Management of difficult airways in surgical patients at the Port Moresby General Hospital operating theatre and intensive care unit


Port Moresby General Hospital, Papua New Guinea and Chongqing Three Gorges Central Hospital, China

SUMMARY

We report on the results of a retrospective audit of airway management in patients presenting to the Port Moresby General Hospital from 1998 to 2009. Safe and secure airway management can be challenging in the operating room during head and neck surgery. These challenges continue into the postoperative period and can present significant issues to intensive care staff. This series includes many patients with upper airway and upper gastrointestinal malignancy, head and neck trauma, head and neck infections, thyroid pathology and cleft palate. This series highlights the importance of anticipating the possibility of difficult airway preoperatively and modifying the airway management appropriately. We consider that all members of the operating team including surgeons, anaesthetists, intensive care physicians and nursing staff should cooperate and communicate effectively to optimize outcomes for these potentially difficult cases. A proposed airway management algorithm is presented to guide surgical teams performing head and neck surgery in Papua New Guinea and similar regions.

Introduction

Difficult airway is a clinical scenario where a trained anaesthetist experiences difficulty with mask ventilation, tracheal intubation or both. Difficult airway can contribute to dental damage, airway injury and hypoxaemia. Hypoxaemia can lead to the dreaded complications of hypoxic encephalopathy and death. Furthermore, adverse events relating to the airway occur in up to 20% of critical incidents in intensive care units (1). Difficult mask ventilation (DMV) is a condition in which it is not possible for the anaesthetist to provide adequate face mask ventilation because of one or more of the following problems: a) inadequate mask seal, b) excessive gas leak, and 3) excessive resistance to the ingress and egress of gas.

Methods to improve the airway patency include the triple airway manoeuvre (TAM) (T = head tilt, A = advance mandible and M = mouth open), as well as insertion of oral and nasal airways. Various studies have shown that DMV occurs in 2-8% of patients (2,3). Tracheal intubation is described as difficult when it requires multiple attempts in the presence or absence of tracheal pathology. The incidence of DMV and difficult tracheal intubation (DTI) is highly variable amongst reported studies. This reflects differences in the definitions of DMV and DTI.

Several clinical predictors of difficult intubation have been proposed; unfortunately they all have a low positive predictive value. As a result many airways predicted to be difficult by such tests are straightforward.

1 Surgery Department, Port Moresby General Hospital, Free Mail Bag, Boroko, National Capital District 111, Papua New Guinea
2 g_gende@yahoo.com
3 Department of Anaesthesia, Chongqing Three Gorges Central Hospital, Jian Kang Road 1, Yu Zhong District, Chongqing 400014, China
4 Anaesthesia Department, Port Moresby General Hospital, Free Mail Bag, Boroko, National Capital District 111, Papua New Guinea
5 Nursing Division, Port Moresby General Hospital, Free Mail Bag, Boroko, National Capital District 111, Papua New Guinea
Mallampati and colleagues described a clinical scale (4) which on its own has a low predictive value. When considered together with other dependent variables such as inter-incisor distance and short thyromental distance, the predictive value increases. There are also other important factors that can influence the success or failure of tracheal intubation. These include the experience of the operator, correct positioning of the head and neck (‘sniffing the wind’ position) and the quality of equipment used. Considering that the overall difficult intubation rate varies, a preplanned strategy is central to the safe management of difficult airways when they do occur.

The incidence of DTI and adverse events is not known in Papua New Guinea (PNG). It is reasonable to assume that the incidence is higher in PNG than that cited in the western anaesthetic literature. Factors that might contribute to this include: 1) a shortage of experienced anaesthetists in PNG, 2) the late presentation of patients with advanced pathology, 3) limited preoperative imaging, and 4) limited access to equipment to allow alternative airway management strategies.

This paper reports on one general surgery unit’s experience with managing difficult airways over a period of 10 years. The lessons learned can be useful to others faced with similar challenges with their patients.

