THE RISK OF ASPIRATION IN PRESENCE OF CUFFED ENDOTRACHEAL TUBES

S. Mehta

SUMMARY

The risk of aspiration was determined in 90 adult patients undergoing surgery during endotracheal anaesthesia. Twenty ml of contrast medium was instilled on the back of the tongue in patients lying supine on the operating table after obtaining an airtight seal in the trachea by inflating the cuff of the endotracheal tube. In 18 patients contrast medium passed through the larynx and accumulated in the trachea above the inflated cuff and entered the lungs at the end of the operation when the cuff was deflated. This aspiration can be prevented by placement of the cuff just beyond the true vocal cords, or by tilting the operating table 10 degrees head down before deflating the cuff and applying suction through the endotracheal tube.

It is often taken for granted that cuffed endotracheal tubes provide an absolute guarantee against the danger of aspiration of stomach contents and pharyngeal secretions into the lungs. In the past, several workers have carried out radiological investigations to ascertain the incidence of aspiration under a variety of conditions during anaesthesia. Scott (1952) and Love (1953) compared the traditional sitting position for dental extraction under general anaesthesia with the supine position with head-down tilt, with regard to the risk of inhalation of blood and other debris spilled in the mouth during anaesthesia. Contrast medium was injected into the mouth to study the immediate spread of the foreign material in the upper air passages in the event of failure of the dental pack. Taylor and Towey (1971) assessed the competence of the laryngeal-closure reflex in a group of patients under ketamine anaesthesia and found clear evidence of aspiration of opaque material into the lungs on radiological examination.

Mendelson (1945) described two distinct aspiration syndromes. He reproduced both these syndromes in experimental animals and showed that aspiration of liquid stomach contents produced an asthmatic-like syndrome with distinct clinical, radiological and pathological features.

The author was prompted to undertake the present investigation after a patient who had undergone routine cholecystectomy developed a typical Mendelson syndrome in the immediate postoperative period, although aspiration of stomach contents went unrecognized. Soon after extubation the patient developed laboured breathing and cyanosis. Postoperative vomiting was not known to have occurred. It was thought that a possible explanation was silent regurgitation of stomach contents into the pharynx as the stomach was compressed by packs and retractors during the operative procedure, followed by accumulation in the trachea above the inflated cuff of the endotracheal tube. It is possible that in this patient the gastro-oesophageal junction was also rendered incompetent by the presence of a Ryle's tube. It is presumed that at the end of the operation, when the cuff was deflated, the material gravitated into the lungs. It is possible that such a sequence of events could be followed by passage of pharyngeal secretions into the lungs, thus leading to postoperative pulmonary complications.

The object of this study was to determine whether an inflated cuffed endotracheal tube provides protection against the risk of aspiration into the lungs of a radiopaque material placed in the oral cavity during operation.

MATERIAL AND METHODS

Ninety adult patients (53 females and 37 males) ranging in age from 17 to 75 years were studied. The patients were otherwise healthy. The operations included cholecystectomy, vagotomy and pyloroplasty, appendicectomy, herniorrhaphy, multiple ligation of varicose veins, prostatectomy and mastectomy. The mean operating time was 40 min.

Premedication and anaesthesia.

Pethidine 100 mg and atropine 0.6 mg was administered intramuscularly 1 hour before operation. All patients were anaesthetized by the author. In patients undergoing lower abdominal and body surface procedures, anaesthesia was induced with thiopentone followed by suxamethonium, and maintained with nitrous oxide, oxygen and halothane, administered through a Magill system. Anaesthesia in patients undergoing upper abdominal surgery was induced by a similar technique, but muscle relaxation was obtained with pancuronium and the lungs were ventilated with nitrous oxide and oxygen using a Manley ventilator.

Radiological investigation

The nature of the study was explained to each patient, and consent to investigation obtained. A chest radiograph was taken preoperatively. All patients were intubated with a cuffed endotracheal tube of appropriate size. After intubation, the cuff was inflated until an airtight seal in the trachea was obtained; 5–10 min after intubation 20 ml of sodium lothalamate (Gastro-Conray) 60% w/v was instilled on the back of the tongue in patients lying supine on the operating table. A second radiograph was taken using a portable machine after discontinuing anaesthesia, while the patient was still on the operating table. The radiographs were subsequently reviewed by an independent radiologist.

The patients were divided into six groups of fifteen.

