



Tracheostomy: The Dynamics of Indications in an Old Procedure

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Abstract

Background: Securing a surgical airway remains one of the fundamental components of critical care medicine as an obstructed airway for more than three minutes is not compatible with life.

Purpose: Critical appraisal of the dynamics of the indications for tracheostomy in a developing country.

Study design: Retrospective

Methods: Analyzed tracheostomy patients' data over a 3-year period.

Results: We studied 41 tracheostomy cases of the 235 Ear Nose Throat operations, constituting 17.4%. The M:F = 2.2:1, mean age = 33.2 yrs ± 20.3. The relief of upper airway obstruction (n = 30, 73.2%) was the main indication with tumors accounting for 50% (n = 15, 36.6%). Ventilatory support was the next main indication (n = 9, 22.0%). Of this, 4 (9.8%), representing 1.6% of the intubated who developed laryngotracheal stenosis. Emerging indications included Cut throat and infective causes that had a tie (n = 4, 9.8%). Twenty-nine (70.7%) were successfully decannulated. The study recorded 12.2% complications while perioperative mortality was 4.9%.

Conclusion: Indications for elective tracheostomy is well established, however, an algorithm describing the indications and timing for a surgical airway in emergency cannot be drawn due to the multiplicity of variables and the inapplicability in the context of life-threatening critical emergency.

Keywords

Tracheostomy, Emergency surgical airway, Indications

as an airway-tracheotomy or a site for a tracheostomy tube to be inserted-tracheostomy, so as to establish an alternate airway. This is a valuable life-saving operation employed in critical airway [1].

Tracheotomy was first depicted on Egyptian artifacts in 3600 BC [2]. It was described in the Rigveda, a Sanskrit text, Circa 2000 BC [3]. It is believed that an early tracheotomy was performed by *Asclepiades of Bithynia*, who lived in Rome around 100 BC; *Galen and Aretaeus* both of whom lived in Rome in the 2nd century AD, credit *Asclepiades* as being the first physician to perform a non-emergency tracheotomy [4]. *Antonio Musa Brassavola (1490-1554)* of Ferrara treated a patient suffering from peritonsillar abscess by tracheotomy after the patient had been refused by barber surgeons. The patient apparently made a complete recovery, and Brassavola published his account in 1546. This operation has been identified as the first recorded successful tracheostomy [5]. The currently used surgical tracheotomy technique was described in 1909 by *Chevalier Jackson* of Pittsburgh Pennsylvania. Jackson emphasised the importance of postoperative care [5]. However, *Thomas Fienus (1567-1631)*, Professor of Medicine at the university of Louvain was the first to use the word "tracheotomy" in 1649 [6].

In literature, specific indications for emergency tracheostomy are scattered while the indications for surgical airway in elective scenario, specifically for tracheostomy, are however well established in intensive care unit (ICU) and Oto-laryngologic practice. This study was therefore designed to critically appraise our experience on the dynamics of the indications for this age- long operation, in our environment both as elective and emergency procedures. We further highlighted the complications commonly encountered and the risks inherent with local versus general anaesthesia, as relates the outcome of either procedure.

Method

This was a three-year retrospective study of all patients that had

Introduction

Tracheostomy is a surgical procedure in which an incision is made in the anterior part of the neck in order to gain access into the trachea via a stoma. The resultant stoma can serve independently

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tracheostomy at the Jos University Teaching Hospital (JUTH), Jos, Plateau state, Nigeria from January 1, 2012- December 31, 2014. Patients' clinical data were retrieved from case files using standard codes for the International Classification of Diseases (ICD-10) version 10 via the hospital's health record's database from the Ear Nose Throat (ENT) theatre, High Dependency Unit (HDU), Intensive Care Unit (ICU), Accident and Emergency department, and ENT ward records.

Clinical data was generated from patients' demographic, diagnosis, indication, type of tracheostomy, operative technique and type of anaesthesia. Furthermore, those that had cuffed endotracheal intubation (CETT), duration of CETT before procedure, those intubated and later extubated without having to undergo tracheostomy, those that developed laryngo-tracheal stenosis post intubation and the outcome of tracheostomy were studied for relevant data. All cases of tumors/obstructive adenoidal diseases, retropharyngeal abscess were diagnosis based on clinical assessments, CT scan, plain radiographs, histopathologic and laboratory reports as appropriate. Case notes with insufficient data were excluded from the study.

Results obtained were statistically analyzed using STATA version 12.0, StataCorp, College Station, Texas, USA statistical software while presentation was by simple diagrams, tables, and figures.

Table 1: Showing Age-gender distribution of tracheostomy n = 4.

