IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 20, Issue 9 Ser.7 (September. 2021), PP 36-40
www.iosrjournals.org

'Suction Aid Tracheostomy Tubes' reduce Ventilator Associated Pneumonia:A Pilot Study

Dr. Sanketshukla(senior resident), Dr. Rahul Gupta (asso prof), Dr.R.G.Aiyer (HOD)

Abstract:
Conventional Tracheostomy tubes have a disadvantage of stagnation of tracheal secretions above its inflated cuff. These Secretions act as a medium for microbial growth and increases the incidence of Ventilator Associated Pneumonia in ICU Patients. A modified Tracheostomy tube with additional above the cuff suction channel prevents the stagnation of such secretions and can help to decrease the incidence of Ventilator Associated Pneumonia in ICU Patients.The Aim of Our studywas to Compare the incidence of Ventilation Associated Pneumonia between two groups.40 patients were equally divided in two arms. Randomization was done beforehand by the principal investigator. Arm 1 – Patients with Conventional Tracheostomy tubes (without suction aid).Arm 2- Patients with Modified Tracheostomy tubes (with Suction Aid). Pre-existing Pneumonia was ruled out in all the patients. After Performing the tracheostomy,a bedside Chest X-ray AP view was performed, temperature & White blood cell counts of the patient were also recorded on 3^{rd},5^{th} and 7^{th} day in patients of both arms. Microbial swabs were taken from the lower end of the tubes after 48 hours.Data regarding development of Ventilator associated pneumonia,duration of the Ventilation support and the length of stay in intensive care unit was recorded and compared between both the groups. The prevalence of VAP was found to be 40% in the control group and 25% in the suction aid group. The Mean number of Days on ventilator support was 11 in the control group and 9 in the suction aid group.Use of Tracheostomy tubes with above the cuff Suction channel decreases the incidence of Ventilator Associated Pneumonia in ICU Patients. There were trends toward decreasing length of stay in ICU.

Keywords:*Ventilator associated Pneumonia, Suction aid tracheotomy tube, Subglottic secretions.*

Date of Submission: 29-08-2021 Date of Acceptance: 13-09-2021

I. Introduction

A Significant Proportion of patients admitted in Intensive Care units require Tracheostomies for continuing with prolonged ventilatory support. The conventionally used Tracheostomy tubes have a cuff, to provide a lower airway seal & hence facilitate mechanical ventilation. However, the inherent disadvantage of this cuff is that, it causes stagnation of naso-oropharyngeal secretions in the region above the inflated cuff in the subglottis. These stationary secretions rapidly become a medium for microbial growth, eventually leading to development of pneumonia in the patient.

A modified Tracheostomy tube, which has an inbuilt Suction aid, allows frequent external suctioning to prevent the accumulation of secretions in the region above the cuff of the tube. Eliminating the stagnant secretions brings down the infectious colonies in the subglottic region. This henceforth decreases the rate of development of ventilator associated pneumonia in the patients of Intensive Care Units.

Fig.1 Tracheostomy tube with above the cuff suction aid.

Fig 2.Conventional Tracheostomy Tube.

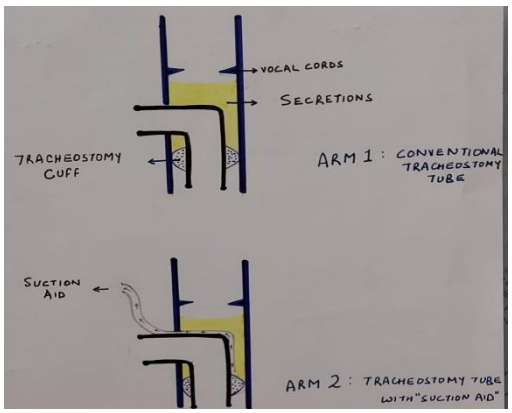

Fig3 showing mechanism of action of tube with "above the cuff suction aid".

