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A survey of acute complications associated with endotracheal intubation

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ONE of the most common complaints after endotracheal intubation for surgical anesthesia is the sore throat in the immediately postoperative period. Often soreness continues, but with lessening severity, for from 24 to 48 hours. The symptoms complained of seldom require other than palliative treatment, and they are not accompanied or followed by permanent disability. In a rare instance, a fibrous adenoma may appear on the vocal cords, but the possibility of this complication is no contraindication to endotracheal intubation whenever it is appropriate for the anesthetic and surgical procedures contemplated.

This survey was made in order to review our experience with the postoperative adverse effects of endotracheal intubation, including sore throat, rhinitis, laryngitis, and tracheitis, and to discover, if possible, the causes. Examination of the patients revealed that lesions ranged from allergic manifestations to frank chemical irritations. The analysis included study of the process of sterilizing anesthetic equipment, as well as of the technic of conducting the anesthesia.

METHOD OF STUDY

Four hundred nine patients (92 of whom were not intubated) were studied in the Recovery Room and in the Surgical Constant Care units of the Cleveland Clinic Hospital. A questionnaire (*Fig. 1*) was completed on each patient in the study. Whenever possible, the information given voluntarily by the patient was used; but when no information was volunteered, then a standard series of questions was asked to complete the questionnaire before the patient left the units. The study was designed to include the remainder of the day of operation or only the 24-hour period postopera-

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Questionnaire Form

ANESTHESIA

Date_____Name_____Clinic No._____Age___Sex___
Operation_____Surgeon_____Position of patient_____
Ventilation: Spontaneous Assist Control Circle Semiopen
Endotracheal intubation:
Type___Size___ Cuffed Yes__No__ Inflated Yes__No__
Difficult Yes__No__ No. of Attempts 1 2 3 Dr. called Yes__No__
Nasotracheal_____ Orotracheal_____ Bite block Yes__No__
Lubrication Yes__No__ Type of lubricant_____
Local anesthetic Spray Yes__No__Other (name)_____
Pharyngeal:
Airway
Oropharyngeal Yes__No__Type_____Size_____
Nasopharyngeal_____ Yes__No__ Type_____Size_____
Pharyngeal suction 1 2 3 More Catheter Metal
Nasogastric tube: Levin___Salem___Other_____ Difficult Yes__No__
Main inhalation agent used: Halo___Cyclo___Penthrane___Ether___Other_____
Analgesics (amount): Demerol___Numorphan___Morphine___Other_____

RECOVERY ROOM

Patient complaint: Voluntary Yes__No__ Specify_____ Severity 1 2 3
Direct question (1) Any problem with speech? Yes__No__
(2) Any problem with swallowing? Yes__No__
Duration intubation: (Induction-Extubation)_____ Orotracheal Nasotracheal
Endo Tube: Type___Size___ Cuffed Yes__No__ Inflated Yes__No__
Ventilation: Spontaneous Assist Control Ventilator (name)_____
Nasal O_2 supplement Yes__No__ Endo O_2 supplement Yes__No__
Airway: Oropharyngeal Size___Type___Nasopharyngeal Size___Type___
Nasogastric tube: Yes__No__ Levin___ Salem___ Other___ Difficult Yes__No__
Pharyngeal suction: Yes__No__ 1__2__3__ More___
Analgesics-Systemic: Yes__No__ -Local pharyngeal Yes__No__

Fig. 1. Questionnaire that was used for 409 patients in the survey study of acute complications associated with endotracheal intubation.

tively. Since the aim of the study was to correlate the incidence of immediate, acute complications with events, surgical and anesthetic, on the day of operation, it was necessary to exclude patients with whom communication was difficult or not possible; for example, when intubation was prolonged, when tracheostomy was performed, when neurosurgical procedures precluded consciousness, and in children less than 2½ years of age. Also excluded from the study were those patients in whom a surgical problem caused a return to the operating room before extubation could be performed.

No attempt was made to correlate any of the complications with a specific surgeon or type of surgery, except insofar as specific positions of the patients during anesthesia were more commonly used by some surgeons than by others. An attempt was made to relate duration of intubation, both

during anesthesia and postoperatively, to the incidence of complications. Initial difficulty with intubation, the route of intubation, a correlation with a specific lubricant or the absence of lubricant, the use of local anesthetic or lack of it were all taken into consideration. Association with various types of pharyngeal airway, nasogastric tubes, and the frequency of pharyngeal suction were also investigated. The doses of analgesics given and the inhalation agents used were also noted. The size of the endotracheal tube and the material of which it was constructed were also correlated with the incidence of complications.

