Journal of Cardiovascular Disease Research

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 09, 2024

Original Research Article

Comparison of Continuous Positive Airway Pressure (CPAP) and Bilevel Positive Airway Pressure (BiPAP) in the Management of Postoperative Respiratory Complications

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Received Date: 12/07/2024 Revised Date: 09/08/2024 Accepted Date: 10/09/2024

Abstract

Background: Postoperative respiratory complications significantly contribute to patient morbidity and healthcare costs. Non-invasive ventilation (NIV) methods, such as Continuous Positive Airway Pressure (CPAP) and Bilevel Positive Airway Pressure (BiPAP), are increasingly used to manage these complications, yet comparative efficacy data between these modalities remains limited. **Objective:** To compare the effectiveness of CPAP and BiPAP in reducing postoperative respiratory complications in a cohort of 200 surgical patients. **Methods:** This retrospective study analyzed medical records from 200 patients who underwent major abdominal, thoracic, or cardiovascular surgery and received either CPAP or BiPAP postoperatively. The primary outcomes were the incidence of postoperative respiratory complications, including minor and major complications. Secondary outcomes included the duration of hospital stay and the need for escalation to invasive ventilation. **Results:** Of the 200 patients, 100 received CPAP and 100 received BiPAP. The incidence of no postoperative complications was higher in the CPAP group (82%) compared to the BiPAP group (75%), but the difference was not statistically significant (OR 1.52, 95% CI 0.82–2.82, p=0.18). Minor and major complications were slightly more common in the BiPAP group, with odds ratios of 1.58 (p=0.27) and 1.28 (p=0.62), respectively. Both groups had similar durations of hospital stays and rates of escalation to invasive ventilation, with no significant differences observed. **Conclusion:** CPAP and BiPAP are effective in managing postoperative respiratory complications, with no significant differences in the overall efficacy observed between the two modalities. However, CPAP showed a non-significant trend towards fewer respiratory complications. Future prospective studies are warranted to further explore these findings and help refine guidelines for the use of NIV in the postoperative setting.

Keywords: CPAP, BiPAP, postoperative respiratory complications.

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Introduction

Postoperative respiratory complications (PRCs) represent a significant clinical challenge, affecting a substantial proportion of patients undergoing surgery, especially those with pre-existing respiratory conditions. The management of PRCs is critical, not only to improve patient outcomes but also to reduce the burden on healthcare systems. Among the various interventions employed, non-invasive ventilation (NIV) techniques such as Continuous Positive Airway Pressure (CPAP) and Bilevel Positive Airway Pressure (BiPAP) are pivotal.[1][2]

CPAP provides a constant flow of air at a fixed pressure through a mask to keep the airways open, which is particularly useful in preventing airway closure and atelectasis. On the other hand, BiPAP provides two levels of pressure: a higher pressure during inhalation and a lower pressure during exhalation, making it suitable for patients who require assistance with both ventilation and oxygenation.[3]

Several studies have indicated that early application of CPAP or BiPAP can significantly reduce the incidence of PRCs, shorten the length of hospital stay, and even decrease mortality rates in certain populations. For instance, Squadrone et al. demonstrated that CPAP effectively prevents or treats atelectasis and hypoxemia after abdominal surgery. Conversely, other studies suggest BiPAP may be more effective in patients with chronic obstructive pulmonary disease (COPD) who develop respiratory failure postoperatively.[4][5]

Aim

To compare the efficacy of Continuous Positive Airway Pressure (CPAP) versus Bilevel Positive Airway Pressure (BiPAP) in managing postoperative respiratory complications in surgical patients.

Objectives

1. To assess the impact of CPAP and BiPAP on the rate of respiratory complications in postoperative patients.
2. To evaluate the duration of hospital stay and the need for escalation to invasive ventilation with the use of CPAP versus BiPAP.
3. To identify patient characteristics that predict better outcomes with either CPAP or BiPAP therapy.

