

Anaesthetic management of difficult intubation in the paediatric population when direct laryngoscopy initially has failed or is not possible: an audit of current practice at a tertiary paediatric hospital

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Key points

This audit explored over a 12 month period what techniques were utilised by a group of experienced Paediatric Anaesthetists in a difficult airway scenario. Despite the availability of newer devices such as videolaryngoscope, fibre-optic intubation was still found to be the most utilised and successful technique.

Abstract

Background

Information regarding rates of difficult airway in the paediatric population is lacking, but available data suggests increased frequency in the young and those with congenital or acquired airway abnormalities. Although newer devices, such as the videolaryngoscope, have been developed, fibre-optic intubation (FOI) probably still remains the gold-standard technique for the management of the difficult paediatric airway.

Objectives

The aim of this audit was to determine what airway management techniques are being utilised in the difficult airway situation, by a group of experienced Consultant Anaesthetists, at a large paediatric centre.

Methods

For a 12 month period, from September 2011 to August 2012, Consultant Anaesthetists at Birmingham Children's Hospital completed a pro-forma for all anaesthetics in which tracheal intubation was difficult. Patient notes were also studied to retrieve all possible data.

Results

60 cases of difficult intubation (DI) were analysed. 90% of cases were predicted DI, and 62% had previously been found to have DI. 58% had a medical condition associated with DI and 60% were aged under six years. FOI was the first choice rescue technique in 70% of cases; 90.6% of nasal FOI and 66.7% of oral FOI were successful. Glidescope (GS) videolaryngoscope and Airtraq techniques had a 77.8% and 44.4% success rate respectively. 12 cases required utilisation of two different rescue techniques, and in one case progression to a third technique was necessary.

Conclusions

No intubation technique was 100% successful. Whilst newer equipment available is useful, FOI probably remains overall the best method in the difficult paediatric airway.

Keywords: paediatric, difficult airway, intubation, fibre-optic, videolaryngoscope.

Background

No single clear definition of what constitutes a difficult airway exists. The American Society of Anaesthesiologists defines it as "the clinical situation in which a conventionally trained anaesthesiologist experiences difficulty with facemask ventilation, tracheal intubation, or both." (1). A difficult tracheal intubation has been defined as a situation when "a normally trained anaesthesiologist needs more than 3 attempts, or more than 10 min for a successful endotracheal intubation." (2). The incidence of the difficult airway in the adult population has been well explored, but information regarding rates in children is less available. The few studies that have looked specifically at difficult intubations in the paediatric population, as defined by a Cormack-Lehane (CL) grade of 3 or 4, have found rates of 0.58-3% (3,4,5). The National Audit Project 4 (NAP 4) included 13 paediatric cases, representing 7% of all reported cases, and 8.3% of anaesthesia related cases (6). Although the numbers were small various points were highlighted; difficult intubation was associated with recognised congenital or acquired abnormalities in 6 cases, and in 9 cases the children were under 4 years of age. Guidelines regarding the management of the difficult adult airway have been produced by The Difficult Airway Society (DAS) for a number of years,(7) and in 2012 The Association of Paediatric Anaesthetists (APA), in conjunction with DAS, produced guidelines for the management of the difficult paediatric airway (8). Fibre-optic intubation has been described as a useful technique in paediatric anaesthesia, (9) and probably remains the most common approach in the difficult airway. Newer devices, such as the videolaryngoscope, have also been used with success in the paediatric difficult airway (10,11,12,13). The aim of this audit was to determine what airway management techniques are being utilised in the difficult airway situation, by a group of experienced Consultant Anaesthetists, at a large paediatric centre.

Methods

Birmingham Children's Hospital (BCH) is a large paediatric hospital offering all major surgical specialty services, and performs 12000-15000 surgical procedures per year; analysis of the database suggests approximately 40-45% will be intubated. For a 12 month period beginning September 2011, Consultant Anaesthetists at BCH completed a pro-forma following all anaesthetics in which tracheal intubation was difficult. The information collected included: patient demographics; airway assessment; anaesthetic technique and airway management strategies employed; and reasons for failure of intubation attempts. For the purposes of this audit a difficult intubation was defined as an unsuccessful attempt at direct laryngoscopy and intubation, causing a change in airway management technique, or a situation where direct laryngoscopy was not attempted i.e. due to limited mouth opening, therefore leading to an alternative airway management strategy. The Rescue 1 Technique was the intubation method used after a difficult intubation was identified, Rescue 2 and 3 techniques being utilised when previous methods were unsuccessful.