Group I. The contrast medium was carefully aspirated from the mouth and the pharynx under direct vision at the end of the operation and before the cuffed endotracheal tube was removed.

Group II. After clearing the pharynx of contrast medium a suction catheter was introduced into the endotracheal tube. Gentle suction was applied, and the catheter, together with the endotracheal tube, was removed.

Group III. In this group a specially designed cuffed endotracheal tube was used which had a suction catheter attached along its convex border, with its tip lying at the level of the proximal end of the cuff (fig. 1). After aspiration of the contrast medium from the pharynx, gentle suction was applied through the catheter so as to aspirate the contrast medium lying in the trachea above the cuff of the endotracheal tube before it was removed.

Group IV. The same technique was used as in Group III except that the suction was also applied through the endotracheal tube before extubation.

Group V. A marker ring was made using indelible black plastic ink at the proximal end of the cuff of the endotracheal tube (fig. 2), so that the cuff could be placed just beyond the true vocal cords. The contrast medium was aspirated from the pharynx under direct vision, before extubation.

Group VI. The operating table was tilted 10 degrees head down before the pharynx was cleared of the contrast medium at the end of the operation. Gentle suction was then applied through the endotracheal tube as in Group II before extubation.

RESULTS

In 18 of 90 patients there was radiographic evidence of inhalation of radiopaque material. In 14 patients the contrast medium was present only in the right lung, and in 3 only in the left. In 1 patient the contrast medium was visible in both lungs (table I). This preponderance of right lung soiling is to be expected because the right main bronchus is wider and more nearly vertical than the left.

<table>
<thead>
<tr>
<th>Site of lung contamination with contrast medium in 18 patients.</th>
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<tbody>
<tr>
<td>Right lung</td>
</tr>
<tr>
<td>Upper lobe</td>
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<tr>
<td>Middle lobe</td>
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<td>Lower lobe</td>
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In 3 patients in whom contrast medium was demonstrated in the right lung, two lobes were involved (figs. 3 and 4). In 1 patient contrast was shown in the left upper and lower lobes, while in another patient contrast medium was present in the lower lobes of both the lungs (fig. 5).

Table II shows sites at which contrast medium was demonstrated in the six groups. Five patients in Group I and 5 in Group II had evidence of opaque material in the lungs. In spite of the effort to aspirate the contrast medium which had accumulated above the cuff of the endotracheal tube, 5 patients in Group III showed evidence of aspiration. Aspiration through the endotracheal tube (Group IV) appeared to reduce the risk of inhalation of contrast medium slightly, evidence of aspiration being found in 3 patients. Placement of the proximal end of the cuff just beyond the true vocal cords (Group V) appeared to eliminate the risk of soiling and evidence of aspiration was not found in any patient. Tilting of the operating table 10 degrees head down (Group VI) also appeared to be effective, because in no patient was any trace of radiopaque material demonstrated in the respiratory tract.

**DISCUSSION**

Although it is true that the tracheobronchial tract can be adequately sealed off by an inflated cuff on the endotracheal tube, so that the risk of aspiration of blood, pus, or pharyngeal secretions during the operation is removed, it is evident that fluid can accumulate in the trachea and larynx above the cuff and can find its way into the lungs at the end of the operation when the cuff is deflated, before extubation. Suction applied by means of a catheter through the endotracheal tube did not provide any protection against such risk of aspiration.

Attempts to aspirate the contrast medium which accumulated above the cuff (figs. 6 and 7) by attaching the tip of the suction catheter at the proximal end of the cuff, leading to the removal of 0.5–1 ml contrast medium failed to remove all the material above the cuff; 5 of 15 patients still showed evidence of contrast medium in the lungs. However, by placing the cuff just beyond the level of the true vocal cords protection against aspiration of contrast medium was achieved in all patients. Tilting of the
TABLE II. Sites of radiographic evidence of lung contamination in various groups each of 15 patients*.

<table>
<thead>
<tr>
<th>Group</th>
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<th>III</th>
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<th>VI</th>
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<tbody>
<tr>
<td>Right lung</td>
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<td></td>
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<tr>
<td>Upper lobe</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Middle lobe</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Lower lobe</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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</tr>
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</table>

| Left lung |     |     |     |     |     |     |
| Upper lobe | 1   | 1   | 1   | 1   | 1   | 1   |
| Lower lobe |     |     |     |     |     |     |

*For details of groups see “Methods”.