**Materials and Methods**

This is a retrospective study looking at the instances of DMV and DTI. All patients admitted to the Port Moresby General Hospital (PMGH) for surgery of the head and neck region and requiring general anaesthesia were included. They were admitted through the general surgery unit with special interest in plastic and reconstructive surgery. The period of study was from 1998 to 2009, excluding 1999 when the principal author (GG) was overseas: a study period of 10 years within an 11-year span. Cases were identified by manual review of the theatre registry books. A single investigator who had primary responsibility for all the cases collated and analysed all data to minimize observer errors and duplications. When there was uncertainty regarding the data in the theatre registry, patient medical records were obtained to ensure that relevant cases were included.

Many patients with DMV and DTI would naturally follow on with a surgical airway such as cricothyroidotomy. In the event that a preoperative assessment had identified concerns regarding the patient’s airway then the appropriateness of fibre optic intubation (FOI) or other adjunctive techniques would be considered. However, patients with severe jaw ankylosis and/or trismus went straight to tracheostomy under local anaesthesia.

There were no exclusion criteria related to patients or diseases. The only indications to abort an operation were 1) where the case failed to meet the ‘World Health Organization (WHO) Safe Surgery Checklist’ and 2) where there were more than 4 attempts at tracheal intubation.

Table 1 lists the techniques of tracheal intubation used during the 11-year period under review.

**Operating theatre procedure**

For all patients undergoing elective or emergency surgery on any upper aero-digestive tract area where a real or possible difficult airway situation exists, all concerned team members must be present. This includes the surgeon, senior anaesthetist and nurse with a full retinue of support staff during the airway access phase until ventilation is safely delivered. The anaesthetic management is fully explained to the team and all necessary adjuncts such as tracheostomy trays are always available in the room. The surgeon must not leave the room at any time during this interval. Since 2009 the WHO Safe Surgery Checklist (Table 2) was trialed in this unit. This extends from the arrival in the operating room to the completion of the operation and on to the recovery room. The planned procedure is aborted in elective cases if the WHO Safe Surgery Checklist is not met in full (5).

**Non-surgical tracheal intubations**

The standard techniques for non-surgical tracheal intubations as described in specialist texts should be administered by senior anaesthetists, who should physically be in attendance during the procedure. We advise that the techniques must be taught and mastered and would encourage referrals of all potentially difficult airways. Inadvertent use of the techniques by novices can result in more harm than good.
TABLE 1

TECHNIQUES USED FOR TRACHEAL INTUBATION IN DIFFICULT AIRWAYS AT PORT MORESBY GENERAL HOSPITAL, PAPUA NEW GUINEA, 1998-2009

Gas induction and intubation whilst spontaneously breathing
Awake fibre optic intubation (FOI)
Retrograde intubation (RI)
Stylet-assisted and gum elastic bougie-assisted intubation
Cricothyroidotomy
Tracheostomy (Bjork)

TABLE 2

WORLD HEALTH ORGANIZATION SAFE SURGERY CHECKLIST

Before induction of anaesthesia
- Patient verifies name, procedure, site and consent
- Surgical site is marked or not applicable
- Pulse oximeter is on the patient and functioning
- All members of team are aware of patient allergy, if any
- The patient’s airway and risk of aspiration have been evaluated and appropriate corrective equipment is available

Before skin incision – verbally
- Confirm that all team members have been introduced by name and role
- Confirm patient’s identity, surgical site and procedure
- Review the anticipated critical events by surgeon, anaesthetist and nurse
- Confirm that prophylactic antibiotics have been administered ≤60 minutes before incision or not indicated
- Confirm that all imaging results for correct patient are displayed in operating room

Before patient leaves operating room
- Nurse final check aloud with team
- Name of procedure as recorded
- That the needle, sponge and instrument counts are complete (or not applicable)
- That the specimen (if any) is correctly labelled including patient’s name
- Whether there are any issues with equipment to be addressed

- The team review aloud any key concerns for the recovery room management

Awake fibre optic intubation is a well-validated technique that is widely used for management of the difficult airway. The success of this technique is highly operator dependent and also requires that equipment be in good working order. Awake FOI is unlikely to achieve safe and secure airway access in a difficult airway scenario if the operator lacks experience with the technique. Medical staff involved in the management of difficult airways should train themselves to perform awake FOI, including the performance
of many intubations in patients with normal airway anatomy. The equipment required for FOI is costly and delicate. Special care is required in handling such equipment. Damage to the optical bundles or the case of the instrument often mandates replacement, which is a costly exercise.

