine in PCIA are protective.

Trial registration

ChiCTR2000035169; retrospectively registered on 01.08.2020.

Background

Insomnia is a subjective experience in which sleep time and sleep quality are not satisfied even though there are appropriate sleep opportunities and sleep environment, affecting social function during the day. Studies showed that, in the previous month, 5.4% of Chinese people experienced varying degrees of sleep disturbances, 25% met diagnostic criteria for insomnia, and 50% over the age of 65 suffered from insomnia [1, 2]. Insomnia affects daytime mental state, including fatigue, depression, or irritability, and reduces life quality. It can also lead to cognitive impairment, reduce work efficiency, alertness, and
judgment, especially for postoperative sleep disturbances. Postoperative sleep disturbances include insomnia, hypersomnia, narcolepsy, changed sleep structure and increased frequency waking [3, 4]. Postoperative sleep disturbances caused by general anesthesia might increase postoperative complications such as postoperative fatigue, severe anxiety and depression, delirium, and even severe stroke [5–7].

There are few studies of postoperative sleep disturbances in elderly patients. The aging of China's population and their particular medical environment will increase postoperative sleep disturbances in elderly patients. We aimed to identify the risk factors of sleep disturbance in elderly patients after thoracic surgery to provide reference for the development of effective preventive measures.

**Methods**

**Study design and setting**

This study enrolled 200 patients from August 2020 to November 2020. This prospective study was approved by the Ethics Committee of Henan Provincial People's Hospital [Ethics Committee: (2020) Lun Shen No. (100)], and written informed consent was obtained from the patients. The study was registered at www.chictr.org.cn (ChiCTR2000035169). The study protocol complied with the 1975 Declaration of Helsinki.

**Characteristics of participants**

We enrolled patients classified as American Society of Anesthesiologists status I or II, were aged 65 years and older and were scheduled for elective thoracic surgery. We excluded patients with communication disturbances, inability to cooperate (e.g., language comprehension disturbances, mental illness), unstable angina pectoris or myocardial infarction within 3 months, New York Heart Association grade ≥3, severe cardiovascular and cerebrovascular diseases, those who underwent an unplanned second operation in the post-anesthesia care unit (PACU), those transferred to intensive care unit (ICU) after surgery, and those transferred from the ward to ICU after surgery.

We recruited patients in the PACU admission after August 2020. A nurse anesthetist and a PACU nurse scrutinized the medical records. During the reviewer training, the study protocol, definitions, and the case record form were explained. Initially, both reviewers practiced completing the case record forms for 20 cases together. Then, each reviewer independently examined half of the remaining 180 medical records to prepare a form for each case. Each reviewer subsequently checked every 20th form completed by the other reviewer, and a third reviewer (an anesthesiologist) randomly checked 60 of the total 200 case record forms. Finally, 200 forms were converted to electronic data for input to PASW SPSS Statistics for Windows ver. 26.0 (SPSS Inc., Chicago, IL, USA). We recorded the following: age; sex; smoking history; drinking history; chronic insomnia; hypertension; diabetes; American Society of Anesthesia classification; body mass index (BMI); surgical diagnosis; type of operation; surgical duration; bleeding; nerve block;
whether dexmedetomidine was included in PCIA; postoperative pain, nausea and vomiting; and the patient’s subjective sleep quality evaluated by Pittsburgh Sleep Quality Index (PSQI) after 48 hours.

**Preoperative preparations and anesthesia protocol**

No patients received pretreatment before admission to the operating room. All patients were monitored using electrocardiography, pulse oximetry, invasive blood pressure recordings, and bispectral index. The anesthesiologist determined whether to perform PCIA with dexmedetomidine or thoracic paravertebral block after surgery, depending on the patient's condition. Subsequently, we administered a comprehensive evaluation of satisfaction with analgesia from patients and their family members at the end of PCIA (very satisfied; satisfied; general; dissatisfaction). We grouped very satisfied and satisfied as satisfaction. We considered this group as having no pain after surgery; If patients reported general or dissatisfaction, we classified them as dissatisfied, and defined this group as having postoperative pain. We used the Pittsburgh Sleep Quality Index (PSQI) questionnaire to evaluate their subjective sleep quality, including sleep quality, sleep time, sleep efficiency, daytime dysfunction, sleep disturbances, and hypnotic drug use. The scale consists of nine questions, with 18 items, and each index is scored 0–3. The total score of each index is 21 points [8]. When the PSQI score is greater than or equal to 5, the patient is defined as having sleep disturbances. We divided patients into a non-sleep disturbances group and a sleep disturbances group.