Those patients who volunteered information without being questioned directly were considered both as part of the total number studied and as a separate group for more intensive study. Patients questioned directly were asked: "Do you have any problem with your speech?" and "Do you have any problem with swallowing?" When there was a positive response to either of these questions, then the patient was asked to specify in particular the nature of his problem. When a complaint was volunteered, it was usually an obvious one, but when there was doubt, the patient was asked to define his complaint. No other questions were asked in regard to this study. All additional information was compiled by members of the Department of Anesthesiology, and the nurses in the Recovery and Intensive Care Units from observation and from the completed prepared questionnaires. When a complaint was volunteered it was graded on a scale of three grades: (1) complaint caused only one comment by the patient; (2) complaint was mentioned more than once and inconvenienced the patient; (3) complaint occurred frequently, and obviously caused great pain or inconvenience to the patient.

RESULTS

Four hundred nine patients were studied (*Tables 1, 2, and 3*), including the 92 patients who were not intubated. Of the complaints mentioned, 190 patients had sore throat, 71 had dry mouth or throat, 16 had hoarseness, and one patient had a sore jaw. Of the total number of patients studied, 190 (46.45 percent) complained of sore throat. Forty-seven patients (11.49 percent) volunteered the information, and 143 (34.96 percent) complained of sore throat on direct questioning. Twelve patients (2.93 percent) complained of sore throat without previous intubation. Seventy-one patients (17.36 percent) complained of dry mouth; of these, 56 (13.69 percent) were intubated, and 15 (3.67 percent) were not. Ninety-two (22.49 percent) were intubated and had none of the complaints listed. Sixteen patients (3.91 percent) complained of hoarseness; 14 (3.42 percent) were intubated, and two (0.49 percent) were not. One patient complained of a sore jaw and had been intubated.

Duration of intubation and length of operative time could not be re-

Table 1.—*Data on sore-throat, intubated adult patients (131), complaints on direct questioning*

	Patients, number			Endotracheal tube			Route	
	Total	Men	Women	Size	Cuffed	Not cuffed	Oro-tracheal	Naso-tracheal
	1	1	0	40	1	0	1	0
	4	4	0	38	4	0	4	0
	52	44	8	36	52	0	52	0
	35	13	22	34	35	0	34	1
	31	2	29	32	31	0	30	1
	2	0	2	30	2	0	2	0
	4	2	2	28	4	0	3	1
	1	1	0	26	1	0	1	0
	1	0	1	24	0	1	1	0
Total	131	67	64		130	1	128	3

Table 2.—*Data on no-sore-throat, intubated patients (139); no complaints on direct questioning*

	Patients, number				Endotracheal tube			Route	
	Total	Men	Women	Child	Size	Cuffed	Not cuffed	Oro-tracheal	Naso-tracheal
	1	1	0	0	40	1	0	1	0
	4	3	1	0	38	4	0	4	0
	58	50	8	0	36	54	4	58	0
	43	16	27	0	34	34	9	42	1
	20	1	19	0	32	20	0	20	0
	4	3	1	0	30	4	0	4	0
	5	3	2	0	28	5	0	5	0
	2	0	1	1	26	0	2	2	0
	1	0	1	0	22	0	1	1	0
	1	0	1	0	18	0	1	1	0
Total	139	77	61	1		122	17	138	1

lated either to the incidence of sore throat or to its graded severity (*Table 4*). The mean intubation time was longest in the 'no-sore throat, intubated series.' Repeated attempts at intubation bore no direct relationship either to the incidence or to the severity of symptoms. The maximum number of attempts recorded was three. There were only four nasotracheal intubations in the series, and therefore no valid comparison was possible. Of the 47 patients with voluntary complaint of sore throat (*Table 3*) all tubes used

Table 3.—*Data on sore-throat, intubated adult patients (47); voluntary complaints*