Age (years)	Gender		frequency	Percentage (%)
	Male	Female		
0-9	4	3	7	17.1
10-19	1	2	3	7.3
20-29	7	2	9	22.0
30-39	6	3	9	22.0
40-49	2	1	3	7.3
50-59	4	1	5	12.2
60-69	3	-	3	7.3
70 >	1	1	2	4.9
Total	28	13	41	100.0

Results

This study evaluated 41 cases of tracheostomy of the 235 Ear Nose Throat (ENT) operations, constituting 17.4 % which is almost 1/5 of all the operations within the study period. There were 28 males and 13 females (M:F = 2.2:1). Their ages ranged from 1 month-70 years, mean age was 33.2 years \pm 20.3 with a median age of 32.0 years. The age groups 20-29 years and 30-39 years (Table 1) had the highest number of cases with a tie (n = 9, 22.0%), followed by age group 0-9years (n = 7, 17.1%) in which all were 5 years or less. Three (7.3%) had recurrent respiratory papillomatosis (RRP) (Figure 1). This was followed by all cases of acute laryngo-tracheobronchitis (ALTB) [n = 2, 4.8%], laryngeal foreign body (FB larynx) [n = 1, 2.4%] and a case of obstructive adenoidal disease (n = 1, 2.4%). The smallest age group was 70 yrs and above (n = 2, 4.9%) in which all had malignancies as main indications (a laryngeal and a tonsillar squamous cell carcinoma). Main indication for tracheostomy was for the relief of upper airway obstruction (UAO) [n = 30, 73.2%] in which tumors of the upper aerodigestive tract accounted for half of the cases (n = 15, 36.6%). Malignant lesions were responsible for two thirds of the tumors (n = 10, 24.4%) with laryngeal cancers contributing 70% (n = 7, 17.1%) while all the benign tumors were recurrent respiratory papillomatosis (n = 5, 12.2%). Half of the malignant lesions in the study were from the age bracket 20-39 years. (Figure 1) This was followed by the use of Cuffed endotracheal intubation (CETT) for ventilatory support in cases with Glasgow Coma Score (GCS) of < 8 (n = 9, 22.0%). There were 504 Intensive Care/High Dependency Units' (ICU/HDU) admissions of which 248 (49.2%) were intubated. Out of this, 4 (1.6%) developed laryngo-tracheal stenosis after extubation for which they had emergency tracheostomy while 5 (2.0%) had elective tracheostomy due to prolonged intubation (Figure 1) The average length of stay of CETT before tracheostomy was 32.5 days, earliest was 14 days while longest was 114 days. The 3rd main indication, which hitherto were uncommon included cut throat and infective causes that had a tie (n = 4, 9.8%). Those that had cut throat were from the age bracket 20-39 years consisting of 3 (7.3%) males and a female.

THE INDICATIONS FOR TRACHEOSTOMY n=41

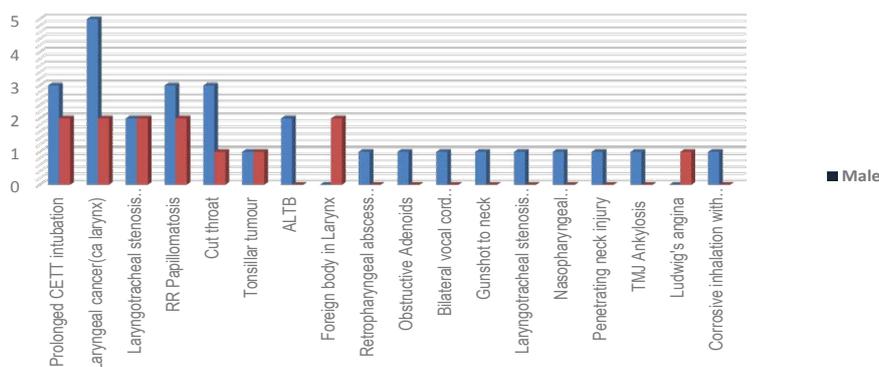


Figure 1: Showing the indications for tracheostomy.

CETT: cuffed endotracheal tube; RRP: Recurrent respiratory papillomatosis; ALTB: Acute Laryngo-tracheobronchitis; TMJ: Temporomandibular joint

Table 2: Tracheostomy indications in comparison with earlier reports from JUTH.