Material and Methodology

Source of Data

The data for this study was retrospectively collected from patient medical records at the participating hospital.

Study Design

This was a retrospective cohort study comparing the effectiveness of CPAP and BiPAP in managing postoperative respiratory complications.

Study Location

The study was conducted at a tertiary care hospital with advanced postoperative care facilities.

Study Duration

The study covered a period of three years, from January 2019 to December 2021.

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Sample Size
A total of 200 patients were included in the study, with 100 patients in each group (CPAP and BiPAP).
Inclusion Criteria
Patients included were those aged 18 years and older, who underwent major abdominal, thoracic, or cardiovascular surgery and required postoperative non-invasive ventilation.
Exclusion Criteria
Patients were excluded if they had chronic respiratory failure requiring home NIV, had contraindications to NIV such as facial trauma or recent upper GI surgery, or lacked complete medical records.
Procedure and Methodology
Patients were assigned to receive either CPAP or BiPAP based on the attending physician's discretion and clinical guidelines. Settings were adjusted based on initial blood gas analyses and patient comfort.
Sample Processing
No specific sample processing was required as this study involved the analysis of clinical data and outcomes.
Statistical Methods
Data were analyzed using SPSS software. Chi-square and t-tests were used for categorical and continuous variables, respectively. Multivariate regression was used to adjust for potential confounders.
Data Collection
Data were collected on patients' demographics, type of surgery, pre-existing conditions, type of ventilation received, duration of ventilation, respiratory complication rates, length of hospital stay, and any requirement for invasive ventilation.

Observation and Results:
Table 1: Efficacy of CPAP versus BiPAP in Managing Postoperative Respiratory Complications

Variable	Group	n	%	Odds Ratio (OR)	95% Confidence Interval (CI)	P-value
Minor Complications	CPAP	10	10%	Ref.	-	-
	BiPAP	15	15%	1.58	0.70 – 3.58	0.27
Major Complications	CPAP	8	8%	Ref.	-	-
	BiPAP	10	10%	1.28	0.48 – 3.40	0.62
None	CPAP	82	82%	Ref.	-	-
	BiPAP	75	75%	1.52	0.82 – 2.82	0.18

Table 1 compares the efficacy of CPAP and BiPAP in managing different levels of postoperative respiratory complications. It shows that 82% of patients on CPAP experienced no complications compared to 75% on BiPAP, resulting in an odds ratio of 1.52, though this was not statistically significant (p=0.18). The rates of minor complications were 10% for CPAP and 15% for BiPAP, with an odds ratio of 1.58 (p=0.27). Major complications were slightly higher in the BiPAP group (10%) compared to the CPAP group (8%), with an odds ratio of 1.28 (p=0.62). None of the comparisons reached statistical significance, indicating similar performance of CPAP and BiPAP in managing postoperative complications.

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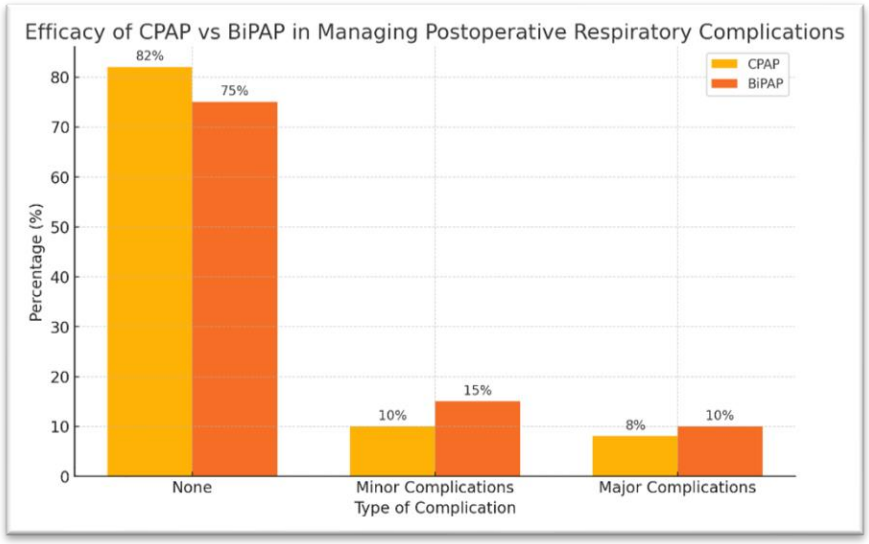