**Sample size calculation**

The sample size was calculated with “Power and Sample Size.com,” an online power and sample size calculator. The primary objective of this study identified the risk factors of sleep disturbances in elderly patients after thoracic surgery. The calculation of the sample size was based on the pilot study finding that the incidence of sleep disturbances in elderly patients after thoracic surgery was approximately 45%. It was thus assumed that the incidence of sleep disturbances in elderly patients after thoracic surgery was 60%. To detect a clinically significant difference with a power of 80%, an alpha error of 0.05 (twosided), a total of 87 patients were required. To compensate for data that may be found to be missing during the retrospective review, the sample size was adjusted upward to 200 cases.

**Statistical analysis**

The data analysis was performed using the independent sample Student t-test, the Pearson’s chi-square test, and the Mann–Whitney U-test, and it employed the program PASW SPSS Statistics for Windows ver. 26.0 (SPSS Inc.). All descriptive data were presented as case (%), mean ± standard deviation, and median (interquartile range). Univariate analyses of each factor were performed to calculate the p-value, OR, and 95% confidence interval (CI). Multiple logistic regression analysis was performed by choosing the factors with a p-value of <0.10; p<0.05 was considered to be significant.

**Results**
In total, 200 patients met the inclusion criteria, and 16 patients declined to participate. We enrolled a total of 174 patients, five of whom developed delirium. The final analyses included 169 patients (Fig. 1).

The incidence of sleep disturbances in elderly patients after thoracic surgery was 45%. We performed univariable and multivariable analyses by selecting factors whose p-values were < 0.10: age, chronic insomnia, hypertension, diabetes, BMI, surgical diagnosis, type of operation, surgical duration, bleeding, nerve block, whether dexmedetomidine was included in PCIA, and postoperative pain (Table 1). We performed multiple logistic regression analysis by selecting factors whose p-values were < 0.10: chronic insomnia, diabetes, BMI, surgical diagnosis, type of operation, surgical duration, bleeding, nerve block, dose of dexmedetomidine in PCIA, and postoperative pain. Only nerve block (p < 0.001; OR, 0.085; 95% CI, 0.046–0.155) and dexmedetomidine (p = 0.003; OR, 0.772; 95% CI, 0.609–0.979) were marginally significant preventive factors for sleep disturbances in elderly patients after thoracic surgery. Chronic insomnia, BMI, diabetes, surgical diagnosis, type of operation, surgical duration, bleeding, and postoperative pain were independent risk factors of postoperative sleep disturbances in elderly patients (Table 2).
Table 1
Analysis of suspicious factors of postoperative sleep disturbances in two groups

| Variable                                | Sleep disturbances group (n = 76) | non-sleep disturbances group (n = 93) | p-value |
|-----------------------------------------|----------------------------------|--------------------------------------|---------|
| Smoking history                         | 35.6                             | 32.5                                 | 0.055   |
| Drinking history                        | 31.1                             | 34.3                                 | 0.078   |
| Chronic insomnia                        | 47.7                             | 36.0                                 | 0.014*  |
| Hypertension                            | 29.3                             | 25.5                                 | 0.035*  |
| Diabetes                                | 27.9                             | 22.5                                 | 0.027*  |
| Body mass index (kg/m²)                 | 23.9 ± 4.3                       | 19.4 ± 3.7                           | 0.083   |
| Age (yr)                                | 78.3 ± 5.5                       | 71.2 ± 4.7                           | 0.077   |
| Sex (female)                            | 34/42                            | 46/47                                | 0.223   |
| American Society of Anesthesia status   |                                  |                                      | 0.562   |
| □                                       | 87.8                             | 88.5                                 |         |
| □                                       | 12.2                             | 11.5                                 |         |
| Type of operation                       |                                  |                                      | 0.018*  |
| Thoracoscopy                            | 29.1                             | 10.4                                 |         |
| Video assisted thoracoscopy             | 70.9                             | 89.6                                 |         |
| Surgical diagnosis                      |                                  |                                      | 0.031*  |
| Benign tumor of lung                    | 27.4                             | 38.5                                 |         |
| Lung cancer                             | 37.2                             | 33.7                                 |         |
| Esophageal cancer                       | 35.4                             | 27.8                                 |         |
| Surgical duration                       | 233.8 ± 108.3                    | 185.06 ± 76.6                        | 0.029*  |
| Nerve block                             |                                  |                                      | 0.011*  |
| None                                    | 46.9                             | 33.1                                 |         |
| TPVB                                    | 53.1                             | 66.9                                 |         |
| Postoperative pain                      | 48.8                             | 22.7                                 | 0.005*  |