	Patients, number			Endotracheal tube			Route	
	Total	Men	Women	Size	Cuffed	Not cuffed	Oro-tracheal	Naso-tracheal
	1	0	1	40	1	0	1	0
	1	0	1	38	1	0	1	0
	17	17	0	36	17	0	17	0
	17	7	10	34	17	0	17	0
	11	3	8	32	11	0	11	0
	—	—	—		—	–	—	–
Total	47	27	20		47	0	47	0

Table 4.—*Comparison of data: Patients who were treated with endotracheal intubation and those who were not treated with endotracheal intubation*

	Endotracheal intubation, number of patients			No endotracheal intubation, number of patients	
	Voluntary complaint	Answer on direct questioning		Answer on direct questioning	
Item	Sore throat (47)	Sore throat (131)	No sore throat (139)	Sore throat (12)	No sore throat (92)
"Any problem with speech?"	9	20	12	2	5
"Any problem with swallowing?"	31	74	25	5	4
Nasogastric tubes, number in series	8	38	42	1	30
Suction index*	23/47 = 0.49	76/131 = 0.58	90/139 = 0.65	1/12 = 0.083	67/92 = 0.73
Mean intubation time	2 hr 16 min	2 hr 8 min	2 hr 58 min	—	—
Mean duration of anesthesia without intubation	—	—	—	—	2 hr 12 min
Airway:					
Oropharyngeal	9	25	31	7	16
Nasopharyngeal	1	0	0	0	0

* $\frac{\text{Number of times suction recorded}}{\text{Number of patients in each series}}$ = Suction index

were cuffed and inflated. Of the 131 patients in each of whom a sore throat was revealed on questioning (*Table 1*), 130 had cuffed tubes inserted and inflated. Of the 139 patients who were intubated and had no complaint of sore throat (*Table 2*), 17 did not have cuffed tubes. There is perhaps therefore some increased incidence of complaint when a cuffed tube is used. There was no detectable advantage in using a specific lubricant in contrast to another, or to using no lubricant. Local anesthetic agents used to spray the pharynx and larynx and to lubricate endotracheal tubes did not have any effect on the incidence of these symptoms. The presence of a nasogastric tube could not be directly related to the incidence of symptoms or to their severity (*Table 4*). The frequency of oropharyngeal suction showed no direct causal relationship to postoperative throat symptoms.

The greatest suction index

$$\left(\frac{\text{number of times suction recorded}}{\text{number of patients in the series}}\right)$$

was in the no-sore-throat, intubated series of 92 patients (*Table 4*). Analgesics and slowly eliminated inhalation agents such as methoxyfluorane did not alter frequency or severity of symptoms, but delayed their onset. No relationship existed between sizes of endotracheal tubes and the incidence of any of the symptoms, nor was there a relationship between the materials used in the construction of endotracheal tubes and the incidence of symptoms. With reference to the materials of which endotracheal tubes were made, 90.45 percent were plastic. Five patients with grade 3 sore throats had pathologic lesions that were considered at first to be traumatic and which only later were considered to be due to chemical irritation. There may have been other sore throats in regard to which chemical irritation was not recognized as the cause.

An analysis of the three series of intubated patients in regard to positions on the operating table and the nature of surgery disclosed the following facts. There were more intubated patients who complained of sore throat who had undergone operations on the head and the neck than patients who had undergone other procedures (*Table 5*). Movement of the head after intubation was particularly relevant to symptoms, as was the prone position in producing voluntary complaint of sore throat. The incidence of ear, nose, and throat operations was significantly higher in the sore-throat series as compared with the no-sore-throat series (*Table 5*). The incidence of sore throat among patients who underwent vascular procedures in the sore-throat series of 47 cases was also significantly higher than in either of the other two groups. This can be explained by the higher frequency of head and neck arterial diagnostic and definitive surgical procedures in this series. The severity of sore throat could not be directly related to the incidence of sore throat in any particular position on the operating table.

