

COMPLICATIONS OF TRACHEAL INTUBATION IN PEDIATRICS

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ABSTRACT

OBJECTIVE. Describe the frequency and the types of complications of tracheal intubation and its main causes.

METHODS. Cross-sectional study of inpatients in the UTI Pediátrica (Pediatrics Intensive Care Unit) of Santa Casa de Misericórdia, São Paulo, between May/1998 and December/1999, who were submitted to tracheal intubation over 24 hours. The criteria of exclusion included previous intubation, surgeries or traumas in the cervical region or oropharynx.

RESULTS. 147 cases were studied, with ages ranging from one month to 15 years and 3 months. In 31.3% tracheal tubes of improper size were used, and 14.3% needed five or more attempts to be intubated. Intubation was more difficult for resident physicians. The bigger number of attempts of tracheal intubation was related to an increase of traumas, hypoxia, bradycardia, and worsening of Downes' score after extubation. 21.8% of accidental extubation were observed. This rate was related to the worsening of Downes' score and the need of reintubation. Resident physicians also caused a bigger number of traumas and bradycardia.

CONCLUSION. Most of the complications can be attributed to the lack of experience and training of the physician who performed the tracheal intubation; thus, it is important, in order to minimize those incidents, to implement training programs and intensify supervision during tracheal intubation.

KEY WORDS: Intratracheal intubation. Complications. Artificial breathing. Pediatrics.

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INTRODUCTION

Mechanical ventilation is a therapeutic method of great importance in co-treatment of various diseases, but it is subject to complications. Currently it is considered as a mechanical ventilation complication any counter effect resulting from it or from its inability of meeting its objectives.¹

Among mechanical ventilation complications there are those resulting from tracheal intubation (TI). In this study, these complications will be divided, for didactic reasons, into complications occurred during the tracheal tube placement (traumas, hypoxia, bradycardia, cardiac arrest, esophagic intubation, etc.), during mechanical ventilation (selective tracheal tube, tracheal tube obstruction, accidental extubation, etc.) or after extubation (dysphonia, post-extubation laryngitis, need for reintubation, etc.).

In Pediatrics the more frequently studied lesions occurred during placement of tracheal tube are dental traumas, with an incidence ranging from one case in 150 intubations to one in 2805 intubations,^{2,3} and arrhythmias, that range from 32% to 68%.^{4,5} During mechanical ventilation the more frequently described complication is accidental extubation, that occurs in 1% to 16% of the cases, and selective tracheal tube, with an incidence of 4% to 9.6%.^{2,5-18}

More frequent complications after extubation in Pediatrics are dysphonia and laryngeal edema. Dysphonia may vary from 1 to 80% and in adults, it is more common in females and in patients intubated with large tracheal tube (TT), but these data are not confirmed in pediatric patients.^{2,5,6,19-25}

Incidence of laryngeal edema in pediatric age group may vary from 1% to 47%. It is more common in infants, due to the smaller diameter of the airways, to the relatively smaller diameter of cricoid cartilage in relation to the rest of the airways and the presence of a more fragile epithelium. Subglottic region usually presents more sever edemas due to the fragile respiratory epithelium, more liable to traumas and edemas, and the presence of cricoid cartilage, that permits the expansion of the edema only to the interior of the glottal lumen.^{2,6,26-28}

Taking into consideration the importance of the study of tracheal intubation complications and the inexistence of a similar study in our healthcare service, we proposed the undertaking of this work, mainly aiming at describing the frequency and the types of these complications and having as secondary objectives identifying its main causes and to propose measures to minimize them.

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METHODS

Cross-sectional study with data collection based on the bulletins of the inpatients at the UTI Pediátrica of Irmandade da Santa Casa de Misericórdia, São Paulo (ICSMSP), between May, 1998, and December, 1999, who were submitted to TI. To guarantee a higher reliability, data were revised with people involved in tracheal intubation and in the case's follow up. This study was approved by the Ethic Committee of this institution.

Intubations occurred in the emergency room at the children's section or at the Pediatrics UTI (Intensive Care Unit) of the ICSMSP and in hospitals affiliated to this institution. At the time, the tracheal intubation protocol included sedation without curarization of the patients, and all the intubations were oro-tracheal. PVC tracheal tubes were used and in none of the cases the ballonnet was blown.