Note: Values are presented as number (%), mean ± standard deviation, or median (interquartile range). Combined with the non-sleep disturbances group, *p < 0.05 indicates statistical significance.
| Variable                                      | Sleep disturbances group (n = 76) | non-sleep disturbances group (n = 93) | p-value  |
|----------------------------------------------|----------------------------------|---------------------------------------|----------|
| Dose of dexmedetomidine in PCIA              | 38.9                             | 55.6                                  | 0.011*   |
| Bleeding                                     | 164.3 ± 33.2                     | 101.1 ± 25.8                          | 0.041*   |
| Nausea                                       | 4.9                              | 4.8                                   | 0.068    |
| Vomiting                                     | 2.2                              | 2.1                                   | 0.117    |

Note: Values are presented as number (%), mean ± standard deviation, or median (interquartile range). Combined with the non-sleep disturbances group, *p < 0.05 indicates statistical significance.
Table 2
Risk factors of postoperative sleep disorders in elderly patients undergoing thoracic surgery

| Factors                              | B     | S.E.  | Wals   | p-value | OR    | 95% CI       |
|--------------------------------------|-------|-------|--------|---------|-------|--------------|
| Chronic insomnia                     | 0.421 | 0.098 | 18.475 | 0.000   | 1.523 | 1.257–1.845  |
| Body mass index                      | 0.919 | 0.454 | 4.107  | 0.043   | 2.508 | 1.031–6.102  |
| Diabetes                             | 0.364 | 0.154 | 5.569  | 0.018   | 1.439 | 1.064–1.948  |
| Type of operation                    | 0.535 | 0.184 | 8.418  | 0.004   | 1.707 | 1.190–2.450  |
| Surgical diagnosis                   |       |       | 11.453 | 0.003   |       |              |
| Lung cancer vs Benign tumor of lung  | 0.274 | 0.102 | 7.255  | 0.007   | 1.315 | 1.078–1.606  |
| Esophageal cancer Vs Benign tumor of lung | 0.720 | 0.292 | 6.076  | 0.014   | 2.055 | 1.159–3.645  |
| Surgical duration                    | 0.352 | 0.112 | 9.821  | 0.002   | 1.421 | 1.141–1.771  |
| Nerve block                          | -2.466| 0.308 | 64.283 | 0.000   | 0.085 | 0.046–0.155  |
| Dose of dexmedetomidine in PCIA      | -0.259| 0.121 | 4.556  | 0.033   | 0.772 | 0.609–0.979  |
| Postoperative pain                   | 0.454 | 0.123 | 13.694 | 0.000   | 1.575 | 1.238–2.004  |
| Bleeding                             | 0.479 | 0.243 | 3.887  | 0.049   | 1.615 | 1.003–2.601  |

Note: Lung cancer vs Benign tumor of lung: Combined with the Benign tumor of lung, lung cancer is an independent risk factor of postoperative sleep disturbances in elderly patients. Esophageal cancer Vs Benign tumor of lung: Combined with the Benign tumor of lung, esophageal cancer is an independent risk factor of postoperative sleep disturbances in elderly patients.