Aetiology	Various Studies		
	Adoga AA et al Jan 2000 - Dec 2008 n = 46	Adoga AS et al April 2005 - Aug. 2006 n = 18	Kokong DD et al (current study) 1 Jan. 2012 - 31 Dec. 2014 n = 41
1. Ca larynx	-	4 (22.2%)	7 (17.1%)
2. CETT for prolonged coma	5 (10.9%)	3 (16.7%)	9 (22.0%)
3. RRP	20 (43.5%)	3 (16.7%)	5 (12.2%)
4. Infective	2 (4.3%)	1 (5.6%)	4 (9.8%)
5. FB larynx	-	1 (5.6%)	2 (4.9%)
6. Cut throat	-	1 (5.6%)	4 (9.8%)
7. Gunshot	-	1 (5.6%)	1 (2.4%)
8. Obstructive Adenoids	-	-	1 (2.4%)

Ca Larynx: Laryngeal cancer; CETT: Cuffed endotracheal tube; RRP: Recurrent respiratory papillomatosis; FB Larynx: Laryngeal foreign body

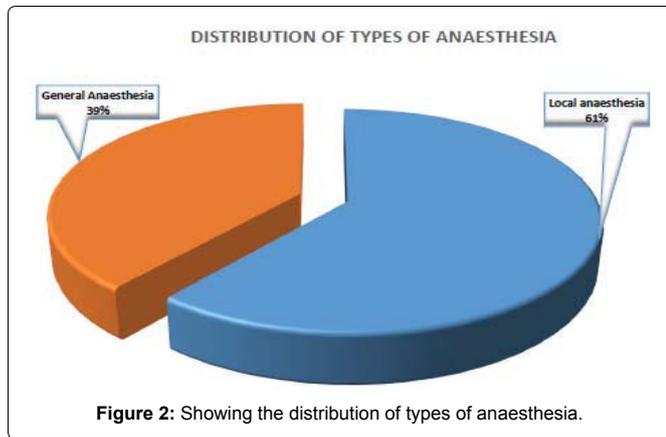


Figure 2: Showing the distribution of types of anaesthesia.

Her case was that of attempted murder by a male friend for HIV status disclosure (Figure 1). There were isolated cases of gun-shot injury to the anterior neck, penetrating neck injury in a road traffic crash victim amongst others that had emergency procedure under local anaesthesia (LA) (Figure 1) However, the only preoperative indication for tracheostomy was for the release of temporomandibular joint ankylosis. See table 2 for institutional changing indications.

Emergency procedures were done on 35 (85.4%), while Elective on 6 (14.6%). General anaesthesia (GA) was instituted in 16 (39.0%) and local (LA) in 25 (61.0%) (Figure 2).

The operative technique for all cases was the standard open surgical tracheostomy via a transverse incision at 4cm above the suprasternal notch at the anterior neck with tube insertion via a vertical slit between 2nd-4th tracheal rings. No tracheal window or Bjork flap created at the point of tracheostomy tube insertion. Twenty-nine (70.7%) were successfully decannulated including the case of difficult decannulation from exuberant suprastomal granulation tissues that had surgical decannulation. All cases of laryngo-tracheal stenosis (n = 3, 7.3%) are yet to be decannulated, however, we cannot comment on the tracheostomy status of all those with laryngeal, oropharyngeal and nasopharyngeal cancers that were referred for chemo-radiation in other facilities.

Complications were recorded in 5 (12.2%) that included cases of laryngo-tracheal stenosis (n = 2, 4.9%) in addition to the case of post traumatic laryngo-tracheal stenosis and a case of suprastomal granulations. There were 2 cases (4.9%) of perioperative mortality recorded in which one was due to patient's frequent accidental removals of tracheostomy tube that succumbed during a repeat tracheostomy and a case of long segment laryngo-tracheal stenosis that did not permit complete passage of the stenotic segment by the tracheostomy tube. Both had emergency procedures under LA.

Discussion

Tracheostomy has been reported as among the most frequently performed surgical procedures [7] which was confirmed in this study with a prevalence of 17.4%. This has remained so because of its role in critical airway.

The development of tracheostomy has been divided into five periods: the 'period of legend'-dating from 2000BC to AD 1546; the 'period of fear'-from 1546-1833 during which the procedure was performed only by a brave few often at the risk of their reputation; 'the period of drama'-from 1833-1932 during which the procedure was performed only in emergency situations of acutely obstructed patients, the 'period of enthusiasm' from 1932-1965 during which the adage 'if you think tracheostomy...do it' became popular; and the 'period of rationalisation' from 1965 to date during which the relative merits of intubation versus tracheostomy were debated [8]. Despite the view of this current era, the frequency of the procedure has persistently remained high. This procedure will continue to remain relevant in Oto-laryngological practice and critical care medicine as airway problems necessitating this procedure requires immediate treatment to prevent fatal consequences [1].