As inclusion criterion all the patients submitted to mechanical ventilation for over 24 hours were accepted. As exclusion criterion, besides the already informed time, it was mandatory that the patient had not been previously submitted to TI and had not undergone surgeries or traumas in the cervical region or the oropharynx.

The variables were analyzed both individually and as a whole, in an attempt to demonstrate the existence of some association between them. The Chi-square test or the Fisher's Exact Test were used, according to the case's demands, and the limit of significance was 5% ($p < 0.05$).

The adequacy of the tracheal tube's size to the age of the patient and the consequences of using an improper tube were also assessed. To this assessment the formula $\text{age}/4 + 4$ was used for infants over two years old, and for infants from zero to six months TT 3.5, from six to 12 months TT 3.5-4.0 and for infants from one to two years TT 4.0-4.5.²⁹⁻³³

Criteria for complications' diagnosis:

Tracheal intubation immediate complications:

A- Difficult tracheal intubation: considering the number of attempts needed for the TI. The authors proposed the following division: one attempt – easy TI; two to four attempts – medium difficulty; and over five attempts – difficult TI.

B- Traumas: the authors considered as trauma only the cases of teeth breaking or avulsion or important cut-contusion injury in the lips, tongue, gingiva, palate, or esophagus.

C- Hypoxia: the authors considered as hypoxia cases with a decrease equal to or over 20 percentual points in the pulse oxymeter or signs of worsening of cyanosis in the non-monitored cases.

D- Bradycardia: the authors considered bradycardia cases with a decrease equal to or over 30 beats per minute.

E- Cardiac arrest: the authors considered as cardiac arrest cases in which it occurred during the IT.

F- Esophageic intubation: only the cases in which the physical exam was not sufficient to detect that the tracheal tube was not placed in the trachea, resulting in the need of other exams for the diagnosis.

Intercurrences during mechanical ventilation:

A- Selective tracheal tube: diagnosed through torax radiography.

B- Tracheal tube obstruction: diagnosed through the presence

of obstruction in a tracheal tube that was changed due to sudden worsening of lung ventilation.

C- Accidental extubation: the authors considered as accidental extubation the cases in which extubation did not occur following medical order, even if the patient did not need a new TI.

Complications after tracheal extubation

A- Post-extubation laryngitis (PEL): in this study Downes' score will be used for upper airway obstruction,³⁴ to classify laryngitis according to its severity.

B- Need for reintubation: the cases in which it was due to post-extubation laryngitis were considered.

RESULTS

147 cases were assessed, 81 (55.1%) male, 66 (44.9%) female. Age ranged from one month to 15.3 months, with an average of 37.3 months, standard deviation of 48.4 months and median of 10 months.

The indications to mechanical ventilation were: lung infections (52.4%), surgeries (21.8%), traumas (7.5%), apnea (4%), and others (14.3%).

Because the study was set at a school hospital, most of the cases (64.6%) were intubated by resident physicians, 27.2% by attendant physicians, and 8.2% arrived at our service already intubated.

From the 147 patients that were studied, 46 (31.3%) were intubated with TT with improper size according to the age, and in 27 (18.4%) cannulas bigger than indicated were used, and in 19 (12.9%) smaller TTs were used. In the cases of malpractice, usage of big TT was dominant in patients up to two years old, and of small TT in patients over two years old.

Immediate complications of tracheal intubation

Of the 147 cases studied, only 45 (30.6%) were intubated in the first attempt, and in 21 cases (14.3%) five or more attempts were necessary. There was no statistically significant difference in difficulty of TI related to the age of the patient, but there was a greater difficulty of intubation for the resident physicians (Table 1).

During the TI performing, 17 patients (11.6%) presented some kind of trauma. Out of these, we observed 13 cases (8.8%) with dental traumas, 6 cases (4.1%) with gingiva injuries, 3 cases (2%) with lips injuries, and 1 case (0.7%) had an injury in the tongue). The sum bigger than 17 is due to the fact that in various cases there was more than one injury in the same patient. There was no statistical difference when we analyzed the number of traumas related to the doctor who tried to perform the TI (Table 2), but there was an association with the number of attempts of TI (Table 1) and with the age of the patient (Table 3).

In this study we found a direct relation between the number of attempts of TI and the occurrence of hypoxia and bradycardia (Table 1). There was also a greater incidence of hypoxia and bradycardia when the TI was performed by resident physicians (Table 2) and there was a relation between the patient's age and the occurrence of bradycardia (Table 3). The occurrence of hypoxia during TI was related to the occurrence of bradycardia and cardiac arrest.