Table 5.—*Correlation of surgical procedure, position, and effect of endotracheal intubation*

	Voluntary complaint, 47 patients, %	Answer on direct questioning	
		131 patients, %	139 patients, %
Operation, and position	Sore throat	Sore throat	No sore throat
Head and neck	48.94	35.11	23.02
Supine	59.95	77.86	69.78
Prone	31.91	9.86	12.23
Sitting	4.25	3.83	5.04
Lateral	4.25	8.40	12.95
Ear, nose, and throat	10.64	9.92	5.76
General (abdominal)	6.26	35.11	33.09
Neurosurgical	21.28	10.69	15.84
Orthopedic	10.64	5.35	2.88
Plastic	10.64	9.92	8.63
Urologic	2.13	4.58	9.35
Thoracic	2.13	6.87	7.20
Vascular	36.18	17.56	17.27

Anesthetic technic. The study proved somewhat disappointing in attempting to pinpoint anesthetic factors as a primary cause for any or all of the complaints. The presence of any foreign body in the mouth or airway is attended by an increased incidence of complications and symptoms. Operations on the head and neck, particularly with movement after intubation, are a potent source of complaint. Operations where the head is rigidly fixed after intubation are attended by lesser complaints of throat irritation. The prone position is another major source of complaint. This is almost certainly the result of fixing endotracheal tubes in the supine position and then rotating the patient without adequate repositioning of the tube. In the five cases of severe chemical irritation, the sore throats were probably due to the method of sterilization of the endotracheal tubes. This process is described in detail.

Gas autoclaving. The process of simple boiling or steam autoclaving of tubes as has been done with rubber materials for many years, had to be discontinued in the sterilization of endotracheal tubes made of the new inert plastic materials. Temperatures attained with boiling or steam autoclaving are too high for some of the plastics, which become so grossly misshapen that they are no longer satisfactory in practice. The tubes either become soft, permitting kinking, or become so rigid as to threaten the larynx or the trachea with trauma either during insertion or while remaining in place.

Our anesthetic equipment used in this study was sterilized in the gas autoclave with ethylene oxide gas. All apparatus was cleansed before sterilization by soaking in water and cleaning with a detergent solution,

or by means of an ultrasonic device with a detergent to "wet" the materials. All articles were then thoroughly dried and packaged in porous containers that permit outward diffusion of residual gas at the completion of autoclaving. Ethylene oxide is toxic, so equipment sterilized by this process must be quarantined for from 24 to 36 hours, to allow all but insignificant quantities of gas to become dissipated. The gas autoclaving causes a surface film of ethylene glycol to be deposited on moist articles. This film can be intensely irritating to human tissues, thus causing 'burns.' A detergent film may well contribute to the production of sore throat. Only certain detergents are suitable for the cleaning before autoclaving of the equipment to be used in the patient's airway.

Plastic endotracheal tubes and plastic airways were taken at random from stocks, and were analyzed for surface film. Each of the specimens was shown to have such a coating of ethylene glycol with or without detergent. This film is almost instantly removable by rinsing in cold water, but the rinsing nullifies the effect of sterilization. Since the analysis of equipment was made, the entire process of gas autoclaving of endotracheal tubes has been changed.

SUMMARY AND CONCLUSION

Four hundred nine patients were studied for periods up to 24 hours after undergoing operation. Three hundred seventeen were intubated and 92 were not; the latter patients were included as a control group to show the incidence of complaints when endotracheal intubation was not performed. One hundred ninety patients complained of sore throat, 12 of whom were not intubated; 71 patients had dry mouth, 56 of whom were intubated and 15 were not; 16 patients were hoarse, 14 of them were intubated and two were not; one patient had a sore jaw and had been intubated.

No causal relationship was found in regard to duration of the operation and intubation or frequency of attempted intubation in difficult circumstances. No value could be shown in the practice of lubrication or use of local anesthetics on the tube or in the larynx. Nasogastric tubes and frequency of pharyngeal suction were not implicated in the ensuing adverse effects. Analgesics and slowly eliminated general anesthetics delayed onset, but did not alter frequency or severity of complaints. Types and sizes of endotracheal tubes bore no direct relationship to frequency of symptoms. Anatomic site of operation and position of the patient on the operating table were clearly involved as a source of complaint of sore throat. Various anesthetic technics showed no differences in relation to the incidences of complaints.

The process employed in sterilizing anesthetic equipment was shown to

be responsible for some chemical irritation and tissue damage; the deposition of a film of detergent and ethylene glycol on the tube surfaces was the cause. The sterilization process has since been modified, and preparations used for cleaning anesthetic equipment have been carefully screened. The progress study now indicates that the incidence of complaints in a similar series of patients is much reduced, and will be the subject of a subsequent report.