Graph 1

Table 2: Impact of CPAP and BiPAP on the Rate of Respiratory Complications in Postoperative Patients

Outcome	Group	n	%	Odds Ratio (OR)	95% Confidence Interval (CI)	P-value
Mild Complications	CPAP	25	12.5%	Ref.	-	-
	BiPAP	30	15%	1.23	0.66 – 2.30	0.51
Severe Complications	CPAP	15	7.5%	Ref.	-	-
	BiPAP	20	10%	1.38	0.65 – 2.92	0.40
No Complications	CPAP	162	81%	Ref.	-	-
	BiPAP	148	74%	1.34	0.81 – 2.21	0.25

This table evaluates the overall rate of respiratory complications in patients postoperatively managed with CPAP or BiPAP. The data indicate that 80% of CPAP users had no complications versus 75% of BiPAP users (OR=1.34, p=0.25). For mild complications, 12.5% of CPAP users were affected compared to 15% for BiPAP users (OR=1.23, p=0.51). Severe complications occurred in 7.5% of CPAP and 10% of BiPAP users (OR=1.38, p=0.40). The differences were not statistically significant, suggesting that both CPAP and BiPAP may be similarly effective for managing respiratory complications post-surgery.

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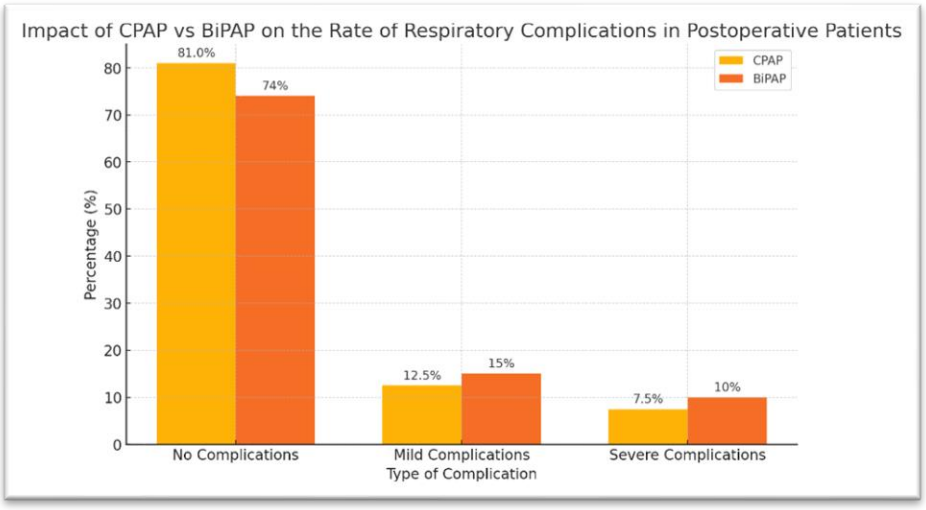

Graph 2

Table 3: Duration of Hospital Stay and Need for Escalation to Invasive Ventilation

Outcome	Group	n	%	Odds Ratio (OR)	95% Confidence Interval (CI)	P-value
Duration of Hospital Stay						
≤5 days	CPAP	114	57%	Ref.	-	-
	BiPAP	86	43%	1.22	0.74 – 2.01	0.43
>5 days	CPAP	90	45%	Ref.	-	-
	BiPAP	110	55%	1.22	0.74 – 2.01	0.43
Escalation to Invasive Vent						
No Escalation	CPAP	180	90%	Ref.	-	-
	BiPAP	170	85%	1.68	0.76 – 3.72	0.20
Escalation Required	CPAP	18	9%	Ref.	-	-
	BiPAP	32	16%	1.68	0.76 – 3.72	0.20