Results

There were 61 cases of difficult intubation (DI) reported, of which 1 was excluded due to incomplete documentation. The 60 DI's comprised of 39 different patients, with some having multiple operations within the study period.

Pre-operative

The cases were classified according to age group and the average weight per group was calculated (median, IQR) (see Table 1). 90% of cases required intubation for surgical operations, with 30% undergoing ENT/maxillofacial procedures, and 10% were intubated on the paediatric intensive care unit (PICU). 90% of cases had an anticipated DI, with 62% having a history of previous DI. 57% had a Mallampati assessment performed, with increasing rates in older children. All patients had some form of airway assessment performed. Table 2 summarises the features identified, the most common

being micrognathia (50%) and temporal-mandibular joint (TMJ) ankylosis (21.7%). 58% (n=35) of cases had a medical syndrome known to be associated with difficult airway (DA) management. These 35 cases consisted of 23 different patients, of which 9 had repeated operations during the study period.

Intra-operative

Figure 1 illustrates the induction technique and initial airway management of the 60 cases, and Figure 2 summarises the intubation rescue management.

Tables 3 and 4 give details of the different devices used for Rescue 1 and 2 Techniques, the intubation view obtained, the number of intubation attempts, the rates of successful intubation and the reasons for failure. NB In a number of cases the data collection sheets were not fully completed, therefore some information is missing from the tables.

Figure 1. Diagram illustrating induction techniques used.
 OP = Oropharyngeal airway, NP = Nasopharyngeal airway, LMA = Laryngeal Mask Airway

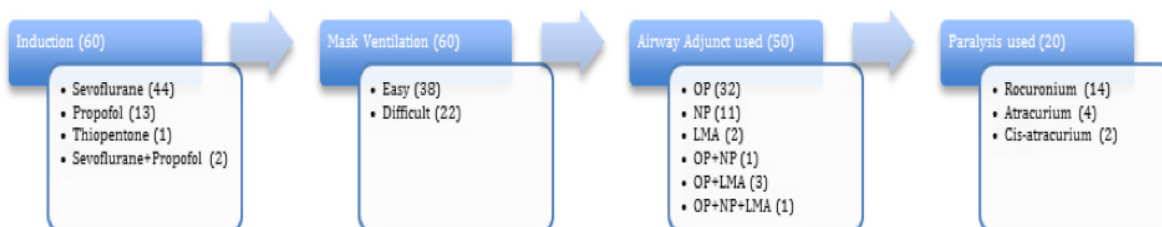


Figure 2. Diagram illustrating the rescue techniques used.
 FOI = Fiberoptic Intubation
 ENT = Ear Nose Throat Surgeon
 RB = Rigid Bronchoscopy

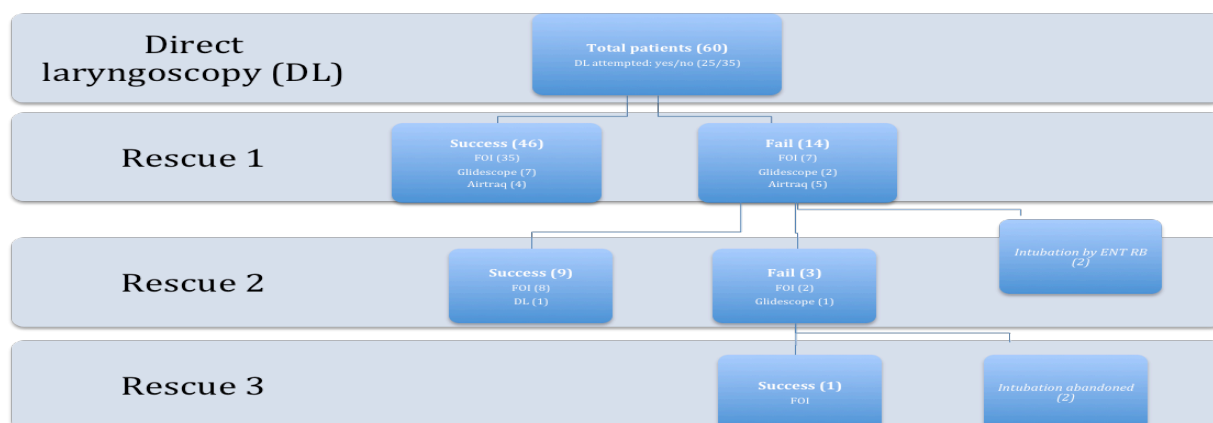


Table 1. A table showing the 60 cases of difficult intubation (DI).

