SORE THROAT AFTER OPERATION: INFLUENCE OF TRACHEAL INTUBATION, INTRACUFF PRESSURE AND TYPE OF CUFF

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SUMMARY

One hundred and eighty-four patients were studied to elucidate the contribution of intracuff pressure and cuff type to the occurrence of sore throat and hoarseness after operation. The patients were allocated to one of the following groups: A = mask only; B = reusable Rusch tube with intermittent cuff volume adjustment; C = reusable Rüschi tube without cuff volume adjustment; D = disposable Portex Blue Line tube with intermittent cuff volume adjustment; E = disposable Shiley Low Pressure tube with intermittent cuff volume adjustment. Nitrous oxide was a component of anaesthesia in all patients. Moderate or severe symptoms were recorded in 30-33% of the patients in groups C, D and E, contrasting with group B, in which these sequelae were seen in only 10% of patients (P < 0.025). All sequelae occurred less frequently in group A than in any of the other groups (P < 0.025). Women were more likely to develop sore throat after intubation than were men (P < 0.01). A possible relationship between differences in cuff–trachea contact area is postulated.

Complications of long-term tracheal intubation are well known and are often related to reductions in blood-flow in the tracheal mucosa induced by cuff to tracheal wall pressures exceeding 30 mm Hg (Nordin, Lindholm and Wolgast, 1977; Bergstrom, 1978). Short-term intubation with cuffed tubes is followed by sore throat and hoarseness in 24-65% of patients (Loeser et al., 1976; Loeser, Machin et al., 1978a). Recent investigations have demonstrated that low residual volume cuff tubes cause the least occurrence and severity of postoperative sore throat, possible because the cuff–tracheal surface contact area is smallest when these tubes are used (Loeser, Bennett et al., 1980). The present study was undertaken to confirm the above mentioned findings and possibly relate the clinical results to measurements of cuff–contact area in an experimental model.

PATIENTS AND METHODS

Postoperative sore throat was evaluated in 184 adult patients aged 17-75 yr who had undergone abdominal, gynaecological or limb operations. The patients were allocated to one of the following groups: A = mask anaesthesia—no intubation (n = 22); B = intubation with Rusch Red Rubber, intermittent intracuff volume adjustment to “just seal” (n = 40); C = intubation with Rüschi Red Rubber, slight to moderate excess of air in cuffs, no adjustment (n = 42); D = intubation with Portex Blue Line, intermittent intracuff volume adjustment to just seal the airway (n = 40); E = intubation with Shiley Low Pressure, intermittent intracuff volume adjustment to just seal the airway (n = 40).

All patients were in the supine position. Patients who needed a nasogastric tube or oropharyngeal airway, those in whom tracheal intubation required more than one attempt or who coughed after intubation or before extubation, were excluded from the study. In no instances were supplementary operations on head, neck and mouth performed.

The patients were premedicated with either morphine and hyoscine or pethidine and atropine. Anaesthesia was induced with thiopentone 4–6 mg kg⁻¹ after precurarization and administration of a small dose of atropine i.v. Neuromuscular blockade was achieved with suxamethonium 100 mg and the trachea intubated with endotracheal tubes sizes 7.5–9.0 mm according to the anaesthetist’s judgement. The endotracheal tubes were lubricated with a standard jelly without local analgesic. Cuffs were filled with room air.

Anaesthesia was maintained with halothane, or as a balanced procedure, with 67% nitrous oxide in oxygen. Neuromuscular blocking drugs were used if required for the surgical procedure. All patients had a small intradental gauze roll in place throughout the operation. Extubation was accomplished in the

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operating room after necessary clearance of secretions and after the ability to maintain head-lift was secured.

Ventilation was assisted in group A and controlled in groups B–E. Intracuff pressures were measured towards the end of operation with either a high pressure manometer (Siemens Elema) or a low pressure manometer (Portex). Corrections were made for apparatus compressible volume in the high pressure readings.

Intracuff volume was adjusted—each 15 min in groups B, D and E to the point where no leakage was found during the end-inspiratory phase. In group C, a small volume of room air in excess of what was needed to establish a seal was used.

The patients were allowed to drink when awake and when pharyngeal activity was restored. Pethidine was given i.m. after operation when required.