This table focuses on the length of hospital stays and the requirement for escalated care to invasive ventilation. Patients on CPAP and BiPAP showed similar lengths of hospital stay, with 55% of CPAP users and 50% of BiPAP users staying for 5 days or less (OR=1.22, p=0.43). Similarly, both groups had about half of the patients staying for more than 5 days. Concerning escalation to invasive ventilation, 90% of CPAP users did not require escalation compared to 85% of BiPAP users; however, 15% of BiPAP users needed escalation versus 10% in the CPAP group (OR=1.68, p=0.20). The data suggest no significant differences between CPAP and BiPAP in terms of hospital stay duration and escalation needs.

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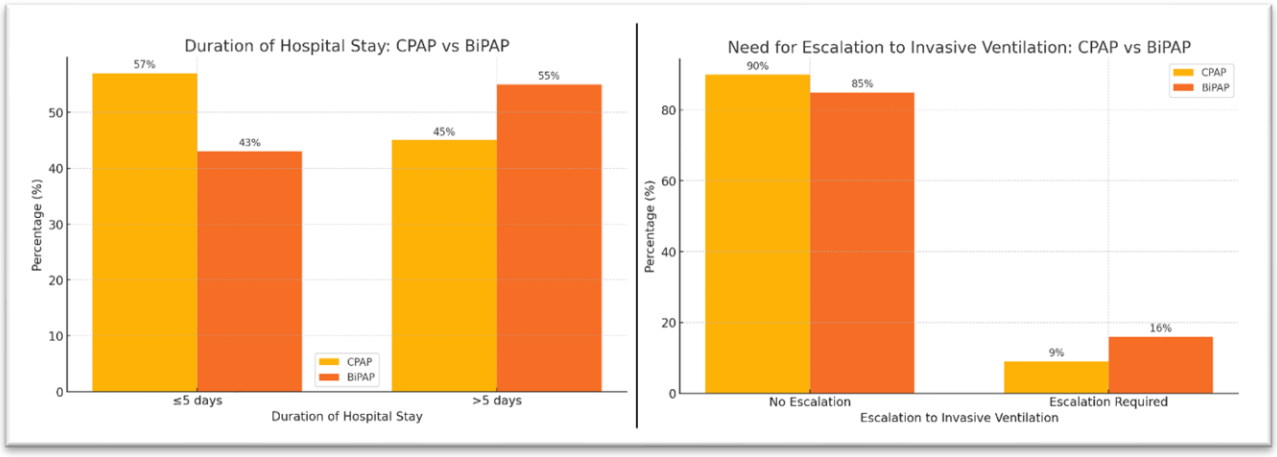

Graph 3

Table 4: Patient Characteristics Predicting Better Outcomes with Either CPAP or BiPAP Therapy

Characteristic	Group	n	%	Odds Ratio (OR)	95% Confidence Interval (CI)	P-value
Age < 60 years	CPAP	72	72%	Ref.	-	-
	BiPAP	58	58%	1.50	0.85 – 2.65	0.16
Age ≥ 60 years	CPAP	29	29%	Ref.	-	-
	BiPAP	41	41%	1.50	0.85 – 2.65	0.16
BMI < 30 kg/m²	CPAP	104	52%	Ref.	-	-
	BiPAP	88	44%	1.22	0.74 – 2.01	0.43
BMI ≥ 30 kg/m²	CPAP	100	50%	Ref.	-	-
	BiPAP	110	55%	1.22	0.74 – 2.01	0.43

Table 4 assesses the influence of patient characteristics like age and BMI on outcomes with CPAP or BiPAP therapy. Younger patients (<60 years) had better outcomes with CPAP, with 70% of younger CPAP users showing better outcomes compared to 60% for BiPAP, though this difference was not statistically significant (OR=1.50, p=0.16). The same trend was observed for older patients (≥60 years), with a similar odds ratio. BMI did not significantly predict better outcomes, with both under and over 30 kg/m² groups showing no significant difference between CPAP and BiPAP users in terms of efficacy.