Age	Number of difficult airway cases	Median weight (IQR) (kg)	Number of anticipated DI	Number of previous DI	Cases with Mallampati documented (%)	Mallampati grade 2/3/4 documented
0-4 weeks	4	2.3 (2-2.7)	3	0	25	0/0/1
4 weeks-1 year	9	6 (5-7.7)	6	5	22	1/0/1
2-5 years	23	12 (10-15)	22	16	61	1/1/12
6-14 years	18	25 (24-42.3)	17	11	61	2/3/6
15-17 years	6	61.5 (56.5-62)	6	5	100	1/3/2

Table 2. A table of airway features found during assessment.

Airway features	Number of cases	MP score recorded	MP score 3/4	Previous history of DI
Micrognathia	30	16	15	17
TMJ ankylosis	13	12	12	7
TMJ trismus	4	3	3	4
C-spine pathology	0			
Space-occupying lesions				
Haematoma	1	1	1	1
Lymphatic cyst	1	0	0	0
Tumour mandible	1	1	1	1
Other features				
Macroglossia	1	0	0	1
Microstomia	3	2	1	3
Scarring	5	4	3	3
Short neck	1	0	0	0
Recurrent laryngeal nerve palsy	1	1	1	0

Table 3. A table showing the first advanced intubation technique (Rescue 1) used for all 60 cases.

Intubation view: good = Grade 1/2, poor = Grade 3/4

NB. In one case using Glidescope as the Rescue 1 technique the decision was made to intubate via a rigid bronchoscope following the LTB

1 ST Advanced airway techniques	Number of cases	Intubation View: good/poor	Number of intubation attempts: 1/2/≥3	Number of successful intubations (%)	Percentage success at each intubation attempt 1:2:≥3	Reasons for failure				
						Unable to insert device	Poor view	Blood in airway	Unable to pass ETT	Anterior larynx
Glidescope	9	9/0	3/4/1	7 (77.8)	38:50:12				1	
Airtraq	9	5/2	1/4/0	4 (44.4)	20:80:0	2	2		1	
Oral FOI	9	2/2	4/1/3	6 (66.7)	50:12:38		2		1	
Nasal FOI	32	19/2	23/8/1	29 (90.6)	72:25:3			2		1
FOI via LMA	1	0/1	0/0/1	0 (0)	0:0:0		1			

Table 4. A table showing the second advanced intubation technique (Rescue 2) used for cases with failed Rescue 1 technique
 First Advanced airway technique: Glidescope = G, Airtraq = A, Oral FOI = O, Nasal FOI = N, FOI via LMA = L
 Intubation view: good = Grade 1/2, poor = Grade 3/4
 N* = Rescue 2 nasal FOI technique used a wire and cooks catheter to aid intubation

2nd Advanced airway technique	Number of cases	First Advanced airway technique	Intubation View: good/poor	Number of successful intubations (%)	Percentage success at each intubation attempt 1:2:≥3	Reasons for failure		
						Oesophageal intubation	Blood in airway	Poor view
Glidescope	1	O		0 (0)	0/0/0	1		
Airtraq	0							
Oral FOI	5	A,N,G,L,A	0/2	3 (60%)	33/33/33		1	1
Nasal FOI	3	A,O,N*	1/0	3 (100%)	100/0/0			
FOI via LMA	2	A,O	2/0	2 (100%)	100/0/0			
Direct laryngoscopy	1	N	0/1	1 (100%)	0/100/0			

Rescue 3 One case went onto have a third intubation technique, for which nasal FOI was used and intubation was achieved successfully after 2 attempts. In this case the previous techniques utilised had been Glidescope (Rescue 1) and oral FOI (Rescue 2).

Post operative

Of the 60 cases, 44 were discharged directly to the ward and 12 to PICU; discharge destination was not documented in 4 cases.

