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Intraoperative Nasal Positive Airway Pressure in High-Risk Obstructive Sleep Apnea Patients Undergoing Total Knee Arthroplasty

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Background

- Patients with obstructive sleep apnea (OSA) face increased risk of perioperative pulmonary complications, including hypoventilation, hypoxemia, atelectasis, prolonged intubation, and extended hospital stay[1].
- Nasal continuous positive airway pressure (NCPAP) relieves upper airway obstruction, prevents and treats atelectasis, and reduces incidence of acute respiratory failure[2] (**Figure 1**).
- OSA has been associated with postoperative complications without perioperative NCPAP use[3].
- CPAP is typically used postoperatively to treat airway obstruction, however, less is known about the potential benefits of intraoperative NCPAP use under spinal anesthesia and deep sedation.
- This study evaluated the effects of intraoperative NCPAP on patients who underwent total knee arthroplasty (TKA) with known or high-risk for OSA over the standard simple mask.

Figure 1. SuperNO$_2$VA Nasal Continuous Positive Airway Pressure Mask, Diagram from Vyaire Medical Clinical Use Protocol VYR-US-1900144 2.0 VY SuperNO2VA ET clinical protocol US R1.1.pdf

Methods

Hypothesis: Intraoperative NCPAP would be associated with more favorable outcomes than a similar cohort that used simple masks:

- (Primary) Fewer PACU desaturation episodes (O_2<88%)
- Shorter time to pass room air trials
- Shorter PACU stays
- Fewer pulmonary complications

Population: 1516 patients diagnosed with or at high risk for OSA that underwent TKA between January 2020 and February 2024.

- 386 (NCPAP group)
- 1130 (Control group, simple mask)

Ethics Statement: This study was approved by the Institutional Review Board. Since the study involved only minimal risk to the participants, a total waiver of written informed consent was granted by the IRB.

Table 1. Demographic Characteristics

Variable	Control (n=1,130)	NCPAP (n=386)	Total (n=1,516)	p-value
Age, mean ± SD	68.17 ± 8.38	67.90 ± 7.99	68.10 ± 8.28	0.579
Sex, n (%)				0.276
Male	667 (59.0)	240 (62.2)	907 (59.8)	
Female	463 (41.0)	146 (37.8)	609 (40.2)	
Race, n (%)				0.171
American Indian or Alaska Native	4 (0.4)	2 (0.5)	6 (0.4)	
Asian	6 (0.5)	2 (0.5)	8 (0.5)	
Black or African American	62 (5.5)	25 (6.5)	87 (5.7)	
Multiracial	10 (0.9)	2 (0.5)	12 (0.8)	
White or Caucasian	981 (86.8)	347 (89.9)	1,328 (87.6)	
Other	64 (5.7)	8 (2.1)	72 (4.7)	
Unknown	1 (0.1)	0 (0.0)	1 (0.1)	
Patient refused	2 (0.2)	0 (0.0)	2 (0.1)	
Ethnicity, n (%)				0.080
Hispanic or Latino	53 (4.7)	8 (2.1)	61 (4.0)	
Not Hispanic or Latino	1,062 (94.0)	373 (96.6)	1,435 (94.7)	
Unknown	2 (0.2)	2 (0.5)	4 (0.3)	
Patient refused	13 (1.2)	3 (0.8)	16 (1.1)	
BMI (kg/m2), mean ± SD	36.05 ± 5.78	36.75 ± 6.03	36.23 ± 5.85	**0.042**

Abbreviations: NCPAP, Nasal Continuous Positive Airway Pressure; SD, Standard Deviation; BMI, Body Mass Index.

Table 3. Postoperative Complications

Variable	Control (n=1,130)	NCPAP (n=386)	Total (n=1,516)	p-value
Postoperative Complications, n (%)				
Atelectasis	2 (0.2)	0 (0.0)	2 (0.1)	1.00
Hypoxemia	13 (1.2)	10 (2.6)	23 (1.5)	**0.046**
Pleural effusion	1 (0.1)	1 (0.3)	2 (0.12)	0.445
Pneumothorax	0 (0.0)	0 (0.0)	0 (0.0)	--
Bronchospasm	0 (0.0)	0 (0.0)	0 (0.0)	--
Aspiration pneumonitis	0 (0.0)	0 (0.0)	0 (0.0)	--
Pneumonia	1 (0.1)	1 (0.3)	2 (0.1)	0.445
Acute respiratory distress syndrome	0 (0.0)	0 (0.0)	0 (0.0)	--
Tracheobronchitis	0 (0.0)	0 (0.0)	0 (0.0)	--
Pulmonary edema	1 (0.1)	0 (0.0)	1 (0.1)	1.00
Pulmonary embolism	2 (0.2)	0 (0.0)	2 (0.1)	1.00
Respiratory failure	6 (0.5)	1 (0.3)	7 (0.5)	0.686
Myocardial infarction	2 (0.2)	0 (0.0)	2 (0.1)	1.00
Cardiac arrhythmias	11 (1.0)	4 (1.0)	15 (1.0)	1.00
Other	23 (2.0)	3 (0.8)	26 (1.7)	0.115
Any postoperative complication	71 (6.3)	21 (5.4)	92 (6.1)	0.549