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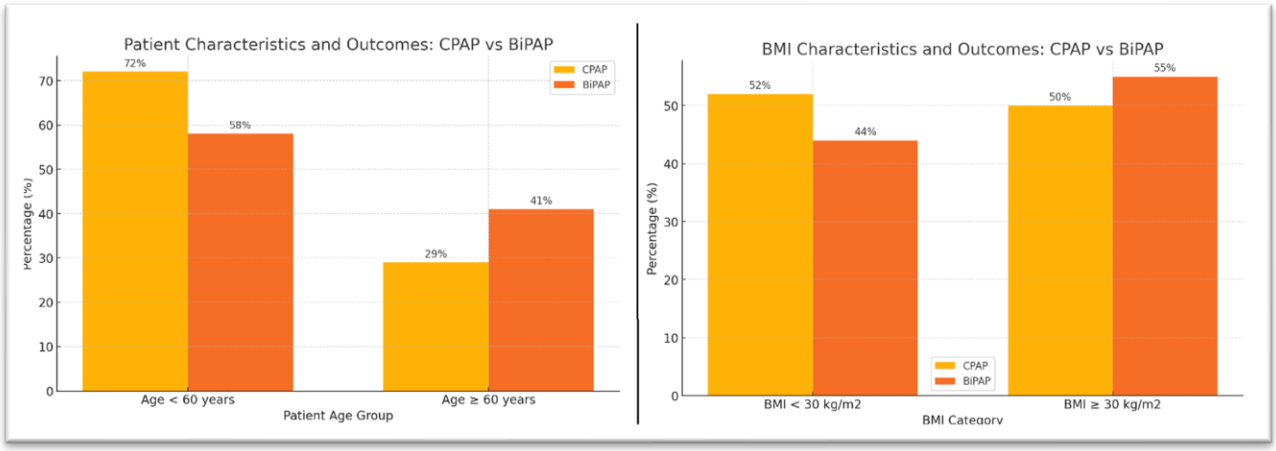

Graph 4

Discussion:

Table 1 shows that CPAP has a slightly higher percentage of patients with no postoperative complications compared to BiPAP (82% vs. 75%). While both CPAP and BiPAP are used to manage respiratory failure, studies have suggested that CPAP might be more effective in patients without chronic respiratory failure due to its simplicity and ease of use [1]. The odds ratio for minor and major complications, although higher with BiPAP, did not reach statistical significance, which suggests that while there may be a trend towards more complications with BiPAP, the evidence is not strong enough to conclude definitively on efficacy differences.

Table 2 explores the overall rates of respiratory complications, where CPAP users exhibited slightly lower rates of complications compared to BiPAP users. Previous research indicates that CPAP may be more effective in preventing atelectasis and improving oxygenation post-surgery [2]. The results here align with such studies, showing a modest but non-significant reduction in complications with CPAP.

Table 3, Both CPAP and BiPAP showed similar lengths of hospital stays, with non-significant differences in the need for escalation to invasive ventilation. These findings suggest that both interventions are equally effective in potentially reducing the length of hospital stay and preventing the escalation of care [3]. This equivalence highlights that the choice between CPAP and BiPAP may be more dependent on patient-specific factors rather than clear differences in efficacy.

In table 4, The impact of patient characteristics like age and BMI shows that outcomes are not significantly different between CPAP and BiPAP groups across different demographic groups. This suggests that both CPAP and BiPAP can be effectively tailored to individual patient needs regardless of age or BMI [4]. The non-significant odds ratios across all categories indicate that while there might be small differences in how each device performs in different subgroups, these differences are not statistically significant.

