Section: Anaesthesiology

Original Research Article

COMPARISON OF THE EFFECTIVENESS OF SUCTIONING WITH CLOSED TRACHEAL SUCTION AND OPEN TRACHEAL SUCTION SYSTEMS IN ADULT PATIENTS RECEIVING MECHANICAL VENTILATION

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Abstract

Background: Endotracheal suction is a process that includes patient preparation, suctioning, and follow-up care. **Aim:** This study aimed to compare the effectiveness of closed tracheal suction and an open tracheal suction system in adult patients receiving mechanical ventilation. **Material and Methods:** This randomized controlled trial was conducted in patients aged > 18 years who required mechanical ventilation for more than 48 consecutive hours and were enrolled in this study for 1 year and 6 months in the Department of Anesthesiology, SRM Medical College Hospital and Research Centre. A patient's history includes age, sex, VAP frequency, fever frequency, and microbiological and radiological signs. Each patient was subjected to thorough history taking, general and chest physical examination, Chest X-ray anteroposterior view daily or every other day, and conventional bacteriological culture in patients with suspected VAP. **Results:** The p-value for VAP frequency after opening and closing the tracheal suctioning system was 0.242. This implies that there is no correlation between the VAP frequency and suctioning, and there is no difference between the open and closed suction systems. There were no infections caused by Staphylococcus aureus, MRSA, or any of the Acinetobacter species that caused VAP. Patients in the CTSS group had a significantly higher frequency of ventilator-associated pneumonia caused by Pseudomonas spp. **Conclusion:** As a result, there was no advantage of CTSS over OTSS; however, there was a decrease in the average length of stay in patients receiving CTSS.

INTRODUCTION

Ventilator-associated pneumonia (VAP) is characterised by pneumonia that appears in an intubated patient after receiving MV support for at least 48 hours. The risk of VAP is increased by mechanical ventilation (MV) and interventional techniques, such as endotracheal suction.[1] It is regarded as one of the most challenging illnesses to identify and prevent due to its high morbidity and mortality. The most frequent invasive treatment performed in an intensive care unit (ICU) is endotracheal suctioning which is used to increase oxygenation, enhance clearance of respiratory tract secretions, and prevent atelectasis.[2] Its main objective is to provide sufficient breathing, oxygenation, and airway patency as a crucial component of therapy for intubated patients.

Hypoxaemia, tissue hypoxia, significant changes in heart rate or blood pressure, cardiac dysrhythmias, and cardiac or respiratory arrest are some of the main risks and challenges associated with endotracheal suctioning. Short-term effects of suction include decreased lung compliance and intrapulmonary pressure, which lower oxygen saturation and decrease carbon dioxide retention.[3] Additionally, endotracheal aspiration can indirectly cause lung hyperinflation or directly stimulate the trachea, both of which can quickly change blood pressure and heart rate through autonomic reflexes. Patient stability was monitored using a variety of

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cardiopulmonary function endpoints during mechanical breathing and endotracheal aspiration. In patients receiving mechanical ventilation, tracheal suctioning is a routine and crucial treatment.[4]

The Open Tracheal Suction System (OTSS) and Closed Tracheal Suction System (CTSS) are two types of suction available. The ventilator must be shut down before using the OSS, which is useful only once. CSS is used more than once and allows suction without disconnection. It cannot stay within the patient for longer than 24 hours and is situated between the tracheal tube and the mechanical ventilator circuit. The open tracheal suction system (OTSS), which traditionally entails removing the patient from the ventilator and inserting a single-use suction catheter into the endotracheal tube, is used to perform the endotracheal suctioning technique. The closed tracheal suction system (CTSS) introduces a multiuse catheter into the airways without removing the patient from the ventilator. It is possible to leave this catheter system in place for up to 24 hours.[5]