The male gender was found to be frequently involved in a ratio of 2.2:1 in this study which agrees with similar findings by other researchers across the globe [7].

The frequent involvement of the age group 20-39 years which accounted for almost half of the cases in this study is worth noting. This is the productive age that had to undergo such risky procedures for which this study recorded a morbidity and mortality of 12.2% and 4.9% respectively. Mortality of as high as 25% has been reported for tracheostomy [9]. This is aside risks associated with the primary disease in which this study recorded malignancies with their grave prognosis; with over 70% being cancers of the larynx. Laryngeal cancers carry a poor prognosis as a 5-year survival of 40% with surgery alone and 70% with surgery and radiotherapy has been reported [10]. The socio-economic burden from both the surgery for the primary disease which is in multiples and chemo-radiation; often in several cycles for several months is enormous. Laryngeal cancers have also been reported as the commonest head & neck malignancy by researchers [11,12]. Furthermore, in cases of the benign lesions which this study recorded recurrent respiratory papillomatosis in 12.2%; their prognosis is unpredictable with the victims frequently undergoing several sessions of tracheostomy and surgical clearance of the papillomas due to frequent recurrence. Similar findings have been reported in our environment [7,13].

The age group 0-9 years, all less than 5 years was the second most afflicted (17.1%) for which the indication was primarily RRP, with 7.3%. The prevalence of RRP in the under- five age group is worrisome because of the sufferings associated with repeated operations. Furthermore, it may be related to the incidence of human papilloma virus (HPV) serotypes 6, 11, 16, 18 among mothers of the childbearing age in our environment [13]. The current efforts for the inclusion of HPV vaccine in the new National Program on Immunization(NPI) schedules is commendable as this would go a long way in reversing this trend [14]. A dissimilar finding was reported by *Nwawolo and co-workers* [7] who reported laryngeal foreign bodies in the under-five age group with the highest frequency of tracheostomy accounting for 33.7%.

Researchers around the globe reported the relief of upper airway obstruction as the main indication for tracheostomy [15] which was also observed in this study, representing 73.2% though with varying etiology. While tumors of the upper aerodigestive tract were responsible for 50% of the cases of UAO in which two thirds were malignant lesions in our series, all the benign lesions were RRP. A recent study reported a prevalence of 43.5% [16] for RRP though they said study involved the paediatric population. Accordingly, severe cervico-facial trauma was the main cause of UAO reported recently, in a separate study, consisting 27.8% [17] in our health institution within the previous decade. However, in a separate health institution, in the South Western part of the country, four decades ago, tracheo-bronchial toileting secondary to tetanus was reported the major indication for tracheostomy [18]. This study recorded no case of tetanus as an indication for tracheostomy. We believe the improved global NPI coverage enforced by WHO was responsible for this finding. Historically, *Homerus of Byzantium* is said to have written of *Alexander The Great* of saving a soldier from suffocation by making an incision with the tip of his sword in the man's trachea [3].

Previously, researchers reported infective causes as major indications for emergency tracheostomy with acute laryngo-tracheobronchitis (ALTB) predominating [7]. However, contrary results were later observed that improved health care services and hygiene were found to be responsible [19]. The resurgence of malignancies as indications as observed in this study as well, has been related to a change in social habits and diet by researchers [12]. This calls for concern as cancers affecting young adults tend to be very aggressive [20]. In this series, half were found in the 2nd-4th decades of life.

It is worth noting that a case of obstructive adenoidal disease had emergency tracheostomy from UAO in our study; this is uncommon in the literature. In our environment, patients with obstructive adenoidal

diseases or RRP are frequently managed for bronchopneumonia/asthma by non-specialist medical practitioners due to similarity in features which may be responsible for such delays [17].