**Surgical tracheal intubation**

**Cricothyroidotomy**

Cricothyroidotomy is indicated as a rescue technique for the ‘can’t intubate, can’t ventilate’ situation. Cricothyroidotomy can be performed by either a cannula or surgical technique. We advocate a surgical approach that does not rely on potentially unfamiliar or unavailable equipment.

**Equipment:**

- Scalpel with number 15 blade
- Small (e.g., 6 or 7 mm) cuffed endotracheal tube

**Steps:**

i. Identify the cricothyroid membrane.

ii. Stab incision through skin and membrane. Start with scalpel tip in midline and blade lateral. Turn scalpel through 180 degrees and repeat.

iii. Enlarge wound with scalpel handle or forceps.

iv. Insert tube and inflate cuff.

v. Verify tube position and ventilation.

**Tracheostomy**

Tracheostomy is indicated when conditions of difficult intubation exist and as an adjunctive procedure to assist in postoperative care. It can be done under local anaesthesia or under general anaesthesia. Bjork’s method of tracheostomy is used as the method of choice except for burns to the airways when a slit tracheostomy is used.

**Steps:**

The detailed steps can be learned from any standard textbook. However, it is relevant for this paper to bring out the salient points that will make the procedure smooth, safe and less of a drama in the operating theatre.

i. Take time to explain the procedure to the patient and ask for his cooperation.

ii. Extend the neck and use local anaesthesia with adrenaline.

iii. A crease incision is better and after separating the muscles the thyroid isthmus is divided and tied or retracted upward.

iv. An inverted ‘U’ is made in the 2-3 tracheal rings and the tracheostomy tube inserted. The base of the flap must be slightly wider than the tip to make it springier (Figure 1).

v. The skin is approximated with two stitches and the tube secured to the neck.

**Airway management in the Intensive Care Unit (ICU)**

Airway management in ICU patients with tracheal intubation aims to ensure adequate oxygenation and ventilation, avoid tube displacements and extubate successfully. Nursing care must be judicious to avoid tube displacements during patient repositioning and ensure that the patient is well sedated. Almost all our patients had sedation using morphine infusion or fentanyl/midazolam and after a successful leak test the tracheal tube is removed. Some problem cases may have an ‘airway exchange catheter’ (AEC) introduced through the endotracheal tube (ETT) and held in place while the ETT is removed. Through this AEC, oxygen can be delivered by means of jet ventilation or oxygen insufflations. Patients with Bjork-type tracheostomy were nursed in the surgical high-dependency unit (HDU), the next step downward after ICU, as long as their condition was stable after the operation.

**Results**

We found that 115 months out of a total of 132 months from 1998 to 3009 were available for the study. Anaesthetic records did not state the techniques used to access difficult airways but stated the length of anaesthetic induction time and made only brief remarks.
Patients’ anaesthetic records in the medical charts may give details, but this study did not look at them. Nursing records were very particular in recording time in theatre but did not show any other objective information.

There were a total of 602 major operations for which there existed a real or an apparent difficult tracheal intubation risk (Table 3). Of these, 168 were for cancers of the oropharyngeal cavity and/or lips, 110 for thyroid diseases and 52 for salivary gland diseases. Cleft lip and palate operations totalled 181, accounting for 30% of cases. There was only one death, in a 28-year-old man with a massive colloid goitre who died from a possible obstruction from a late haematoma or tracheomalacia. No postmortem examination was done since relatives refused. There were no perioperative deaths directly related to airway access interventions during the study period.

The commonest surgical airway was Bjork’s flap tracheostomy, of which 62 were performed, both at preinduction under local anaesthesia and as an adjunctive procedure while under general anaesthesia (Table 4). There was only one suspected tube displacement, which could not be verified with a flexible bronchoscope. The patient was well after suction. Two patients had basal atelectasis without fever and were on crystalline penicillin. Only one perinatal patient had failed intubation and a vertical slit tracheostomy was done under local anaesthetic infiltration.

One cricothyroidotomy was performed in a patient presenting with a massive left pleomorphic adenoma. After the induction the anaesthetist was unable to intubate or ventilate the patient with a mask. This is a rate of 0.2% of all the cases considered to be a difficult airway.