The benefits of CTSS over traditional OTSS include enhanced oxygenation; fewer clinical indicators of hypoxaemia; maintenance of positive end-expiratory pressure; less contamination of the environment, employees, and patients; and lower lung volume loss. CTSS is now being used to reduce the risks and issues associated with endotracheal suctioning. Studies have been done to compare CTSS to OTSS, investigating the prevalence of VAP, assessing hyperoxygenation, the impact of airway pressure and ventilation mode, the impact on cardiorespiratory parameters, the effectiveness of secretion removal, and mortality.[6]

The suction catheter can be introduced by disconnecting the patient from the ventilator and the open tracheal suction system (OTSS), which generally involves removing the patient from the ventilator and inserting a single-use suction catheter into the patient's endotracheal tube, is used to carry out the endotracheal suctioning technique.[7]

Aim

This study aimed to assess the effects of suctioning with a closed tracheal suction system in comparison with an open tracheal suction system in adult patients receiving mechanical ventilation for > 24 h in terms of VAP frequency.

MATERIALS AND METHODS

This randomized controlled trial (randomization was based on computer-generated random numbers) was conducted on 88 patients for 1 year and 6 months in the Department of Anesthesiology, SRM Medical College Hospital and Research Center, Kanchipuram. This study was conducted after obtaining approval from the Institutional Ethics Committee and informed consent from the patients.

Inclusion Criteria

All patients aged > 18 years who required mechanical ventilation for > 48 consecutive hours were enrolled in this study.

Exclusion Criteria

Infants and neonates, patients who were unwilling to participate, and patients with pneumonia were excluded from the study.

The inclusion criteria for patients receiving mechanical ventilation were randomized into two groups by computer-generated random number. Group A included mechanically ventilated patients admitted to the intensive care unit with an open tracheal suction system (OTSS), and Group B included mechanically ventilated patients admitted to the intensive care unit with a closed tracheal suction system (CTSS).

Each patient was subjected to thorough history taking, general and chest physical examination, Chest X-ray anteroposterior view daily or every other day, and conventional bacteriological culture in patients with suspected VAP.

Statistical Analysis

Means, standard deviations, frequencies, and percentages were used to present data. Continuous and categorical variables were compared using the independent sample t-test and Pearson's chi-square test, respectively. Using a two-tailed test, the significance was determined at $p < 0.05$. Data analysis was performed using IBM SPSS version 21.0 (IBM-SPSS Corp., Armonk, NY, USA).

RESULTS

Of the 88 patients, 12 (14.3%) belonged to the age group of 15-25, 8 (9.5%) were 25-35 age group, 12 (14.3%) were 35-45, 20 (23.8%) belonged 45-55 age group, 12 (14.3%) were 55-65 age group, 15 (17.9%) were 65-75 age group, 3 (3.6%) were 75-85 age group, and 2 (2.4%) were 85-95 age group. Of the 84 patients, 50 (59.5%) were male gender and 34 (40.5%) were female gender. Open tracheal suction and closed tracheal suction were compared using the chi-square test, and the p-value was insignificant; therefore, there was no significant difference between the two groups based on age and sex. [Table 1]

Of the 84 patients, only 9 patients had VAP frequency, fever frequency, radiological signs, and microbiological signs and were not found in 33 patients when the open tracheal suctioning system was used, whereas during the closed tracheal suctioning system, 5 patients had VAP frequency, fever frequency, radiological signs, and microbiological signs, and it was not found in 37 patients. The p-value for VAP frequency, fever frequency, radiological signs, and microbiological signs after opening and closing the tracheal suctioning system was 0.242 ($p > 0.05$). After statistical analysis, the difference was found to be statistically insignificant. This implies that there was

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no correlation between VAP frequency, fever frequency, radiological signs, microbiological signs, and suctioning, and there was no difference between the open and closed suction systems. [Table 2]

Out of 42 patients, for open tracheal intubation, 1 patient stayed for 2 days, 6 patients stayed for 3 days, 6 patients stayed for 4 days, 10 patients stayed for 10 days, 5 patients stayed for 6 days, 5 patients stayed for 7 days, 2 patients stayed for 8 days, 2 patients stayed for 9 days, 1 patient for 11 days, 1 patient for 13 days, 1 patient for 17 days, 1 patient for 19 days and 1 patient for 22 days. [Figure 1]