II. Methodology:

The present study was carried out in Department of E.N.T. and Head-Neck Surgery, Medical College Vadodara.All the patients admitted in Medical ICU on Ventilator support; in whom the treating Physician required a planned tracheotomy were selected. A total of 40 patients were included in this study. The Study design was an Interventional study.All the Procedures perfoemed in these study were in accordance with the standards of the institutional research committee and ethical standards.

The patients following the below mentioned criteria were included in the study:

1. Age of the Patient above 15 years.
2. Tracheostomy done bedside in Medical ICU for patients requiring prolonged Ventilator support.
3. Patients without any preexisting Pneumonia.

On receiving a call for performing tracheostomy from Medical ICU, case was immediately discussed with the MICU consultant in-charge/Physician. Absence of any co-morbid condition was confirmed and other inclusion/exclusion criteria were analyzed, before deciding to include the case in the study.As the study was designed to include 40 patients equally divided in two arms, randomization was done beforehand by the principal investigator. Plan of Randomization was Simple Random Sampling. Numbers from 1 to 40 were assigned. These numbers were divided into two equal groups (i.e. Arm1 and Arm 2)using computerized randomization before the start of study.

The patients hence were divided into two arms.

Arm 1 – Patients with Conventional Tracheostomy tubes (without suction aid)

Arm 2- Patients with Modified Tracheostomy tubes (with Suction Aid)

The principle Investigator withheld the information regarding 'which tube to be used' and was disclosed only at the time of actual tracheotomy, to reduce chances of surgical bias.

After Performing the Tracheostomy. A bedside Chest X-ray AP view was performed in patients of both Arms on 3rd, 5th, and 7th day of Tracheostomy. (The day of tracheostomy was considered the first post-operative day), Temperature was measured using Digital thermometer over axillary region of the patient & White blood cell counts of the patient were also recorded on 3rd,5th and 7thday.All tracheostomy tubes were changed after 48 hours and a microbial swab was taken from the distal tip of tracheostomy tube. The fresh tubes were same as the

original tubes, e.g. Arm 1 patients had a conventional tube without suction aid and Arm 2 patients again received a tube with suction aid.

Data regarding development of Ventilator associated pneumonia (Whether Developed or not, and if Developed than extent in terms of Number Of lung fields involved) , duration of the Ventilation support and the length of stay in intensive care unit was recorded and compared between both the groups.

Table1. Criteria for detecting Ventilator Associated Pneumonia (Min 2 criteria should be fulfilled)

TEMP.	>39 or <36 ^{o}C
White Blood cell Count	<4000 or > 11000
Chest Xray Infiltrates	Diffuse or Localized

A conclusion was drawn to reveal the effect of the Modified "above the cuff suction aid" in decreasing the rate of Ventilator associated pneumonia.

III. Result:

40 Patients were randomized and evaluated. 20 patients received standard tracheostomy tubes (Control group) and 20 patient received suction above the cuff tracheostomy tubes (Suction tracheostomy group). The prevalence of VAP was found to be 40% in the control group and 25% in the suction aid group. The Mean number of Days on ventilator support was 11 in the control group and 9 in the suction aid group.

These data were applied to Z- test, Standard deviation and P value were calculated using statistic calculator app. When control group and group with suction aid tube was compared for development of VAP the z score was found to be 1.0127. the value of p was 0.15625, the result was not significant at $p<.05$.

IV. Discussion:

The patients were divided into two arms.
Arm 1 – Patients with Conventional Tracheostomy tubes (without suction aid)
Arm 2- Patients with Modified Tracheostomy tubes (with Suction Aid)

Table 2.Distribution According to Type of Tracheostomy tube used:

Type of Tube	Serial No of Patient
Arm 1 (with Conventional Tube)	7,6,8,20,10,17,19,9,2,12,27,26,28,40,30,37,39,29,22,32. Total: 20
Arm 2 (Suction aid tube)	11,5,13,16,15,18,3,1,14,4,31,25,33,36,35,38,23,21,34,24. Total: 20

Table3. Distribution According to Indication of Tracheostomy:

Indication	With suction aid	Without suction aid	Total
Compound ingestion (Organophosphorus, Phenyl ,Acid, unknown)	4	4	8
Tetanus	4	4	8
Hanging	5	4	9
CV Stroke	3	2	5
Meningitis(TB,Bacterial)	3	4	7
GB syndrome	1	0	1
Metabolic Encephalopathy	0	1	1
Craniotomy following Road Traffic Accident	0	1	1

In Arm 1 (in which Conventional tube was used) 8 patients developed VAP. In Arm 2 (in which tube with above the cuff suction aid was used) 5 patients developed VAP. Out of 40 patients under study 13 developed VAP.The findings in this study shows that the concept of suctioning Subglottic secretions pooled above the cuff of tracheostomy tube may have beneficial effect on decreasing the incidence of Ventilator associated pneumonia and related pulmonary complications. This is reinforced by the study conducted by **Coffman et al[(1)] and Ledgerwood et al[(2)]**which shows thatSubglottic suction tracheotomy tubes reduces the risk of aspiration and development of VAP.

Table4. Distribution According to Development of Ventilator Associated Pneumonia (VAP):

Indication	With suction aid (No of Patients Developing VAP)	Without suction aid (No of Patients Developing VAP)	Total
Compound ingestion (Oraganophosphorus, Phenyl,Acid, unknown)	1	2	3
Tetanus	1	1	2
Hanging	2	1	3
CV Stroke	0	1	1
Meningitis(TB,Bacterial)	1	2	3
GB syndrome	0	0	0
Metabolic Encephalopathy	0	1	1
Craniotomy following Road Traffic Accident	0	0	0

In Arm 1 (in which Conventional tube was used) mean of 'number of days on ventilation support' was 11. In Arm 2 (in which tube with above the cuff suction aid was used) this mean was 9 days.Two meta-analysis and systemic reviews that reported the use of Endotracheal tubes with Subglottic suction capability significantly decreased VAP in ICU Patients without an increase in adverse events[3,4]. Similar studies conducted by **Kollef et al[5] and Damas et al[6]** using above the cuff tracheotomy tubes with intermittent suctioning shows reduction in incidence of ventilator associated pneumonia in patients on mechanical ventilator.

Table5. Distribution According to Number of days On Ventilation Support:

Indication	With suction aid (Average days on ventilation)	Without suction aid (Average days on ventilation)
Compound ingestion (Oraganophosphorus, Phenyl,Acid, unknown)	7	5
Tetanus	6	15
Hanging	8	9
CV Stroke	7	10
Meningitis(TB,Bacterial)	10	15
GB syndrome	22	-
Metabolic Encephalopathy	-	20
Craniotomy following Road Traffic Accident	-	4

Use of Above the Cuff tracheostomy tubes have the potential to reduce the supra and Subglottic colonization of the Micro organisms which is supported by the study of **Garcia et al**[7].

Table6. Distribution According to Microbiological Culture of the Tracheal Secretions.

Organism	Suction Aid Tube	Conventional tube	Total
Psuedomonas Species	2	5	7
Klebsella Species	3	2	5
Staph Aureus Species	0	1	1

The Limitations of this study were the small sample size, use of subjects from the same institution, and short follow up period. The strengths of this study were its prospective design, Double blinded patient selection, and microbial analysis of the tube secretion samples.

V. Conclusion:

Use of Tracheostomy tubes with above the cuff Suction channel decreases the incidence of Ventilator Associated Pneumonia in ICU Patients. There were trends toward decreasing length of stay in ICU. Additional research with a larger sample size, a multi institutional sample and a longer follow up period is needed.

Compliance with ethical standards:

Conflict of interest: All the authors declare that they have no conflict of interest in the submission of this manuscript.

Human and animals rights: This article does not contain any studies performed on animals by any author.

Ethical approval: All the procedures performed in the studies involving human participants were in accordance to ethical standards of the institutional research committee and ethical standards.

Informed consent: Informed consent was obtained from all the individuals participating in this study.

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