No specific data were available for stylet-assisted or gum elastic bougie-assisted intubation but one patient had significant airways haemorrhage and there was one postoperative death in a patient with massive colloid goitre. The complication rate was highest at 1.8% when intubating thyroid cases.

Fibre optic, retrograde and awake intubations were successfully done by one of the authors (YX). The failed attempts at FOI were made by colleagues other than the authors and were converted to tracheostomies under local anaesthesia. The failure rate with FOI was high and operator dependent.

Discussion

We have found that it is rare to encounter failed intubation and failed ventilation, which
### TABLE 3

**MAJOR SURGICAL OPERATIONS WITH APPARENT OR REAL DIFFICULT AIRWAYS UNDERTAKEN IN THIS STUDY**

<table>
<thead>
<tr>
<th>Operation</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancer resections</td>
<td>168</td>
</tr>
<tr>
<td>Thyroid operations</td>
<td>110</td>
</tr>
<tr>
<td>Salivary gland operations</td>
<td>52</td>
</tr>
<tr>
<td>Trauma (including burns)</td>
<td>15</td>
</tr>
<tr>
<td>Orofacial clefts</td>
<td>181</td>
</tr>
<tr>
<td>Others</td>
<td>76</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>602</strong></td>
</tr>
</tbody>
</table>

### TABLE 4

**DIFFICULT TRACHEAL INTUBATIONS AND COMPLICATIONS ENCOUNTERED IN THIS STUDY**

<table>
<thead>
<tr>
<th>Technique</th>
<th>Number</th>
<th>Complications</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracheostomy</td>
<td>63</td>
<td>3</td>
<td>1 possible displaced tube 2 atelectasis without fever</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>62 Bjork and 1 vertical slit tracheostomy in a PRS baby</td>
</tr>
<tr>
<td>Cricothyroidotomy</td>
<td>1</td>
<td>-</td>
<td>Fail to intubate and fail to ventilate</td>
</tr>
<tr>
<td>Stylet- and bougie-assisted intubation</td>
<td>NA</td>
<td>2</td>
<td>1 airways haemorrhage 1 post-thyroidectomy death at day 3</td>
</tr>
<tr>
<td>Retrograde intubation</td>
<td>1</td>
<td>-</td>
<td>Requires expert operator</td>
</tr>
<tr>
<td>Fibre optic intubation</td>
<td>5</td>
<td>-</td>
<td>3 failed and converted to tracheostomy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Requires expert operator</td>
</tr>
<tr>
<td>Awake intubation</td>
<td>2</td>
<td>-</td>
<td>1 converted</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Requires expert operator</td>
</tr>
</tbody>
</table>

PRS = Pierre-Robin Sequence  
NA = data not available
in our series of 602 patients had a rate of 0.2%. The single patient that developed this adverse event did not have anything wrong with the larynx but had some limitation with the mouth opening due to a very large left parotid tumour. The patient was quickly salvaged because the full team was there and a cricothyroidotomy was done and a size 5 ETT inserted. There was always a readiness to do tracheostomy as soon as the anaesthetic colleague suggested it or there was marked trismus. Bjork tracheostomy was used because it provides an easy access for changing tubes without the need for bedside trays for emergency reintubations. It also prevents infection because of the wide stoma facilitating expectoration of mucus. It is also noteworthy that when a healed Bjork tracheostomy is reopened the flap is back flush with the trachea with a slight forward bossing from scarring at the incision site. Re-entry is easy. All skin fistulas had healed very well. Future risk of tracheal stenosis at the tracheostomy site is minimized because of the increased luminal diameter with a Bjork flap. Our practice was to decannulate after day 6 in the ward.

A Bjork-type tracheostomy is best suited to our setting where there is lack of adequate nursing care and frequent shortages of consumables. With ease of care and the low complication rate we have come to advocate its use in every situation where tracheostomy is indicated (Figure 1). Over the study period there was only 1 Pierre-Robin Sequence baby that had failed airway access and had a vertical slit tracheostomy. It is speculative at this stage whether a vertical slit or a flap technique should be used. Animal studies and some reviews (6,7) suggest that a flap tracheostomy is possibly safer in children under 16 years of age.