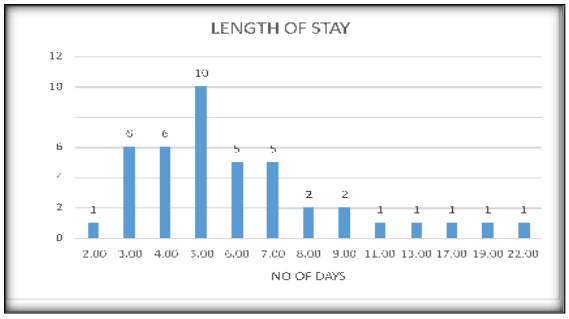

Figure 1: Distribution of length of stay in open tracheal suctioning system

For closed tracheal suctioning, out of 42 patients, 5 patients stayed for 2 days, 7 patients stayed for 3 days, 12 patients stayed for 4 days, 9 patients stayed for 5 days, 2 patients stayed for 6 days, 5 patients stayed for 7 days, 1 patient stayed for 8 days, and 1 patient stayed for 9 days. [Figure 2]

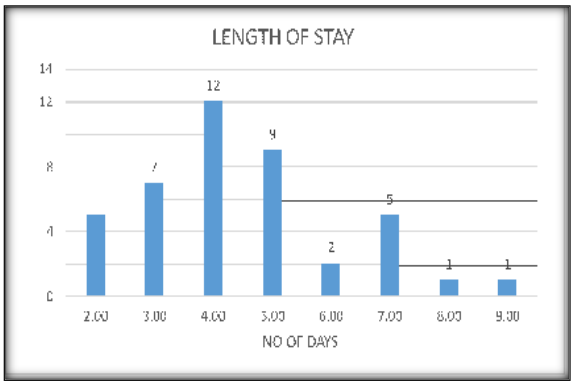

Figure 2: Distribution of length of stay in closed tracheal suctioning system

The length of ICU stay decreased in the closed tracheal suctioning system group (4.47). Therefore, the closed tracheal system is efficient because of the decreased length of stay in the closed tracheal system. Therefore, it is a cost-effective mode of tracheal suctioning. The mean length of hospital stay in both open and closed tracheal suctioning was 4.225±1.714 and the p-value was 0.033 ($p<0.05$) implying that these results were statistically significant.

Table 1: Demographic data of the study population

		Frequency	Percentage	P value
Age	15-25	12	14.3	0.245
	25-35	8	9.5	
	35-45	12	14.3	
	45-55	20	23.8	
	55-65	12	14.3	
	65-75	15	17.9	
	75-85	3	3.6	
	85-95	2	2.4	
Gender	Female	34	40.5	0.1172
	Male	50	59.5	

Table 2: Correlation of VAP, fever, radiological sign, and microbiological sign

		Open tracheal suctioning system	Closed tracheal suctioning system	P value
VAP	No	33	37	0.242
	Yes	9	5	
Fever	No	33	37	0.242
	Yes	9	5	
Radiological sign	No	33	37	0.242
	Yes	9	5	
Microbiological sign	No	33	37	0.242
	Yes	9	5	

DISCUSSION

Ventilator-associated pneumonia (VAP) is a significant complication associated with healthcare that leads to considerable morbidity, mortality, and financial costs. This study was performed on 84 patients who were mechanically ventilated; their mean age group was 49.8, 59.5% were male, and 40.5% were female. Patients were divided into two groups: group A with an open tracheal suction system (OTSS) where the frequency of VAP was,[9] which was not statistically significant in comparison with patients in group B with a closed tracheal suction system (CTSS) with a VAP frequency of.[5]

In our study, the p-value for VAP frequency after opening and closing the tracheal suctioning system was 0.242 ($p>0.05$). After statistical analysis using the chi-square test, the results were found to be

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statistically insignificant. This implies that there is no correlation between the VAP frequency and suctioning, and there is no difference between the open and closed suction systems. This was in agreement with the study conducted by Salloum et al., who studied 49 patients. 24 were subjected to OTSS and 25 were subjected to CTSS. Only 11 patients with OTSS developed VAP, and seven with CTSS developed VAP. They concluded that the closed suction system didn't decrease the frequency of nosocomial pneumonia.[8]

Moreover, this was similar to the results obtained by Topeli et al., in which patients were randomized to receive endotracheal suction with either closed catheters (closed suction group; N = 41) or single-use catheters (open suction group; N = 37). Cultures were obtained from the ventilator tubing of 42 patients to determine the occurrence of VAP. There was no difference between the two groups in terms of the frequency of development of VAP.[9]

In a study conducted by Lorente et al., VAP frequency was assessed in 457 mechanically ventilated patients assigned to the open-suctioning technique or to a closed system which allowed partial (suctioning catheter with its protected covering sheath) or complete system change. The closed system was changed not routinely, but only when it presented with mechanical failure or visible soil (partial change), or when the patient needed reintubation (complete change). There were no significant differences in percentages of patients receiving CTSS and OTSS who developed VAP.[10]

This study was in agreement with the study conducted by Rabitsch et al., who performed their study on 24 patients. The patients were divided into two equal groups. Five patients in the OTSS group developed VAP, while none in the CTSS group developed VAP. This might be due to the small sized sample of patients upon which the study was performed in comparison to the present study and also the difference in location of both studies theirs in the medical ICU and the present study in the medical-surgical ICU.[11]

In our study, the p-value for the microbiological sign after opening and closing the tracheal suctioning system was 0.242 ($p>0.05$). After statistical analysis using the chi-square test, the results were found to be statistically insignificant. This implies that there is no correlation between the microbiological signs and suctioning, and there is no difference between the open and closed suction systems.

This is similar to a study (meta-analysis) conducted by Elmansoury et al., who compared the closed tracheal suction system and the open tracheal suction system in adults receiving mechanical ventilation for more than 24 h. Randomised controlled trials comparing closed and open tracheal suction systems in adult patients who were ventilated for > 24 h. up. Their results showed that the two tracheal suction systems showed no differences in the risk of ventilator-associated pneumonia (11 trials; RR, 0.88; 95% CI 0.70 to 1.12), mortality (five trials; RR, 1.02; 95% CI, 0.84 to 1.23), or length of stay in intensive care units (two trials; WMD, 0.44; 95% CI, 0.92 to 1.80). The closed tracheal suction system produced higher bacterial colonisation rates (five trials; RR, 1.49; 95% CI 1.09 to 2.03). Further, they concluded that More studies of high methodological quality are required, particularly to clarify the benefits and hazards of the closed tracheal suction system for different modes of ventilation and in different types of patients.[12]

In our study, the p-value for the frequency of fever after opening and closing the tracheal suctioning system was 0.242 ($p>0.05$). After statistical analysis using the chi-square test, the results were found to be statistically insignificant. This implies that there is no correlation between the frequency of fever and suctioning and that there is no difference between the open and closed suction systems. The p-value for radiological signs after opening and closing the tracheal suctioning system was 0.242 ($p>0.05$). After statistical analysis using the chi-square test, the results were found to be statistically insignificant. This implies that there is no correlation between radiological signs and suctioning and that there is no difference between the open and closed suction systems.

CONCLUSION

No difference was observed in the frequency of ventilator-associated pneumonia between the CTSS and OTSS groups. In patients in the CTSS group, there were no infections caused by Staphylococcus aureus, MRSA, or any of the Acinetobacter species that caused VAP. By contrast, patients in the CTSS group had a significantly higher frequency of ventilator-associated pneumonia caused by Pseudomonas spp. As a result, there was no advantage of CTSS over OTSS; however, there was a decrease in the average length of stay in patients receiving CTSS.

Limitations

This study included patients aged 18–80 years. This was a single-centre trial with a smaller sample size

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