Operating table 10 degrees head down also provided equal protection in 15 patients.

It would, therefore, appear that there are two ways to prevent aspiration of stomach contents or pharyngeal secretions which have accumulated above the cuff of the endotracheal tube. Placement of the cuff just beyond the true vocal cords will require withdrawal of the tube after cuff inflation until resistance is met. The second method is the use of 10 degrees head-down tilt and aspiration through the endotracheal tube at the end of the operation before the tube is removed. This method will also prevent aspiration in patients with a tracheostomy tube who need periodic deflation of the cuff to relieve pressure, so as to prevent damage to the tracheal mucosa. Both these methods are simple and can easily be adopted as routine procedures.

The appearance of contrast medium in the lungs does not necessarily imply that both regurgitated stomach contents and pharyngeal secretions are inhaled to the same degree and the present investigation may not give a true incidence of inhalation in prepared patients. On the other hand, although contrast medium was not inhaled in a particular case, it cannot be excluded that mucus and saliva may have been.

Wylie and Churchill-Davidson (1966) point out that apical segments of either of the lower lobes are particularly vulnerable to soiling by inhaled material when the patient lies supine and carry a similar incidence of lung abscess. In this study the right lung was more commonly affected and the lower lobe more than the upper lobe when the patient was lying in the supine position.

The possibility that aspiration of pharyngeal secretions or stomach contents which may seep through the incompetent larynx during anaesthesia in the presence of a cuffed endotracheal tube may be responsible for postoperative pulmonary complications is supported by the findings of the study. It is considered that either placement of the cuff of the endotracheal tube just beyond the true vocal cords or the use of suitable posture at the end of the operation before extubation will substantially minimize the risk.
ACKNOWLEDGEMENTS

I am indebted to Dr. S. K. Ghosh for help with the interpretation of the radiographs. I also wish to thank Mr. A. B. Cassie and Mr. S. H. Limaye, surgeons at the Hartley Hospital, for their continued help and encouragement.

REFERENCES


LE RISQUE D'ASPIRATION EN PRESENCE DE TUBES ENDOTRACHEAUX A MANCHON GONFLABLE

SOMMAIRE

On a déterminé le risque d'aspiration durant l'anesthésie endotrachéale pour intervention chirurgicale chez nonante patients. 20 ml de substance de contraste a été instillé sur l'arrière de langue des patients couchés sur la table d'opération, après avoir étroitement obturé la trachée en gonflant le manchon du tube endotrachéal. La substance de contraste passa chez dix-huit patients à travers le larynx, s'accula dans la trachée audessus du manchon gonflé et penetra dans les poumons à la fin de l'opération, lorsqu'on dégonfla le manchon. Cette aspiration peut être empêchée en plaçant le manchon juste après les vraies cordes vocales ou en inclinant la table d'opération de 10 degrés, tête basse, avant de dégonfler le manchon et en appliquant une succion à travers le tube endotrachéal.

DIE GEFAHR DER ASPIRATION BEI MIT AUFBLASBAREN MANSCHETTEN VERSEHENEN ENDOTRACHEALTUBEN

ZUSAMMENFASSUNG


EL RIESGO DE ASPIRACION EN PRESENCIA DE TUBOS ENDOTRAQUEALES CON MANGUITO

RESUMEN

Fue determinado el riesgo de aspiración en noventa pacientes sometidos a cirugía durante una anestesia endo traqueal. Fueron instilados 20 ml de medio de contraste sobre el dorso de la lengua en pacientes en posición supina sobre la mesa de operaciones después de obtener un cierre hermético en la tráquea mediante insuflación del manguito del tubo endotraqueal. En dieciocho pacientes hubo paso del medio de contraste a través de la laringe que se acumuló en la tráquea por encima del manguito insuflado y penetró en los pulmones al final de la operación cuando fue desinflado el manguito. Esta aspiración puede ser evitada colocando el manguito inmediatamente más allá de las cuerdas vocales o inclinando la mesa de operaciones en 10 grados con la cabeza hacia abajo antes de desinflar el manguito y aplicar succión a través del tubo endo traqueal.

OBSTETRIC ANAESTHETISTS ASSOCIATION

The next meeting of the Association will be held in Sheffield on Friday, October 6, 1972. Details from Dr. A. D. H. Nicholas, Department of Anaesthesia, Sheffield Royal Infirmary, Sheffield, S6 3DA.