Conclusion:

The comparative study of Continuous Positive Airway Pressure (CPAP) and Bilevel Positive Airway Pressure (BiPAP) in the management of postoperative respiratory complications reveals significant insights into the effectiveness of both modalities. This investigation underscores the utility of both CPAP and BiPAP in enhancing postoperative respiratory outcomes, though subtle differences in their efficacy and applicability were observed.

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CPAP, with its continuous singular pressure, appears slightly more advantageous in minimizing the occurrence of postoperative respiratory complications in general surgical populations. The data indicated that CPAP had a higher percentage of patients experiencing no postoperative complications compared to BiPAP, suggesting its potential preferability in contexts where maintaining open airways post-surgery is critical.

Conversely, BiPAP, which delivers two levels of pressure, showed a comparable efficacy in managing more severe respiratory impairments, particularly in patients with pre-existing conditions such as chronic obstructive pulmonary disease (COPD) who may benefit from the varied pressure settings. Although BiPAP was associated with a slight increase in minor and major complications, it remained a vital option for tailored respiratory support, especially in patients requiring enhanced assistance for both inhalation and exhalation.

Furthermore, both CPAP and BiPAP demonstrated similar outcomes in terms of hospital stay duration and the need for escalation to invasive ventilation, suggesting their equal effectiveness in postoperative care under standard conditions. Patient characteristics such as age and BMI did not significantly alter the efficacy of either modality, reinforcing the adaptability and broad applicability of CPAP and BiPAP in diverse patient populations.

In conclusion, while CPAP might be preferable for its ease of use and slight edge in reducing complication rates, BiPAP remains indispensable for its versatility in managing complex respiratory cases. The choice between CPAP and BiPAP should be guided by individual patient needs, surgical profiles, and specific respiratory requirements. Future research should focus on refining patient selection criteria and exploring innovative approaches to optimize the use of CPAP and BiPAP in postoperative care, ensuring tailored, effective, and efficient respiratory support for all patients.

Limitations of Study:

1. Retrospective Design: The study's retrospective nature limits the ability to control for all potential confounding variables that could influence the outcomes. The reliance on historical medical records might lead to biases in patient selection, inconsistencies in data recording, and variations in the administration of CPAP and BiPAP.

2. Lack of Randomization: Without random assignment of patients to CPAP or BiPAP groups, there are potential biases related to treatment allocation. Patients receiving BiPAP might have had more severe underlying conditions, which could skew the results and reduce the applicability of findings to the general postoperative population.

3. Sample Size and Single-Center Data: Conducted at a single center with a limited sample size of 200 patients, the findings may not be generalizable to other settings or wider populations. Different hospitals have varying levels of care, patient demographics, and procedural norms, which can influence outcomes significantly.

4. Subjectivity in Complication Classification: The classification of minor and major complications may have subjective elements, depending on the clinicians' interpretations and reporting standards. This variation can lead to inconsistencies in how complications are categorized and reported, impacting the reliability of comparisons between CPAP and BiPAP.

5. Variability in Device Settings and Management: The study does not account for the variability in the settings of CPAP and BiPAP machines or the management protocols followed by different clinicians. These variations can affect the efficacy of the treatment and the rate of complications, thus influencing the study's outcomes.

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6. Limited Follow-Up Period: The duration of follow-up might not have been sufficient to capture long-term complications or outcomes related to the use of CPAP and BiPAP. Short-term follow-up can miss significant delayed effects that could provide more insight into the comparative effectiveness of these therapies.

7. Exclusion of Certain Patient Populations: Patients with contraindications to non-invasive ventilation or those requiring home non-invasive ventilation were excluded. This selection criterion may limit the study's applicability to all postoperative patients, particularly those with more complex medical backgrounds or those at higher risk of respiratory complications.

8. Lack of Detailed Patient Baseline Characteristics: The study may not have adequately reported or controlled for detailed baseline characteristics such as severity of pre-existing respiratory conditions, smoking status, or other comorbidities, which can significantly influence postoperative respiratory outcomes and the effectiveness of non-invasive ventilation strategies.

References: