Pre-decannulation Peristomal Findings in Tracheostomized Cases and Their Effect on the Success of Decannulation

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Abstract Decannulating a patient on a tracheostomy is a procedure that has to be dealt with vigilantly. This study evaluated both external and telescopic/bronchoscopic findings at the peristomal level of subjects being considered for decannulation. The patients did not undergo any intervention after above observations and before attempting decannulation. Thereafter peristomal findings and their contribution towards failure to decannulate were correlated. Thirty subjects were studied prospectively, of whom 21 (70 %) demonstrated peristomal complications including granulation tissue, ulceration, mucopurulent discharge, suprastomal granulations, suprastomal collapse and suprastomal flap. Complications were more common in the younger age group ($p = 0.007$) as well as in tracheostomies of longer duration with mean duration >20 months ($p = 0.045$). However there was no statistically significant correlation between the success of decannulation and various peristomal findings. Therefore the success of decannulation in a particular case cannot always be correctly predicted by peristomal assessment.

Keywords Tracheostomy · Bronchoscopy · Airway management · Decannulation

Introduction

Several factors may result in peristomal complications and these must be considered while performing a tracheostomy and also while caring. Of paramount importance is the size of the tracheostomy tube, especially in children. An appropriate size should be calculated [1] since tubes that are too large make their insertion or change difficult [2]. They may also result in injury to the tracheal mucosa by compromising its vascular supply. The material of the tube-plastic polyvinyl chloride, silicone, metal-silver or stainless steel, and presence of cuff [3] can also play a role in some of the complications that develop. Tubes that cause tissue irritation lead to granulation tissue formation around the tube with rubber and latex making for poor tracheostomy tubes. Silicone is preferred especially in paediatric tubes since its flexibility reduces the risk of mucosal trauma and the soft flanges ensure minimal skin trauma around the tracheostome [4]. After a tracheostomy, overzealous suctioning, especially in the immediate post operative period, may lead to mucosal trauma in the distal trachea, especially if the suctioning catheter is inserted into the tracheal lumen itself [5]. This may lead to granulation tissue forming at the tip of the tracheostomy tube (although not strictly a peristomal finding) which can cause obstruction and later failure of decannulation especially in children. Colman et al. found that the common complications of tracheostomies were stomal granulomas that was large enough to require removal, lower respiratory tract infections, stomal bleeding and blocked tubes [6]. Complications of tracheostomy are seen more in children than adults since the airway is more likely to get occluded by secretions, granulomas or a suprastomal collapse due to the relatively smaller diameter [7, 8].

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Decannulation is as important a procedure as performing the tracheostomy. Decannulating a subject successfully ensures that he regains his vocal cord functions and improves his swallowing. In addition, decannulation improves subject comfort and perceived physical appearance [9]. Cochrane and Bailey recommended assessments like laryngoscopy and bronchoscopy at decannulation [1]. Mahadevan et al. found that most of their subjects were successfully decannulated (75 %) with a recannulation rate of only 6.5 % following pre-decannulation bronchoscopy and concluded that their policy of performing bronchoscopy prior to decannulation with subsequent decannulation performed in the ICU has contributed to their high decannulation success rate [10]. Yellon recommends performing routine interval direct laryngoscopy and bronchoscopy in children with tracheostomies approximately once every 4 months, when problems occur and prior to decannulation [11] and treating any granuloma or suprastomal collapse after which the subject can be decannulated in the ward. Following an assessment, the need for active intervention is still debatable. Some studies have shown no benefit in excising granulomas especially when the tracheostomy tube is still in situ since tracheostomy tubes themselves cause foreign body reaction, frictional trauma and bacterial contamination, all of which contribute to granulation tissue formation. Therefore, decannulation will eliminate the cause of granuloma formation [12].

There is currently no strict accepted definition of decannulation failure. Stelfox et al. concluded that most clinicians defined decannulation failure as the need to reinsert an artificial airway within 48–96 h of tracheostomy removal [13]. Bach and Saporito defined successful decannulation as “extubation or decannulation and site closure with no consequent respiratory symptoms or blood gas deterioration for at least 2 weeks” [13, 14] and Ceriana and colleagues defined failure as ‘the need to reopen the tracheotomy because of an acute episode or progressive worsening of arterial blood gases not corrected by the application of noninvasive mechanical ventilation’ [13, 15]. A recannulation rate of 2–5 % has been recommended as acceptable [9, 13].

Materials and Methods

This was a prospective study on 30 tracheostomized patients considered for decannulation at a tertiary care hospital. The protocol was reviewed and approved by the Institutional Review Board and informed consent taken from all eligible patients. Patients fit for tracheostomy decannulation and in whom bronchoscopic assessment was feasible prior to decannulation were included.

Detailed external examination of the stoma was done. Note was made of the size of the tracheostomy tube in situ, size and site of the stoma, distance of the stoma from suprasternal notch (Fig. 1) and from lower border of the cricoid cartilage, position of the stoma in relation to the trachea (central or lateral), inflammation around the stoma, any infection, ulcerations, granulation tissue, skin tags and others. All measurements were made with a Vernier's calliper.

The various findings were defined as follows:

- *Inflammation* area of erythema surrounding the stoma with or without minimal secretions [16].
- *Infection* area of erythema surrounding the stoma with purulent secretions draining from the site [16].
- *Ulceration* wound or sore caused when tracheostomy tube phalange creates a constant pressure on area of the skin surrounding the stoma with loss of epithelium forming a crater like depression with tissue that may have a yellow cheesy appearance [16].
- *Granulation* pink pulpy tissue forming around the stoma that project up from the surface of the skin. It bleeds very easily during tracheostomy tube changes and possibly during tracheostomy care procedures [16].
- *Suprastomal flap* flap in the suprastomal area that was created by the physical force exerted on to the tracheal wall superiorly by the curvature of the tracheostomy tube. This is the definition given by author*. We believe this entity is different than suprastomal collapse.

Following the general examination, all subjects underwent telescopic/bronchoscopic assessment under general anaesthesia. Internal evaluation of peristomal area was done by MLB (microlaryngoscopy and bronchoscopy) using a telescope (0° Hopkins rigid endoscope—Karl Storz, Tuttlingen, Germany) where the stomal level was identified

Fig. 1 Depicting method of measurement of distance of the tracheostome from the suprasternal notch using vernier callipers

by passing a needle in through the stoma, and an endoscopic picture was taken 2 cm away from the stoma. This was done to standardize all endoscopic pictures and their analysis. Retrograde assessment was then performed by removing the tracheostomy tube and introducing an endoscope through the stoma. All subjects were put through a trial of decannulation irrespective of the findings. ‘Decannulation failure’ was defined as recannulation becoming necessary within 90 h of decannulation. Management of complications was done in those who failed decannulation.

Results

Thirty subjects fulfilling the inclusion criteria were studied, of whom 18 were males (60 %) and 12 females (40 %). The mean age of the subjects in the study was 22.67 years. Twenty-five subjects (83.33 %) were decannulated successfully while 5 failed decannulation (16.67 %), 4 of whom were males and 1 female ($p = 0.622$). The mean age for those successfully decannulated was 25.64 ± 13.57 years while for those who failed decannulation was 7.80 ± 7.53 years ($p = 0.007$). The mean duration of tracheostomy in those who were successful decannulated was 6.70 months whereas it was 20.20 months in those who failed ($p = 0.045$). [Table 1].

All subjects had their tracheostomies done on the 3rd tracheal ring with the tracheostome positioned central in 28 (93.33 %) and right lateral in 2 (6.67 %) subjects. The average tube size in those who were successfully decannulated was 7.4 ± 1.48 while those who failed had an average size of 4.9 ± 2.10 . The mean distance of the tracheostome from the sternal notch in those who had successful decannulation was 3.20 ± 0.57 cm while in those who failed was 2.66 ± 0.27 cm.

The contribution of various findings on external examination of the tracheostome is summarized in Table 2.

One (20 %) of the 5 who failed decannulation and 3 (12 %) of those who were successfully decannulated had mucopurulent discharge from the skin around the tracheostome. There was no microbial growth from the pus cultured from any of them. All four patients were admitted

for decannulation and were also on antibiotic therapy which was probably why all pus cultures were sterile. Peristomal granulation tissue was also present in 14 (46.7 %) patients. The maximum width of the granulation tissue (Fig. 2) ranged from 0.5 to 10 cm with a mean of 2.72 cm. Peristomal granulation tissue was seen in 10 (40 %) who were successfully decannulated and in 4 (80 %) who failed decannulation ($p = 0.102$).

On MLB or flexible endoscopy (Table 3), suprastomal granulation tissue (Fig. 3) was seen in 9 (30 %) and was absent in 21 (70 %) cases. The thickness of granulation tissue seen ranged from 1 to 5 mm with a mean of 1.89 ± 1.34 mm. On MLB, the percentage of lumen occupied by the granulation tissue was 56.11 ± 20.28 %. Suprastomal granulation tissue was seen in 7 (28 %) of those who were successfully decannulated but was absent in 18 (72 %) while in those who failed decannulation, it was seen in 2 (40 %) out of 5 ($p = 0.593$). Two children aged 2 and 5 years had suprastomal granulation tissue and both did not tolerate decannulation ($p = 0.147$) whereas all 6 adults with this complication were successfully decannulated. The mean thickness of the granulation tissue was 2.07 ± 1.48 mm in those with successful decannulation and 1.25 ± 0.35 in those who failed. The mean percentage of the lumen occupied in those who were successfully decannulated was 51.43 ± 19.52 % while in those who failed it was 72.50 ± 17.68 %.

Ten patients (33.33 %) had a suprastomal flap with 7 of them successfully completing decannulation. The proportion of the lumen obstructed was more in those who failed decannulation (36.67 %) than those who were successfully decannulated (22.86 %). Among those who failed decannulation, 2 were children aged 5 and 6 years respectively though age was not a significant predictor of failure in those with suprastomal flaps ($p = 0.659$). Suprastomal collapse (Fig. 4) was present in 9 subjects (30 %). The percentage of the lumen occupied by the collapse ranged from 10 to 80 % with a mean of 41.11 ± 20.28 %. Suprastomal collapse was seen in 8 subjects (32 %) who were later successfully decannulated and in 1 of those who failed (20 %) ($p = 0.593$). This subject was a child aged 5 years ($p = 0.270$) while all the adults tolerated the decannulation

Table 1 Relationship of sex, age and duration of tracheostomy with decannulation success

Sl. No.	Parameter	Successful decannulation	Failed decannulation	<i>p</i> value
1.	Sex distribution	14—Males 11—Females	4—Males 1—Female	0.622
2.	Mean age	25.61 years	7.80 years	0.007
3.	Mean duration of tracheostomy	6.70 months	20.20 months	0.045
4.	Total	25 (83.33 %)	5 (16.67 %)	

$p < 0.05$ was taken as significant

Table 2 Relationship of external examination findings of the tracheostome with success of decannulation

Sl. No.	Parameter	Successful decannulation	Failed decannulation	<i>p</i> value
1.	Mean tracheostomy tube size	7.4 ± 1.48	4.9 ± 2.10	0.025
2.	Distance from the lower border of the cricoid cartilage	1.65 ± 0.51 cm	1.74 ± 0.51 cm	0.72
3.	Mean distance of the tracheostome from the sternal notch	3.20 ± 0.57	2.66 ± 0.27	0.015
4.	Position of tracheostome	Central—24 Right lateral—1	Central—4 Right lateral—1	0.310

p value < 0.05 taken as significant

Fig. 2 Depicting the method of measurement for peristomal granulation tissue thickness using vernier callipers

trial. Decannulation was successful in 88.89 % of subjects with collapse and 70 % of subjects with flap. If the two are combined as a common group then 88.88 % were successfully decannulated. In our study the average percentage of the lumen occupied by the collapse was 41.11 ± 20.27 % and the average percentage of lumen occupied by the flap was 27 ± 13.16 % (Fig. 5). The

suprastomal collapse and flap of failed cases were lifted up using prolene sutures (Fig. 6) following which they were decannulated successfully. There was 1 (3.33 %) case of tracheal stenosis that occupied 25 % of the lumen at a distance of 6 mm from the upper part of the tracheostome. Tracheal stenosis was present in only one (4 %) of those who were successfully decannulated.

All subjects underwent decannulation and 25 subjects (83.3 %) tolerated it at 24 h while 5 subjects (16.7 %) failed decannulation. This number did not increase with time with follow-up at 48, 72 and 90 h.

Discussion

During the course of the study, we found a recannulation rate of 16.7 % which compares well with studies by Carr (15 %) [17]. However this was higher than the study by Mahadevan who reported a recannulation rate of 6.5 % [10].

The age of the subject was a major determinant of the success of decannulation in our study and is probably due to the relatively smaller airway in children and higher oxygen requirements per kg body weight as compared to

Table 3 Relationship of endoscopic findings with success of decannulation

Sl. no.	Parameter	Successful decannulation	Failed decannulation	<i>p</i> value
1.	Suprastomal granulations	7—Present 18—Absent	2—Present 3—Absent	0.622
2.	Thickness in mm	2.07 ± 1.484	1.25 ± 0.354	0.539
3.	Percentage of lumen occupied by granulations	51 ± 43 %	72.5 ± 17.678 %	0.232
4.	Suprastomal collapse	8—Present 17—Absent	1—Present 4—Absent	0.593
5.	Percentage of lumen occupied by suprastomal collapse	21.67 ± 16.07 %	20 %	0.655
6.	Suprastomal flap	7—Present 18—Absent	3—Present 2—Absent	0.173
7.	Percentage of lumen occupied by suprastomal flap	22.86 ± 6.97 %	36.67 ± 20.817	0.166
8.	Tracheal stenosis	1—Present 24—Absent	5—Absent	0.649
9.	Percentage of lumen occupied by tracheal stenosis	25 %	—	

p value < 0.05 taken as significant

Fig. 3 MLB finding showing Suprastomal granuloma

Fig. 4 MLB finding showing Suprastomal collapse

adults may have been reasons for the higher failure rate seen [7, 18]. The duration of tracheostomy was also significantly longer ($p = 0.045$) in those who failed decannulation. Even though the duration of cannulation is probably related to the initial disease, this data nevertheless shows that it has a direct negative impact on the success of decannulation and may be related, in part, to the number of tracheostomy related complications with the increased length of cannulation.

Success of decannulation was similar in male and female subjects ($p = 0.622$) and our study shows that sex does not affect the success, or failure, of decannulation

Fig. 5 MLB finding showing Suprastomal flap

Fig. 6 MLB findings after lifting up of the Suprastomal collapse using prolene sutures

even though adult females have a comparatively smaller tracheal diameter than their male counterparts and the female trachea attains its full adult size by the age of 14 years whereas the male trachea continues to grow till the age of 17–18 years [2].

The contribution of the tracheostomy tube material to the complications and success of decannulation was not studied as all of our subjects had a Portex® tracheostomy tube, which is the most commonly used tube in our facility due to its easy availability. There was a significant difference in the tracheostomy size between those who failed decannulation and those who were successfully decannulated ($p = 0.025$) though this difference was probably due to the younger age of subjects who failed decannulation and not simply to the smaller tube size itself.

In our study, the complications affecting decannulation and not the different techniques leading to those complications were studied. All the patients in this study underwent open surgical tracheostomy and none had percutaneous tracheostomy. Both subjects with a right lateral tracheostome developed suprastomal flap. Of these two the child failed decannulation while the adult was successfully decannulated. There was a significant difference in the distance of tracheostome from the sternal notch between those successfully decannulated and those who failed ($p = 0.015$). However, since the length of the neck varies with age, the distance from the suprasternal notch and the lower border of cricoid cartilage is expected to be different in the different age groups and, therefore, this difference seen in decannulation success is probably a function of age rather than the effect of the mean distance itself.

Peristomal findings like ulceration, infection and granulation tissues were not related to the success of decannulation. Peristomal ulceration and infection may have resulted from poor general hygiene of the subjects. Most patients were from a lower socio-economical background and their ability to maintain peritubal hygiene was doubtful. Peristomal granulation tissue is a common occurrence with an incidence of up to 80 % seen by Prescott et al. [19] in their study. In our study, peristomal granulation tissue was present in 14 (46.7 %) patients of whom 10 were successfully decannulated and 4 failed decannulation. Peristomal granulation tissue results from foreign body reaction caused by the tracheostomy tube in situ, explaining its common occurrence in subjects with a tracheostomy. Poor peristomal hygiene causing increased infection also serves as a stimulus for the development of peristomal granulation tissues.

The failure to decannulate resulting from suprastomal granulations was not related to its mere presence but to the age of patient (both were children) and the extent of obstruction because of the granulations. Both children were subsequently successfully decannulated after excision of the granulation tissue though Rosenfeld et al. reported in their study that excision of granulation tissue leads to recurrence and a majority of subjects actually did not need excision of granulation tissue at the time of decannulation. [11].

There was one case of tracheal stenosis that occupied 25 % of the lumen at a distance of 6 mm from the upper part of the tracheostome though the subject remained asymptomatic and was successfully decannulated. Sue et al. in their study found that clinically important symptoms do not typically develop until the luminal diameter is reduced by 50 % [20]. The rate of this complication in this study compared well with the complication rate of 5–11 % in others. Koitschev et al. reported severe tracheal stenosis in 7.3 % of cases

undergoing surgical tracheostomy [21]. Koitschev also found a higher rate of tracheal stenosis in subjects where percutaneous tracheostomy was performed [22].

The suprastomal flap was defined as the flap in the suprastomal area that was created by the physical force exerted on to the tracheal wall superiorly by the curvature of the tracheostomy tube whereas all other factors contributing to the narrowing of the lumen in the immediate suprastomal area are termed suprastomal collapse. We have divided suprastomal collapse and suprastomal flap into two separate groups. In suprastomal collapse cases some degree of chondritis weakens the tracheal wall and with the pressure of the tracheostomy tube over a period of time the entire wall collapses into the tracheal lumen [23–25]. In comparison, a suprastomal flap is a shelf of tracheal wall, which is a part of suprastomal anterior tracheal wall that is pushed into the lumen by the tracheostomy tube. The formation of a flap does not necessarily occur due to inflammation or infection of the tracheal wall but caused simply by the pressure of the tracheostomy tube. Other studies have failed to separate these complications into two groups and when no distinction is made between suprastomal collapse and flap, 18 (60 %) subjects in this study would have fallen in the combined group.

Suprastomal collapse was seen in a child who failed decannulation though there was no statistically significant effect of this complication on the overall success of the procedure. There was difficulty in identifying how many tracheal rings are involved in the collapse since the endoscopic picture only shows us how much of the lumen the collapse is occupying but not necessarily the tracheal rings involved. This is a major limitation of the documentation/calculation since an accurate picture of how large the collapse was could not be assessed just with endoscopic picture as this does not factor in the length of the collapse. Additionally, the contribution of surgical techniques to the development of suprastomal collapse was not considered as ascertaining the various techniques used by different surgeons at the time of decannulation was not possible.

Conclusion

Of the 30 patients evaluated 21 (70 %) had peristomal findings despite which 16 patients were successfully decannulated. Overall rate of decannulation success was 83.3 % even without any active intervention during the endoscopic examination. Since there was no statistically significant correlation between failure of decannulation and the various peristomal findings, the accurate prediction of decannulation failure by external and endoscopic peristomal assessment is not possible. Microlaryngoscopy and bronchoscopy before decannulation is thus primarily useful in looking for the

reversal of any laryngeal condition for which tracheostomy was performed. This study also shows that that age and the duration of tracheostomy were significant contributory factors to failure of decannulation. Children were comparatively more prone to the effects of peristomal complications than adults. Care needs to be taken to ensure that subjects who are fit for decannulation undergo the procedure at the earliest to avoid prolonging their duration of tracheostomy and increasing the chances of failure.

Summary

- A total of 30 subjects fit for decannulation were evaluated in this study.
- Detailed external examination of the stoma was done. Subjects were then taken up for telescopic/bronchoscopic evaluation of the peristomal area under general anesthesia. Stomal level was identified by passing a needle through the stoma and endoscopic pictures taken 2 cm away from the stoma.
- Subjects were put through a trial of decannulation irrespective of the peristomal findings.
- Failure of decannulation was taken when recannulation was required within 90 h.
- Out of a total of 30 subjects, 5 subjects (16.7 %) failed decannulation in this study.
- Children were more prone to the effects of peristomal complications than adults—the mean age of those who failed decannulation was 7.8 ± 7.53 years and those who were successfully decannulated was 25.64 ± 13.57 years ($p = 0.007$).
- The longer the duration of the tracheostomy the more is the chance of decannulation failure ($p = 0.045$).
- The external and telescopic peristomal findings cannot correctly predict the success of decannulation. Of the 30 patients evaluated 21 (70 %) had peristomal findings despite which 16 patients were successfully decannulated. Thus accurate prediction of decannulation failure by external and endoscopic peristomal assessment is not possible.

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Conflict of interest None.

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