In only one case esophageic bradycardia not readily diagnosed

Table 1 - Relation between the number of attempts of tracheal intubation with complications resulting from it

NUMBER OF ATTEMPTS		1	2 to 4	≥ 5	TOTAL	P
WHO TRIED TO INTUBATE	Resident physician	11/95 (11.6%)	66/95 (69.4%)	18/95 (19.0%)	95/147 (64.6%)	0.000
	Attendant physician	34/40 (85.0%)	6/40 (15%)	0	40/147 (27.2%)	
	Physician from other hospital	0	9/12 (75%)	3/12 (25%)	12/147 (8.2%)	
TRAUMA		1 /45 (2.2%)	10 /81 (12.3%)	6 /21 (28.6%)	17/147 (11.6%)	0.007
HYPOXIA		1 /45 (2.2%)	33 /81 (40.7%)	19/21 (90.5%)	53/147 (36.1%)	0.001
BRADYCARDIA		0	10 /81 (12.3%)	9 /21 (42.9%)	19/147 (12.9%)	0.001
DOWNES 0 to 3 4 to 6 ≥ 7		20 /43 (46.5%)	21 /43 (48.8%)	2 /43 (4.7%)	43/134 (32.1%) ¹	0.001
		16 /54 (29.6%)	33 /54 (61.1%)	5 /54 (9.3%)	54/134 (40.3%) ¹	
		8 /34 (21.6%)	20 /37 (54.1%)	9 /37 (24.3%)	37/134 (27.6%) ¹	

Considered significant $p < 0.05$

1st= a total of 134 cases, because there were 13 deaths.

Table 2 – Relation between who tried to intubate and trauma, hypoxia, and bradycardia

Who Tried To Intubate	Resident Physician	Attendant Physician	p
Trauma	13/95 (13.7%)	3/40 (7.5%)	0.393
Hypoxia	43 /95 (45.3%)	3/40 (7.5%)	0.01
Bradycardia	14 /95 (14.7%)	1/40 (2.5%)	0.04

considered significant $p < 0.05$

Table 3. Relation between the patient's age and tracheal intubation complications

Age	< 2 Years	≥ 2 years	p
Trauma	4/90 (4.4%)	13/57 (22.8%)	0.001
Bradycardia	19/90 (21.1%)	3/57 (5.3%)	0.041
Selective	28/90 (31.1%)	4/57 (7.0%)	0.001
Tracheal Tube	6/90 (6.7%)	9/57 (15.8%)	0.162
Tracheal Obstruction	23/90 (25.6%)	16/57 (28.1%)	1.00
Accidental Extubation	37/90 (41.1%)		0.109
Hypoxia			

considered significant $p < 0.05$

by the physical exam occurred. The diagnosis was done by broncoscopy, performed soon after the TI.

Intercurrences during Mechanical Ventilation

In 32 patients (21.8%), at a certain moment the diagnosis showed that the TT was located in the bronchus, always in the right bronchus, with radiological verification. Selective tracheal tube was significantly more frequent in patients younger than two years (Table 3).

We observed 10 patients (6.8%) with tracheal tube obstruction, but, contrarily to what occurred with selective tracheal tube, there was no statistical difference related to the age of the patient (Table 3). Thirty-two patients (21.8%) suffered accidental extubation in one or more opportunities, and there was no relation with the patient's age (Table 3).

Complications after tracheal extubation

As there were 13 deaths during mechanical ventilation, 134 patients were extubated, 37 of whom (27.6%) had 7 in the Downes' score.³ In 32 patients (23.9%), there was the need of reintubation due to post-extubation laryngitis, and in five patients (3.4%) the need of tracheostomy. There was no significant difference between the age groups in relation to Downes' score. There was a relation between the improper use of big TT to the age and Downes' score ≥ 7 , but no relation of this with the need for reintubation was demonstrated.

Table 1 shows that there was a relation between the bigger number of attempts of TI and the worsening of the Downes' score. There was also a relation between the occurrence of accidental extubation and a worsening of Downes' score and the need for reintubation.

Only five patients needed tracheostomy during the study, which makes statistical analysis difficult. Even so, it is important to highlight that all patients had suffered accidental extubation during mechanical ventilation.

It was not possible to demonstrate a relation between the

length of time of the mechanical ventilation and the need of reintubation.

