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Original Research Article

A descriptive study to determine the bacterial flora and antibiotic sensitivity of lower respiratory tract in tracheostomised patients

Kulkarni Manik Rao, Panchami*

Department of Otorhinolaryngology and Head and Neck Surgery, Combined Hospitals of MCH, Vijayanagar Institute of Medical Sciences, Ballari, Karnataka, India

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***Correspondence:**
Dr. Panchami,
E-mail: panchukundar@gmailcom

ABSTRACT

Background: Tracheostomy is one of the commonest operations performed by an otorhinolaryngologist for various indications and in different age groups and tracheo-bronchitis is a common complication in tracheostomised patients. This study designed to determine the bacterial flora and antibiotic sensitivity of lower respiratory tract following tracheostomy in hospitalized patients.
Methods: This is a descriptive study of 50 tracheostomised patients carried out from December 2017 to May 2019, at VIMS Ballari.
Results: Stridor was the most common indication for tracheostomy (70%). Tracheal aspirate was sent for bacterial culture and sensitivity on day 0, 1 week and 3 weeks post tracheostomy. Majority of the patients showed no growth in the day 0 and 3weeks post tracheostomy bacterial cultures of the tracheal aspirate. Bacterial cultures yielded growth in majority of the patients in the 1-week post tracheostomy cultures. The sensitivity pattern, intermediate response pattern and resistance pattern to the first line antibiotics that are regularly used in our hospital were studied in all the 3 samples of tracheal aspirates that were sent for bacterial culture from all the 50 tracheostomised patients.
Conclusions: It is a good practice to send the tracheal aspirate for culture and sensitivity following Tracheostomy. If the patient is started on suitable antibiotics based on the culture postoperative recovery will be hastened, risk of postoperative infections like tracheitis, tracheobrochitis, stoma site infection and other lower respiratory tract infections can be reduced.

Keywords: Tracheostomy, Stridor, Tracheitis, Tracheobronchitis

INTRODUCTION

Tracheostomy is creation of a stoma at the skin surface which leads into the trachea.[1] Today, Tracheostomy plays a pivotal role in airway management. Indications for tracheostomy can be broadly outlined as respiratory obstruction, respiratory failure, respiratory paralysis, retained secretions and reduction of dead space.[2] Being a surgical procedure, it is not without complications. In the current era post-tracheostomy lower respiratory tract infection is a common and important complication.[3] The normal trachea is protected from bacterial colonization, so that the trachea of healthy individuals harbours either no bacteria or oral flora in sparse numbers.[4] These defence mechanisms are partially bypassed following a tracheostomy and direct exposure of the lower airways to the pathogens may occur.[5] The route of this infection is thought to be endogenous or exogenous.[6] Tracheo-bronchitis is common in patients with tracheostomy and observed rates of 60% have been reported in two adult studies.[7,8]

The purpose of this study is to understand the nature of bacterial flora of the lower respiratory tract in tracheostomised patients during hospital stay and follow up, to determine the antibiotic sensitivity pattern, to determine the change in the bacterial flora during follow up, to determine the change in the pattern of drug resistance to the prescribed medications and for the better management of the patients.

METHODS

This is a descriptive study covering a period of eighteen months from December 2017 to May 2019 carried out in the department of otorhinolaryngology at Vijayanagar institute of medical sciences, Ballari. Fifty patients were included in this study, depending upon the indications they underwent tracheostomy which was done either as an elective or as an emergency basis. The study procedure was approved by the institutional ethics committee.

Inclusion criteria

All the patients undergoing tracheostomy irrespective of indication in the department of otorhinolaryngology at Vijayanagar institute of medical sciences, Ballari. Patients who gave written informed consent were only included in the study.

Exclusion criteria

Patients with evidence of lower respiratory tract infection prior to tracheostomy. Terminally ill patients where follow up is unlikely. Patients who are not likely to come for follow up.

All the patients have undergone standard surgical tracheostomy procedure in operation theatre depending upon the indication. All the selected patients who underwent standard tracheostomy procedure were given intensive care for the first 48 hours post-operatively. A cuffed portex tracheostomy tube was used in all cases. Problems encountered during surgery were documented in the operative notes.

Intermediate post-operative wards complications were assessed when patients were shifted towards after 48 hrs. Late post-operative complications were assessed during the follow up of patient. In the post-operative ward, tracheostomy care was given by the surgeon and the attending nurse, while the patient's care giver was asked to observe the same. In the ward tracheostomy tube care was done once in the morning and again in the evening. In the interval period patient's care giver was taught the same.

Sample collection

A total of three samples of tracheal aspirate are collected using a sterile suction catheter from each patient for the study, first sample is collected during tracheostomy, second sample is collected seven days post tracheostomy, third sample is collected three weeks post tracheostomy during follow up. These sterile suction catheter tips with tracheal aspirate were then sent for bacterial culture and antibiotic sensitivity in a sterile labelled container.

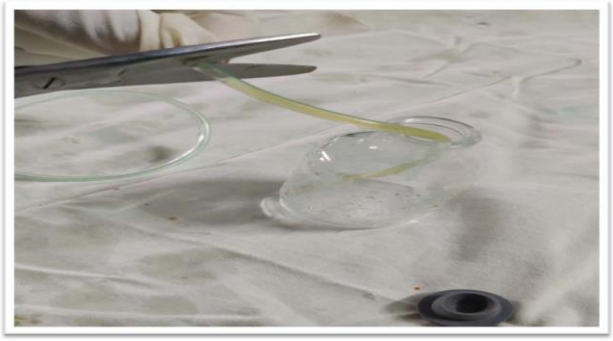

Figure 1: Tracheal aspirate collected in a sterile suction catheter.

Figure 2: The specimen bottle is sealed, labelled and sent for culture and sensitivity.

Data analysis

Data was collected by using a structure proforma. Data was entered in MS excel sheet and analysed by using SPSS 24.0 version IBM USA. Qualitative data was expressed in terms of percentages and proportions, quantitative data was expressed in terms of mean and standard deviation and descriptive statistics of each variable was presented in terms of mean, standard deviation, standard error of mean.

RESULTS

This descriptive study included 50 patients who underwent tracheostomy due to various indications. Among the 50 patients, 42 (84%) were males and 8 (16%) were females. The age group of patients ranged from 20 years to 80 years of age, with majority of the patients being in the 51-60 years age group that is 17 (34%). Majority of the patients in this study were farmers by occupation, that is 23 (46%) patients and about 15

(30%) of the patients were unemployed. Majority of the patients in this study were illiterates that are about 31 (62%) patients.

Patients underwent tracheostomy for various indications; most common indication for tracheostomy in this study was Stridor that is in 35 (70%) of the patients followed by airway management during DL-scopy that is in 13 (26%) patients. Various indications of tracheostomy in this study are represented in (Table 1).

Table 1: Indications of tracheostomy in this study.

		Frequency	%
Indication for trachea -stomy	Airway management during DL scopy	13	26.0
	Part of another procedure	2	4.0
	Stridor	35	70.0
	Total	50	100.0

For the first culture, the tracheal aspirate was collected from the tracheostomy tube on the day of tracheostomy (post-operative day- 0), about 44 (88%) patients yielded no growth. About 3 (6%) patients culture yielded *Streptococcus species*; 1 (2%) patient showed growth of *Staphylococci*; 1 (2%) patient showed growth of *Klebsiella pneumonia* and 1 (2%) patient showed growth of coagulase negative *Staphylococci*. First culture pattern is represented in Table 2.

Most of the bacteria were found to be sensitive to cefotaxime 4 (8%), cefoperazone 4 (8%) and ceftriaxone 4 (8%). Intermediate pattern of response to the antibiotics are shown as follows- amoxicillin clavulanic acid- 1 (2%) and amikacin- 1 (2%). The resistant pattern for first culture was noted to be highest for ofloxacin 2 (4%) followed by amoxicillin clavulanic acid 1 (2%), ciprofloxacin 1 (2%) and cefotaxime 1 (2%). The sensitivity pattern, intermediate response pattern and resistant pattern of the first culture is represented in (Table 3).

Table 2: First culture growth pattern.