Table 2. Clinical Outcomes

Variable	Control (n=1,130)	NCPAP (n=386)	Total (n=1,516)	p-value
PACU Oxygen Desaturation Events O_2< 88%, n (%)	52 (4.6)	17 (4.4)	69 (4.6)	0.872
Abnormal First RASS in PACU, n (%)	346 (30.6)	115 (29.8)	461 (30.4)	0.760
Unanticipated Hospital Readmission, n (%)	36 (3.2)	5 (1.3)	41 (2.7)	**0.048**
Unanticipated ICU Admission, n (%)	1 (0.1)	0 (0.0)	1 (0.1)	1.00

Abbreviations: PACU, Post Anesthesia Care Unit; O_2, Oxygen; NCPAP, Nasal Continuous Positive Airway Pressure; RASS, Richmond Agitation-Sedation Scale; ICU, Intensive Care Unit

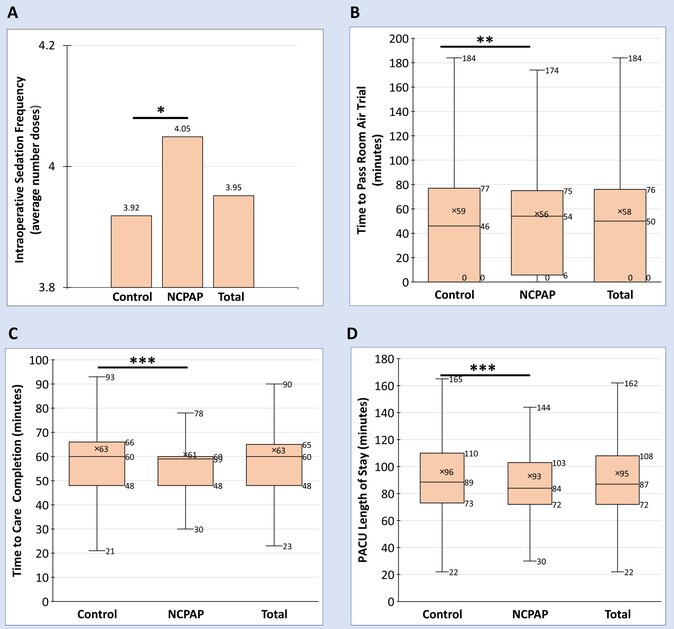

Figure 2A-D. Clinical Outcomes (A) Average Intraoperative Sedation Frequency (number of doses), (B) Time to Pass Room Air Trial (min.), (C) Time to Care Completion (min.); (D) PACU Length of Stay (min.); *p<0.05, **p<0.01, ***p≤0.001

Results

- The NCPAP group had a higher body mass index (36.75 vs. 36.05, *p=0.042*) (**Table 1**).
- There was no difference in PACU desaturation events between the groups (4.6 vs 4.4%, *p=0.872*) (**Table 2**).
- The NCPAP group received more intraoperative sedation on average (4.05 vs 3.92, *p=0.031*) and took longer time to pass room air trial (54 vs 46 minutes, *p =0.006*) (**Figure 2 A & B**).
- The NCPAP had shorter time to care completion (59 vs 60 minutes, *p=0.001*) and PACU length of stay (84 vs 90 minutes, *p<0.001*) (**Figure 2 C & D**).
- Incidence of postoperative hypoxemia was greater among the NCPAP group (2.6 vs 1.2%, *p=0.046,* **Table 3**).
- The NCPAP had fewer hospital readmissions (1.3 vs 3.2%, *p=0.048*) (**Table 2**).

Discussion

- Despite longer time to pass room air trial, the NCPAP group exhibited a shorter PACU length of stay and lower incidence of unanticipated hospital readmissions than the control group.
- Extending the use of NCPAP to the intraoperative period may provide additional pulmonary benefits.
- Further evaluation is needed to thoroughly evaluate the benefits versus drawbacks of intraoperative NCPAP on patients with or at high risk of OSA that underwent TKA.

References

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