Discussion

The 4th National Audit Project (NAP 4) has galvanized anaesthetic departments to look at their airway management. There has been an introduction of new airway devices to help with difficult intubation and guidelines for dealing with difficult airway scenarios are available. This audit provides detailed data of the airway management techniques utilised over a 1 year period by experienced consultant paediatric anaesthetists in a large specialist centre, specifically looking at cases where intubation was initially not possible with direct laryngoscopy. Analysis of the data reveals that the majority of cases (90%) were anticipated, with 62% having previously been reported as a DI and 20% having repeat operations within the study period. 58% of cases had a syndrome known to be associated with a difficult airway and 60% were aged under 6 years. These findings hi-

ghlight that difficult intubation is usually anticipated, occurs in the young, is associated with recognisable features and a significant proportion are likely to return to have subsequent operations.

However, unanticipated difficult intubation did occur. NAP 4 recommended developing more robust predictors of difficult intubation in children. Performing a thorough airway assessment, including Mallampati score, can be difficult in children, especially in the very young. Heinrich et al performed a review of 11, 219 paediatric procedures and found that Mallampati score was documented 66% of cases, with higher rates being seen with increasing age, reaching greater than 80% in the over 6 years group (3). Our data is comparable to this, with 61% documentation of Mallampati score in school aged children and 100% in adolescents. It should be noted that all children had some form of airway assessment documented. A Mallampati score was charted on several infants and one neonate in this series; we are not sure how accurate this was as Mallampati assessment is unlikely to be reliable or consistent in these age groups. In our audit micrognathia was the most common reason cited for predicting a DI, being seen in 50% cases. Although maxillofacial surgery was the specialty associated with the most cases in this series (17%), the numbers were spread across various surgical specialties. Unanticipated difficult intubation does occur, and will not necessarily happen on lists traditionally associated with difficult airways, such as ENT surgery.

Theatre logistics should allow easy access to skilled help and appropriate equipment in anticipation of such an event.

In this audit inhalational induction technique was used in 73% of cases and a pure IV technique in 23%. The reasons that the anaesthetists in our audit opted so frequently for an inhalational technique could be due to a familiarity with the technique, a desire to keep the child breathing spontaneously, and the knowledge that this is traditionally the method of choice for children with the difficult airway (14). This finding is consistent with a Canadian survey of anaesthetists which found that an inhalational technique maintaining spontaneous ventilation was the preferred method for managing the difficult intubation in infants (90%) and younger children (97%) (15).

Mask ventilation was possible in all cases, with the oropharyngeal airway (OPA), followed by the nasopharyngeal airway (NPA), being the most common adjuncts used. The insertion of a laryngeal mask airway (LMA) is one of the strands in the difficult airway guideline when faced with difficult mask ventilation, that it was less frequently used than the NPA in this series may reflect paediatric anaesthetists' familiarity with using the NPA and also the case mix, which included 13 patients with temporal mandibular ankylosis. Trauma to the nasal airway during placement of a NPA is the major disadvantage of this adjunct, as the resultant bleeding may make the intubation more difficult.

The use of neuromuscular blocking agents in the difficult paediatric airway remains a somewhat controversial issue. Although studies have shown that the use of rocuronium during an inhalational induction with sevoflurane significantly reduces the incidence of respiratory complications and increases the rate of acceptable intubating conditions,(16) the decision on their use will depend on the underlying pathology and the expected ease with which face mask ventilation will be performed (17). In this audit rocuronium was the most common agent used; this agent may have been favoured due to its

reversibility with suggamadex. From the data we were unable to analyse whether muscle relaxants improved mask ventilation.

The fiberoptic intubation (FOI) technique has been considered the gold-standard in both the adult and paediatric difficult airway, when intubation via direct laryngoscopy is not possible (14,17). Despite the obvious benefits of the technique, it can be a difficult technique to master and must be frequently performed for skills to be maintained. There are also situations, such as blood and secretions in the airway, which render FOI virtually impossible. In our audit a FOI technique was used as the first advanced airway strategy in 70% of cases (n=42), with nasal FOI (NFOI) being used in 32 cases. FOI may have been the most common technique utilised in part due to familiarity with the procedure, but also due to the case mix of this series, with 13 cases having TMJ ankyolitis, making FOI the most appropriate technique. Of the 32 NFOI 90.6% (n=29) were successful, with 71.9% (n=23) succeeding on the first attempt, these findings are comparable with previous data. One study looking at the use of FOI in the difficult paediatric airway found a first attempt success rate of 80.4% and an overall rate of 95.6% (18). In our audit an oral FOI technique was used as the first choice in 9 cases, however the success rate for this technique was much lower than with NFOI; 66.7% (n=6) successful intubation rate with only 4 cases being successful on the first attempt. Oral intubation using a LMA has been well described (19), and may possibly be a method to improve success with oral intubation. The commonest reason for failure was poor view due to blood and secretions. It is the authors' view that FOI has more success if used early in a difficult intubation scenario when blood and secretions are less likely to have accumulated.