First culture		Frequency	Percent
Growth	Coagulase negative *Staphylococci*	1	2.0
	Klebsiella pneumoniae	1	2.0
	Staphylococcus species	1	2.0
	Streptococcus species	3	6.0
No growth		44	88.0
Total		50	100.0

Table 3: The sensitivity pattern, intermediate response pattern and resistant pattern of first culture.

Antibiotics		Sensitivity pattern N (%)	Intermediate response pattern N (%)	Resistance pattern N (%)
First culture	Gentamycin	3 (6)	0	0
	Amikacin	1 (2)	1 (2)	0
	Amoxicillin clavulanic acid	2 (4)	1 (2)	1 (2)
	Ciprofloxacin	1 (2)	0	1 (2)
	Ofloxacin	2 (4)	0	2 (4)
	Cefotaxime	4 (8)	0	1 (2)
	Cefaperazone	4 (8)	0	0
	Ceftriaxone	4 (8)	0	0
	Doxycycline	0	0	0
	Chloramphenicol	1 (2)	0	0
	Erythromycin	1 (2)	0	0
	Cotrimoxazole	0	0	0
	Tetracycline	1 (2)	0	0

In the second culture of the tracheal aspirate collected from the tracheostomy tube 1 week after the tracheostomy or on post-operative day-7, about 36 (72%) patient's culture yielded growth. Among them majority showed growth of coagulase negative *Staphylococci* 6 (12%) followed by *Acinetobacter species* in 5 (10%). The other organisms that were isolated are *Pseudomonas aeruginosa* in 4 (8%), *Staphylococcus aureus* 4 (8%), *Streptococcus pyogenes* 4(8%), *Streptococcus species* 4

(8%), *Enterobacter species* 3 (6%), *Pseudomonas species* 3 (6%), *Staphylococcus species* 2 (4%) and *Klebsiella*

pneumoniae 1(2%). About 14 (28%) patient's culture yielded no growth. Second culture pattern is represented in (Table 4).

Most of the bacteria's were found to be sensitive to - gentamycin 23 (46%), ciprofloxacin 20 (40%), amoxicillin clavulanic acid 14 (28%), tetracycline 14 (28%), amikacin 11 (22%), erthromycin 10 (20%), cefotaxime 9 (18%), doxycycline 9 (18%), ceftriaxone 8 (16%), cefaperazone 8 (16%), ofloxacin 7 (14%), co-trimoxazole 5 (10%) and chloramphenicol 3 (6%). Intermediate pattern of response to the antibiotics are shown as follows - ciprofloxacin 6 (12%), cefotaxime 4 (8%), amoxicillin clavulanic acid – 3 (6%), ofloxacin 3 (6%), amikacin - 2 (4%), cefaerazone 2 (4%), ceftriaxone 2 (4%), co-trimoxazole 2 (4%), doxycycline 1 (2%), erythromycin 1 (2%) and tetracycline 1 (2%). The resistant pattern for second culture was noted to be highest for amikacin 10 (20%) followed by gentamicin 9 (18%), co-trimoxazole 8 (16%), amoxicillin clavulanic acid 7 (14%), cefotaxime 7 (14%), ceftriaxone 7 (14%), chloramhenicol 5 (10%), ciprofloxacin 3 (6%), ofloxacin 3 (6%), cefaperazone 3 (6%), erythromycin 3 (6%) and tetracycline 1 (2%). The sensitivity pattern, intermediate response pattern and resistant pattern of the second culture represented in (Table 5).

In the third culture of the tracheal aspirate collected from the tracheostomy tube 3 weeks after tracheostomy, about 41(82%) patients yielded no growth. About 9 (18%) patients culture yielded growth among them majority was found to be coagulase negative *Staphylococci* 7 (14%) followed by *Streptococcus* species 1 (2%) and *Pseudomonas areuginosa* 1 (2%). Third culture pattern is represented in (Table 6).

Table 4: Second culture pattern.

Second culture		Frequency	%
Culture	*Acinetobacter* species	5	10.0
	Coagulase negative *Staphlyococci*	6	12.0
	Enterobacter species	3	6.0
	Klebsiella pneumoniae	1	2.0
	No growth	14	28.0
	Pseudomonas areuginosa	4	8.0
	Pseudomonas species	3	6.0
	Staphylococcous aureus	4	8.0
	Staphylococcous species	2	4.0
	Streptococcous pyogenes	4	8.0
	Streptococcus species	4	8.0
	Total	50	100.0

Table 5: The sensitivity pattern, Intermediate response pattern and resistant pattern of the second culture.

Antibiotics		Sensitivity pattern N (%)	Intermediate response pattern N (%)	Resistance pattern N (%)
Second culture	Gentamycin	23 (46)	1 (2)	9 (18)
	Amikacin	11 (22)	2 (4)	7 (14)
	Amoxicillin clavulanic acid	14 (28)	3 (6)	10 (20)
	Ciprofloxacin	20 (40)	6 (12)	3 (6)
	Ofloxacin	7 (14)	3 (6)	3 (6)
	Cefotaxime	9 (18)	4 (8)	7 (14)
	Cefaperazone	8 (16)	2 (4)	3 (6)
	Ceftriaxone	8 (16)	2 (4)	7 (14)
	Doxycycline	9 (18)	1 (2)	4 (8)
	Chloramphenicol	3 (6)	0	5 (10)
	Erythromycin	10 (20)	1 (2)	3 (6)
	Co trimoxazole	5 (10)	2 (4)	8 (16)
	Tetracycline	14 (28)	1 (2)	1(2)

Table 6: Third culture growth pattern.

Third culture		Frequency	Percentage (%)
Culture	Coagulase negative *Staphylococci*	7	14.0
	No growth	41	82.0
	Pseudomonas areuginosa	1	2.0
	Streptococcus species	1	2.0
	Total	50	100.0

Most of the bacteria's were found to be sensitive to - amoxicillin clavulanic acid 8 (16%) followed by gentamicin 6 (12%), ciprofloxacin 5 (10%), doxycycline 5 (10%), tetracycline 5 (10%), amikacin 3 (6%), erythromycin 2 (4%), co-trimoxazole 2 (4%), ofloxacin 1 (2%) and cefotaxime 1 (2%). Intermediate pattern of response was observed with - cefotaxime 3 (6%), cefaperazone 1 (2%), doxycycline 1 (2%) and co-trimoxazole 1 (2%). The resistant pattern for third culture was noted to be highest for co-trimoxazole 3 (6%) followed by gentamycin 2 (4%), amikacin 2 (4%), ceftriaxone 2 (4%), erythromycin 2 (4%), tetracycline 2 (4%), amoxicillin clavulanic acid 1 (2%), cefaperazone 1 (2%), doxycycline 1 (2%) and chloramphenicol 1 (2%). The sensitivity pattern, intermediate response pattern and resistant pattern of the third culture represented in (Table 7).

Table 7: The sensitivity pattern, intermediate response pattern and resistant pattern of the third culture.

Antibiotics		Sensitivity pattern N (%)	Intermediate response pattern N (%)	Resistance pattern N (%)
Third culture	Gentamycin	6 (12)	0	2 (4)
	Amikacin	8 (16)	0	1 (2)
	Amoxicillin clavulanic acid	3 (6)	0	2 (4)
	Ciprofloxacin	5 (10)	0	0
	Ofloxacin	1 (2)	0	0
	Cefotaxime	1 (2)	3 (6)	0
	Cefaperazone	0	1 (2)	1 (2)
	Ceftriaxone	0	0	2 (4)
	Doxycycline	5 (10)	1 (2)	1 (2)
	Chloramphenicol	0	0	1 (2)
	Erythromycin	2 (4)	0	2 (4)
	Cotrimoxazole	2 (4)	1 (2)	3 (6)
	Tetracycline	5 (10)	0	2 (4)

DISCUSSION

Tracheostomy is one of the common surgical procedures performed by the Otorhinolaryngologist for various indications. In the present study of 50 patients who underwent tracheostomy for various indications majority of the patients were males, that is about 42 (84%) and 8 (16%) were females. Age distribution of the patients in this study is from 20 to 80 years, with majority of the patients being in the 51 to 60 years age group that is 17 (34%). Most common indication for tracheostomy in the present study was Stridor that is in 35 (70%) patients. Adeyi et al 2009 reported that upper airway obstruction causing stridor was the commonest indication for tracheostomy noted in about 63% of their patients.[9]

On the day 0 culture of the tracheal secretions majority of the patient's sample yielded no growth that is about 44 (88%). Among the 6 (12%) patients whose culture yielded growth, the most common one was *Streptococcus species* that is in 3 (6%) patients followed by coagulase negative *Staphylococci* in 1 (2%) patients. Aswin et al 2017 reported that in the 130 patients from their study about 123 (94.6%) yielded no growth from the day 0 culture.[10] This is similar to the present study, among the 7 patients who yielded growth *Acinetobacter baumanii* was most common, that is in about 5 (3.9%) patients followed by *Klebsiella pneumonia* in 2 (1.5%) patients. Rao et al 2016 reported that in the 40 patients from their study about 33 (82.5%) patients yielded no growth from the day 0 culture.[11] This is similar to the present study, among the 7 (17.5%) patients who yielded growth about 2 (5%) patients showed *Acinetobacter baumani*, gram positive *Cocci* growth was noted in 1 (2.5%) patient, commensals of respiratory tract was grown in 1 (2.5%) patient, coagulase negative *Staphylococci* was grown in 1 (2.5%) patient, *E. coli* was grown in 1 (2.5%) patients and *Enterobacter species* was grown in culture of 1 (2.5%) patient. In the present study *Streptococcus* species grew in about 6% of the patients. Some of the common bacteria's which are found in lower respiratory tract are *Pseudomonas*, *Streptococcus*, *Prevotella*, *Fusobacteria*, *Acinetobacter* and *Veillonella*, particularly *Prevotella* species predominate in healthy individuals.[12] This observation indicates that the *Streptococcus* species and coagulase negative *Staphylococci* which were noted in majority of the cultures which yielded growth might have been the commensals that are usually found in the lower respiratory tract.

Sensitivity pattern in the first culture are as follows - to the third generation cephalosporins like ceftriaxone 4 (8%), cefaperazone 4 (8%) and cefotaxime 4 (8%). This was followed by gentamycin 3 (6%) and amoxicillin clavulanic acid 2 (4%). It is helpful to know this in the postoperative period as the patient can be treated with the required antibiotics and postoperative complications like tracheitis, tracheobronchitis or stoma site infections can be prevented. Among the 12% of the patients who yielded growth intermediate response are as follows

amikacin 1 (2%) and amoxicillin clavulanic acid 1 (2%). Resistance pattern is as follows - ofloxacin 2 (4%), ciprofloxacin 1 (2%) and so on. The second culture of the tracheal aspirate was sent about one week after the tracheostomy. About 36 (72%) of them yielded growth on the culture of tracheal aspirate and about 14 (28%) yielded no growth. In the study done by Aswin et al in the 130 patients included in the study about 113(87%) yielded growth and 17 (13%) patients yielded no growth when the tracheal aspirate was sent for culture one week after tracheostomy.[10] This was similar to the present study. In the 36 (72%) patients who yielded growth majority of them showed growth of coagulase negative *Staphylococci* that is in about 6 (12%) patients; followed by *Acinetobacter* species in about 5 (10%) patients. *Pseudomonas areuginosa* was noted in 4 (8%) patients and *Pseudomonas species* was noted in 3 (6%) patients. In a study done by Aswin et al majority of patients yielded *Pseudomonas areuginosa* that is in 62 (47%) patients followed by *Klebsiella* in about 24 (18.5%) patients.[10] *Pseudomonas areuginosa* was found to be the third most common organism grown in the culture in present study and the most common one was coagulase negative *Staphylococci* followed by *Acinetobacter* species. In a study done by Rao et al in the total of 40 patients 32 (80%) showed growth and 8 (20%) patients showed no growth during the first tube change which was done approximately 4 days after the tracheostomy.[11] This was similar to the present study. In the same study majority of the patients showed growth of *Acinetobacter baumanii* that is in 11 (27.5%) patients followed by - gram positive cocci seen in 9 (22.5%) of the patients, commensals of respiratory tract seen in 8 (20%) patients, coagulase negative *Staphylococci* in 1 (2.5%) patient, *E. coli* in 1 (2.5%) patient and *Enterobacter* species in 1 (2.5%) patient. In the present study, *Acinetobacter* species was the second most common organism that was grown in the culture and coagulase negative *Stahylococci* was the most common organism whereas in the above mentioned study done by Rao et al coagulase negative *Staphylococci* was noted in only one patient among the 32 (80%) patients who showed growth.[11]

The sensitivity pattern for the second culture is as follows: gentamycin 23 (46%), ciprofloxacin 20 (40%), amoxicillin clavulanic acid 14 (28%), tetracycline 14 (28%), amikacin 11 (22%), erythromycin 10 (20%) and so on. The intermediate pattern of the second culture is as follows: ciprofloxacin 6 (12%), cefotaxime 4(8%), amoxicillin clavulanic acid 3 (6%), ofloxacin 3 (6%) and so on. Resistance pattern to the third culture is as follows - amikacin 10 (20%), gentamycin 9 (18%), co-trimoxazole 8 (16%), ceftriaxone 7 (14%), amoxicillin clavulanic acid 7 (14%), cefotaxime 7 (14%) and so on. In a study done by Koirala et al they have studied the culture and sensitivity pattern in trcheostomised patients, they have found that out of the 50 patients, 45 of them yielded growth on culture, *Pseudomonas areuginosa* was found to be the commonest organism cultured followed by enteric gram negative bacteria, the sensitivity pattern noted in their study are as follows - amikacin in 81.5%, ciprofloxacin in 70.5%, gentamycin in 66.7% and so on.[13] These results were comparable to the present study.

The third culture of tracheal aspirate was done 3 weeks after the tracheostomy when the patients came for follow up. About 41 (82%) patients yielded no growth on culture. About 9 (18%) patient's yielded growth on culture and among them the commonest bacteria cultured was coagulase negative *Staphylococci* in 7 (14%) patients followed by *Pseudomonas areuginosa* in 1 (2%) and *Streptococcus* species in 1 (2%) patient. As previously mentioned, coagulase negative *Staphylococci* and *Streptococcus* species are commensals in the lower respiratory tract that can explain their growth in the culture 3 weeks after the tracheostomy. Since all the patients were started on antibiotic based on the culture and sensitivity pattern most of the patients, that is about 82% of them yielded no growth on the culture.

Most of the studies that were previously done on tracheostomised patients have sent the tracheal aspirate for culture and sensitivity on the day of tracheostomy and one week after the tracheostomy or during the first tube change. This is the novel study that has sent the tracheal aspirate for culture during the 3 weeks follow up after tracheostomy, this helps in detecting and treating any long-standing colonization of bacteria and any newer infection that the patient might have acquired in the postoperative period.

It is a good practice to send the tracheal aspirate for culture and sensitivity following tracheostomy as tracheostomy stoma exposes the lower respiratory tract to the environment thus increasing the chances of bacterial contamination of the lower respiratory tract and infection of the lower respiratory tract. If the patient is started on suitable antibiotics based on the culture postoperative recovery will be hastened, risk of postoperative infections like tracheitis, tracheobrochitis, stoma site infection and other lower respiratory tract infections can be reduced and patient can be discharged on an earlier date from the hospital.

The tracheostomy tube suctioning, dressing, changing of the tracheostomy tube and decannulation procedures should be carried out in a sterile way. The nursing staff and the patient's attendees have to be taught to suction the tracheostomy tube, to do the dressing and change the tube a sterile and hygienic way. In order to avoid further contamination of the tracheostomy tube.

CONCLUSION

It is a good practice to send the tracheal aspirate for culture and sensitivity following tracheostomy as tracheostomy stoma exposes the lower respiratory tract to the environment thus increasing the chances of bacterial contamination of the lower respiratory tract and infection of the lower respiratory tract. If the patient is started on

suitable antibiotics based on the culture postoperative recovery will be hastened, risk of postoperative infections like tracheitis, tracheobrochitis, stoma site infection and other lower respiratory tract infections can be reduced and patient can be discharged on an earlier date from the hospital.

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