DISCUSSION

The lack of proper training is pointed as the main factor causing the complications during tracheal intubation.^{5,6,35-37} Other factors pointed as relevant are the lack of all the material necessary for the procedures, inadequate sedation and analgesia, the lack of pre-oxygenation and ventilation to the patient, traumatic tracheal intubation, and/or various attempts to perform it, incorrect positioning of head and neck, choice of a tracheal tube of improper size, tubes made of improper material.^{6, 25, 35, 37-41}

Because this study was conducted in a school hospital, most of the tracheal intubations were performed by resident physicians, who provoked a bigger number of complications, with more attempts of intubation, bradycardia, and hypoxia.

The bigger number of attempts of intubations was seen as decisive in the occurrence of traumas, hypoxia, bradycardia, and worsening of Downes' score after extubation.

Bradycardia during tracheal intubation may be caused by hypoxia, medication used for sedation and analgesia, and by the laryngeal-vagal reflex, more frequent in infants younger than two years old.^{4, 6, 37, 42} In this study bradycardia was associated with the number of attempts of tracheal intubation, the age of the patient (bigger incidence in younger than two years), and hypoxia during tracheal intubation.

Selective tracheal tube may provoke hypoventilation and atelectasis in one lung and hyperdistension with an increase of the risk of barotrauma in the other.^{5,7,9,10} It is important to perform a torax radiography after tracheal intubation, because the physical exam may not detect the tracheal tube's selectivity.⁹ The index of 20% of selective tracheal tube found in this paper demonstrates the difficulty of diagnosis based solely on a physical exam.

In relation to tracheal tube obstruction, the index was low, and, contrarily to what happened with the cases of tracheal tube selectivity, the incidence was not bigger in kids younger than two years, as could be expected, due to the smaller internal diameter of the tracheal tube.

We observed that more than 20% of the patients suffered one or more tracheal extubations during mechanical ventilation, which is a bigger index than the one found in literature, and that there was no relation with the age of the patient.^{5,7,11-14,16-18} Accidental extubation may lead to the occurrence of hypoxia and the need of a new tracheal intubation. Other consequence is seen after the extubation, when these patients present a worse Downes' score and a bigger need of reintubation due to post-extubation laryngitis. We can observe also that all the cases that needed tracheostomy suffered at least one accidental extubation, characterizing even more the need of controlling this complication.

Most of the accidental extubations occur because of the patient's direct action. Other factors involved are the improper fixation of the tracheal tube, inadequate maneuvering during procedures, and the weight of the mechanical ventilation device's circuit.^{5, 7, 11-14, 16- 18}

In relation to the complications after extubation, the main factors considered are traumatic tracheal intubation, accidental extubation, tracheal extubation length of time, tracheal tube's

size, tracheal tube traction and friction, and balloon's pressure.^{5,6, 19,22,25,39,41} The results of this study showed an association between complications after extubation and a bigger number of attempts of intubation (Table 1), but it was not possible to demonstrate the relation between these complications and the length of the mechanical ventilation.

The doctor's experience appeared as one of the main factors in the genesis of almost all the complications seen in this study (with the exception of accidental extubation and tracheal tube obstruction), and to avoid them it is fundamental to search for means to improve these doctors' training. It would be best if the training was conducted by a specialized team, in appropriate dummies, and the physician should begin to perform tracheal intubation in the patients after being well trained. This method is also advocated by some authors, who highlight that, despite this training with dummies being essential, subsequent training in patients is fundamental for the doctor to acquire adequate skills to perform a well done intubation.^{20,40,43, 44}

Other important factor is the need for a more intense inspection by the assistants involved in tracheal intubation, checking if all the material needed has been previously prepared, if the tracheal tube of choice is the most adequate for the patient, directing the resident physician in relation to the adequate sedation and the use of prophylactic medication (atropine, lidocaine, etc.) and avoiding wrong TI techniques.

After this study, there were changes in the resident physicians' training related to tracheal intubation, and an intubation's rapid-sequence protocol at the pediatrics UTI was instituted. Subsequent studies will be able to demonstrate if those changes were effective.

CONCLUSION

Complications associated to TI were generally more frequent than the ones described in literature. Most of these complications can be attributed to the lack of experience of the physician who performed the tracheal intubation, being necessary, to minimize them, to implement training programs and to intensify supervision of resident physicians during the TI procedures.

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