Discussion
Postoperative sleep disturbances are manifestations of postoperative brain dysfunction, especially for elderly patients, and they are among the important risk factors for delirium, which had gradually attracted attention. Studies confirmed that extensive surgical trauma often leads to postoperative sleep disturbances, increasing the possibility of postoperative cognitive impairment [9]. The expansion of surgical incisions and the complexity of surgical types, the amount of bleeding increased, and the operation time prolonged all increase the degree of severity of surgical trauma of elderly patients; these
factors significantly increase the incidence of sleep disturbances in elderly patients. The operation time was associated with the duration of postoperative sleep disturbances, and this may have been due to the extensive surgical trauma and the severity of the patient's condition [10].

In the present study, we found the perioperative application of thoracic paravertebral block, dexmedetomidine, and reducing postoperative pain reduced the incidence of postoperative sleep disturbances in elderly patients; postoperative pain is the most harmful factor associated with postoperative sleep disturbances [11]; pain can prolong sleep latency and reduce total sleep time, while sleep disturbances increase pain sensitivity and reduce pain threshold, including pain experienced the following day. The degree of pain is also predicted by postoperative sleep quality [12]. General anesthesia disrupts sleep/wake-up cycles and other circadian rhythms [13], leading to postoperative fatigue, severe anxiety and depression, delirium, and even severe stroke [5, 7]. Volatile general anesthetics, including sevoflurane, isoflurane, and halothane, may cause short-term sleep disturbances and fragmentation [14]. Dexmedetomidine can induce bionic sleep [15], that is, natural sleep, and it does not produce dependence, tolerance, or addiction [16]. For elderly patients with minimal trauma, the application of total intravenous anesthesia combined with dexmedetomidine may reduce the incidence of postoperative sleep disturbances.

Sleep disturbances are associated with increased age [17]. In the present study, we showed that people with preoperative insomnia were more likely to have postoperative sleep disturbances. The reason may be that melatonin levels in the elderly are significantly lower than those of young people [18]. The physiological reserve of elderly patients decreases, and the prevalence of infirmity and comorbidities increases, all of which may affect the brain and central nervous system, leading to postoperative sleep disturbances [19]. Diabetes mellitus is a risk factor for long-term use of opioids and persistent pain after surgery; patients with diabetes are in chronic systemic proinflammatory states, characterized by high concentration of the inflammatory cytokine IL-6; persistent immune responses related to host defense prolong peripheral sensitization leading to pain hypersensitivity [20], and this further aggravates postoperative sleep disturbances.

We found that many factors influenced postoperative sleep disturbances, including surgical anesthetic- and patient-related factors. Other studies showed that postoperative sleep disturbances might be affected by psychological and postoperative environmental factors such as ward lighting and sound; elderly patients are a special population. We should comprehensively consider the factors associated with their postoperative sleep disturbances.

Some limitations of this study should be noted. First, postoperative sleep disorders are affected by many factors, including surgery, anesthesia and patient factors, as well as environmental factors which was not noticed by this study. Second, our study did not continue to track the recovery of patients with postoperative sleep disorders, which is the main direction of our future research.

Conclusions
Chronic insomnia, BMI, diabetes, surgical diagnosis, type of operation, surgical duration, bleeding, and postoperative pain are independent risk factors of postoperative sleep disturbances in elderly patients. Nerve block and the dose of dexmedetomidine in PCIA are protective.

**Declarations**

**Consent for publication**

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**Availability of data and materials**

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

**Authors’ contributions**

BL: manuscript and data analysis. YL: sample detection and measurements: human samples and data acquisition. JJ and FDT: sample detection and measurements. WZ and JQZ: design and clinical studies. All authors have read and approved the final version of the manuscript.

**Ethics approval and consent to participate**

This prospective study was approved by the Ethics Committee of Henan Provincial People's Hospital, and written informed consent was obtained from all patients.

**Competing interests**

The authors declare that they have no competing interests.

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Author details

1 Department of Anesthesiology, Henan Provincial People's Hospital, No. 7, Weiwu Road, Zhengzhou City, Henan Province, China.

2 Department of Anesthesiology, People's Hospital of Zhengzhou, No. 7, Huanghe Road, Zhengzhou 450003, China.

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