We observed a high rate of CETT utilisation for ventilatory support that was mostly orotracheal in our series. Within the 3-year study period, there were 504 ICU/HDU admissions with 248 (49.2%) intubated. Four (1.6%) had tracheostomy following laryngotracheal stenosis while 5 (2.0%) on account of prolonged intubation. Prolonged indwelling CETT has been implicated in laryngotracheal stenosis post-intubation. This is true, as all those that re-presented with UAO from laryngo-tracheal stenosis had intubation. However, for unexplained factors, there were those that had prolonged intubation and extubated that never developed laryngo-tracheal stenosis while some with fewer days of intubation returned with laryngo-tracheal stenosis. In this study, half had their CETT in place for 32.5 days while the earliest had it for 14 days while the longest, 114 days before extubation which cannot explain the prevalence of 1.6% of laryngotracheal stenosis from prolonged intubation alone. We believe that the etiology is multifactorial; including expertise, technique, number of intubations, accidental extubation(s) and genetic predisposition. The poor management outcome associated with the treatment of laryngo-tracheal stenosis post intubation made researchers suggest a maximum of 10 days for consideration for an elective tracheostomy when prolonged ventilatory support is anticipated [21]. Studies have shown that the safest length of days with minimal mucosal injury with CETT is 48 hours [22] and that nasotracheal intubation is much safer than orotracheal intubation due to a wider available space that permits wide range of CETT movements in the latter, resulting in more mucosal insults and nasotracheal tubes are often small calibre in addition [22]. However, *Watson* [23] reported up to three weeks as safe. In our environment, there has not been a standing protocol on timing for tracheostomy on the intubated due to patient's and or relation's refusal because of the social stigma of carrying a tube in the neck, added cost on hospital bills and the suspicion of an unstable cervical spine in trauma cases. Historically, *Avicenna (980-1037)* described tracheal intubation in *The Canon of Medicine* in order to facilitate breathing [5].

In previous studies, however, CETT for ventilatory support was not among the indications for elective tracheostomy in our environment, [7] though this has for long been reported in the developed countries due to their well established critical care centres [19] which is gradually being introduced in the developing countries.

Similarly, cut throat for suicidal attempts has emerged a significant major indication for elective/emergency tracheostomy, accounting for 9.8% in our series, report on which has been scanty until of recent [17]. We may speculate the global economic depression with the attendant unemployment, responsible; as all the victims were unemployed youths. For the only female victim, this was an attempted murder by a male friend following disclosure of her HIV status.

Emergency tracheostomy predominated with 85.4% with a varied spectrum of indications which has also been documented [9]. In literature, specific indications for emergency tracheostomy are scattered and are biased, partially comprehensive, not clearly described or not homogeneously gathered [24]. As a matter of fact, the two groups of indications viz.; laryngeal injury and failure to intubate and/or ventilate the patient, are too generic and encompass a broad spectrum of possibilities are not sensitive, specific or accurate. In principle, they are unquestioned; in practice, they are of difficult application and not helpful in deciding who exactly should have an emergency tracheostomy as a life-saving bedside procedure; and most importantly, when. Their application, therefore, depends often on the operator's experience and skills. A universal algorithm on the indications and timing for a surgical airway in emergency, as such, cannot be drawn, due to the multiplicity of variables and the inapplicability in the context of life-threatening critical emergency, where human brain elaborates decisions better in cluster rather than in binary fashion [25]. Indications for surgical airway in elective scenario, specifically for tracheostomy, are however well established in intensive

care unit (ICU) and Oto-laryngologic practice. The emergency procedures tend to carry a grave prognosis [9,15] as most often times the airway is precarious, either because of an obstruction, that makes intubation impossible or dangerous. In this group of patients, general anaesthesia is impracticable and dangerous as the airway may shut-off during pre-anaesthetic administration of inhalational/intravenous agents while local anaesthesia often difficult as neck extension for the procedure can also shut-off the airway. In this study, all the mortalities (n = 2, 4.9%) followed emergency procedures and the anaesthesia was under local. A great deal of intuition, skill and experience are required in decision-making by the surgeon and his team.

The operative technique was mainly the open surgical tracheostomy without the creation of a tracheal window or Bjork flap. The open surgical technique has been found to be more efficacious than the practice of the newer tracheostomy techniques like percutaneous tracheostomy in a meta-analysis [26] adopted by several surgeons. However, the creation of the tracheal window, according to other researchers is to mitigate the chances of fatal accidental extubation [19]. However, our experience has shown a higher tendency of developing laryngo-tracheal stenosis after decannulation [27]. The Bjork flap may produce a similar result from flap necrosis and trachea-cutaneous fistula. These observations have also been reported [28] *Antyllus*, a Roman physician of the 2nd century AD, refined the technique of tracheostomy to be more similar to that used in modern times, recommending that a transverse incision be made between the third and fourth tracheal rings for the treatment of life-threatening airway obstruction [4] which was the technique employed in our series.

The decannulation rate was 70.7% excluding all cases of cancer of the larynx and nasopharynx that were referred to other facilities for further care. All the cases of laryngo-tracheal stenosis (n = 3, 7.3%) who are yet to be decannulated.

Decannulation rate of 100% was reported in a study [19], though the study was done on paediatric population who neither had malignant laryngeal lesion nor laryngo-tracheal stenosis.

Conclusion

Indications for elective tracheostomy is well established, however, an algorithm on the indications and timing for a surgical airway in emergency cannot be drawn due to the multiplicity of variables and the inapplicability in the context of life-threatening critical emergency.

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