Our experience is in agreement with the reports of others (5,8), who estimate impossible intubation and ventilation in about 0.5%. It is the practice to immediately institute mask ventilation and consider other intubating options. In our setting we advise strongly to do cricothyroidotomy at the first instance when mask ventilation is not possible or poses difficulty. It is also worth considering that an operation can be postponed to another day, allowing for a planned tracheostomy performed under local anaesthesia when everyone will be better prepared for it. This we believe is not a failure but a wise and prudent clinical decision. It is also difficult to define what would constitute a failed intubation and how many attempts one would say is enough. Our low threshold for tracheostomy under local anaesthesia has been a path that is well worn and therefore we have seen less of failed intubations, particularly with oropharyngeal cancers. However, we have encountered difficulty with some congenital orofacial clefts in intubations but almost always the ETT has been eventually placed under better controlled conditions. It remains for another study perhaps to investigate this problem and offer some explanations.

Our experience with thyroid patients is important to note when reports from other centres are conflicting. Voyagis and Kyriakos (9) and Wakeling et al. (10) suggest that airway difficulty is present whereas Amathieu et al. (11), Bouaggad et al. (12) and Shaha et al. (13) found only marginally increased difficulty. It is well known that a large goitre can apply pressure on the trachea, affect the recurrent laryngeal nerve, erode the wall and soften the tracheal ring cartilage from long-standing pressure. The complication of haemorrhage in Table 4 was due to the use of a metal stylet rather than the gum elastic bougie. The single death in a patient who had undergone total thyroidectomy occurred on day 3 in the ward and may not be related to the bougie-assisted intubation. We maintain that anecdotal experiences do suggest that intubation difficulty can occur in a thyroid case.

Other methods of intubation (fibre optic, retrograde and awake intubation) are seldom employed unless the operator is well versed in their use. Their use can increase the scope of an anaesthetist’s armamentarium, but they are by no means without disadvantages (14), not to mention the patient’s discomfort. We suggest that they be used only by an experienced operator.

A drawback of this paper is that 17 months of records were missing and the anaesthetic and nursing records were unsuitable for use. We also did not apply the WHO Safe Surgery Checklist (15) until 2009, after it had been introduced at PMGH. The lack of standardization of difficult airways is a problem that may affect the interpretation of results in any investigations in this area.

We believe this is the first paper that audits
one unit's results from the perspective of the team effort involving nurses and doctors in a theatre and ICU/HDU setting. The paper has reaffirmed the well-known adage that good outcomes are possible when all concerned work as a team. The identification of the team leader (usually the surgeon) who will have the ultimate right to proceed or abort an operation must be established from the outset. From induction of anaesthesia to the recovery room open dialogue and total commitment are imperative. This has been emphasized by the introduction of the WHO Safe Surgery Checklist (Table 2) – an instrument that has been rigorously validated in a multicentre trial (6,15). It has been found to significantly reduce the morbidity and mortality from surgical operations by as much as 36%.

Figure 2 shows an algorithm reflecting our experience at the Port Moresby General Hospital. It can only work when a surgeon

![Algorithm diagram]

**Figure 2. Failed intubation algorithm based on experience at Port Moresby General Hospital.**

Sp = saturation percentage
FOI = fibre optic intubation
LMA = laryngeal mask airway
LA = local anaesthesia
ETT = endotracheal tube
has the primary responsibility and is ably supported by a good anaesthetist. The flow chart is simple and our own data suggest that it can be used safely. Though based on our own experience it is similar to flow charts recommended by others. We will welcome any suggestions to improve its validity in the country.

ACKNOWLEDGEMENTS

We thank Mr T. Vincent from the Medical Learning Resources Unit at the School of Medicine and Health Sciences, University of Papua New Guinea for his help with Figure 1. We also thank the Interplast Australia teams, comprising anaesthetists, surgeons and nurses, who helped during their visits with some of the patients. We thank the many trainee doctors who rotated through the yellow unit from 1998 to 2009. We acknowledge the input of David Daly, visiting consultant anaesthetist and consultant anaesthetist at the Alfred Hospital, Melbourne, who helped review and revise our paper.

REFERENCES