In recent years a number of new devices have been developed to aid in the management of the difficult intubation, these have been broadly classified as "videolaryngoscopes" (VL). VL have been found to improve the laryngeal view obtainable when compared to direct la-

ryngoscopy (14), but this does not necessarily mean that passing the ETT through the cords can be achieved easily (11). The role that VL devices should play in the management of the difficult airway has not yet been clearly defined, and evidence is lacking to support replacing standard direct laryngoscopy with newer techniques in the routine or difficult airway situations (17).

The Glidescope is a VL that consists of a single use laryngoscopy blade, angled at 60°, and a reusable video baton (11, 20); the angulation of the blade meaning that the oral, pharyngeal and tracheal axis do not need to be aligned to achieve successful intubation (11). Published data of its use in children has shown that it improves CL grade obtained when compared to DL (10,11), and that it has been used successfully in known difficult airways (11, 13). The data on whether it increases the time required for intubation is conflicting (10, 21). In our audit GS was used as the Rescue 1 technique in 15% (n=9) of cases, and was the second most successful Rescue 1 technique after nasal FOI (77.8% vs 90.6%), although it did have a reduced success at intubation on the first attempt when compared to nasal FOI (first attempt 33% vs 72% respectively). The increased intubation attempts may be accounted for by the fact that it is a newer piece of equipment meaning users are not as familiar with the technique when compared to the more established FOI. The smaller oropharynx associated with patients with micro/retrognathia may make manoeuvring and placing of the ETT more difficult. This may not be apparent until the first attempt and result in reduced success initially. In keeping with previously published data a good view of the glottis was achieved in 100% of the GS cases, suggesting that it was passing the ETT through the cords that presented the problem, rather than obtaining a view.

Airtraq is a single-use VL device that has an optical blade with a side-channel through which the ETT is passed (17). In this audit it was also used as the Rescue 1 technique in 15% (n=9) of cases, but was found to have a low success rate of 44% (n=4). Again, the poor success

rate may be due to lack of experience with the technique, but it may also be due to the fact that a minimal mouth opening of 12-13mm is required, limiting its usefulness in infants and those with poor mouth opening (20).

In this audit 2 patients were woken up prior to surgery. It is important to continually re-evaluate the situation during a difficult intubation scenario, as it may be that abandoning the anaesthetic and allowing the patient to wake is the safest option, especially in elective cases. This approach is highlighted in all published guidelines. In one case successful intubation with direct laryngoscopy was achieved after initial failure with direct laryngoscopy, followed by failure with FOI. It is important to optimise any attempt at direct laryngoscopy by correctly positioning the child and using an appropriately sized blade; in some situations using the paraglossal approach has resulted in success (22).

NAP 4 suggested that involvement of the ENT team when dealing with difficult airways, especially in young, may be helpful (6). In this audit ENT were involved in two cases where a rigid bronchoscope was used to secure the airway. It is the authors' opinion that access to these techniques is extremely important.

20% of cases involved PICU during their admission. 10% of cases were PICU patients requiring intubation, and a further 10% were admitted to PICU for post-operative care. We were unable to delineate whether this was because of the airway management or as a result of the procedure performed. Nevertheless, this underlines the need for good communication between various specialties and the necessity to develop local guidelines when dealing with potential difficult airway situations, which may arise in the accident and emergency or PICU settings.

Conclusions

The idea behind this audit was to create snapshot of the various methods used in the management of difficult intubation at our hospital. No method was 100% successful. Whilst newer equipment available is useful, FOI

probably remains overall the best method. The majority of the patients were predicted to be difficult; this fortunately allows planning, not only within the anaesthetic team, but also with other teams such as ENT. It is the authors' opinion that this communication is equally as important as any technique chosen.

Disclosure and acknowledgements

Permission to perform this audit was granted by Birmingham Children's Hospital Audit Department.

Conflicts of interest: non declared

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