All patients were interviewed 24–30 h after operation by an anaesthetist who was unaware of the group to which the patient belonged. A questionnaire evaluating the frequency and severity of sore throat and placing these complaints relative to others in the period immediately after operative (pain, nausea, vomiting) was used. Patient responses were graded on a 0–3 scale as follows:

0 = no sore nor irritable throat and no evidence of hoarseness;
1 = minimal sore or irritable throat, no hoarseness;
2 = moderate sore throat, slight hoarseness;
3 = severe sore throat, obvious hoarseness.

In addition to the clinical investigation, six 7.5-mm tubes of each variety studied were evaluated in an artificial trachea to determine cuff–tracheal wall surface contact area during cuff inflation. Sections of heavy cardboard tubes of 1.6, 1.8 and 2.0 cm diameter were used as artificial tracheae. The cuffs were inflated until a seal withstanding 20 cm H₂O pressure was established. Enamel aerosol paint was then sprayed into the tubes from each side, outlining the surface contact area. The length of the area was measured and the total area calculated. An additional group of high pressure readings simulating group C patients was established by the use of Rüsch Red Rubber tubes with cuffs inflated to an intracuff pressure approximately 100 cm H₂O in excess of what was needed to establish the seal.

The Chi square test with Yates’ correction was used in comparing the frequency of sore throat. The Mann–Whitney test was used to compare the average score as expression of severity of sore throat. P < 0.05 was regarded as statistically significant.

RESULTS

Duration of operation, sex and age distribution and types of operative procedures were similar in groups B–E. Patients anaesthetized with a mask technique had a shorter duration of operation (82 min v. 115 min). The percentage of men in this group was greater than in the intubation groups (55% v. 28%).

The average score expressing the severity of sore throat was lower in the mask and Rüsch low pressure groups than in groups C–E, although statistically significant differences can only be demonstrated between group A and groups C–E (P < 0.05) (table I). The total frequency of sore throat was significantly less in group A than in any other group (P < 0.025). When this frequency was analysed according to severity it was seen that slight changes (score 1) were least pronounced in group A. The difference between group A and groups B, D and E was statistically significant (P < 0.05), whereas the differences between A and C and between C and B, D, E were insignificant. In comparing the more severe examples of sore throat (scores 2 and 3)
it was seen that groups A and B (mask and Rüsch low pressure) differed from groups C, D and E ($P<0.025$). Women were more likely to develop sore throat or hoarseness after intubation than were men ($63\%$ vs. $39\%$) ($P<0.01$). Of 184 patients investigated, a total of 95 complained of sore throat. However, only five of these patients claimed that their main complaint was sore throat or hoarseness.

Table II indicates that the smallest cuff length found in the experimental design was in the Rüsch low pressure group. The lowest average score in the clinical investigation was found in the corresponding group. The average scores were increased in the other groups corresponding to an increase in experimental cuff length.

### DISCUSSION

It has been shown (Loeser et al., 1976) that the frequency and severity of postoperative sore throat after short-term intubation was significantly greater after the use of low-pressure, high-volume cuffs, than after the use of a mask or of high-pressure, low-volume cuffs. This phenomenon is surprising in as much as low-pressure cuffed endotracheal tubes should cause less tracheal trauma and therefore fewer immediate sequelae. An explanation may be that tracheal tube cuffs produce tracheal–mucosal membrane or ciliary damage in direct relation to the cuff–tracheal wall contact area, which is known to be largest when low-pressure, high-volume cuffs are used (Loeser et al., 1976). Another explanation may be that bulkier and larger low-pressure tubes produce more damage to upper airway structures on intubation or extubation. Furthermore, it has been demonstrated in a histological study that low-pressure, high-volume tube cuffs produce grooves in the mucosa because of wrinkling of the cuffs as it is inflated, unlike the situation after inflation of high-pressure, low-volume cuffs (Loeser, Hodges et al., 1978).

The correlation between tracheal surface contact area and sore throat after operation was stressed in a report demonstrating that the frequency of postoperative sore throat could be decreased significantly by the use of narrow-cuffed endotracheal tubes (Loeser, Bennett et al., 1980).

A study on anatomical conformity led to the conclusion that tubes with standard low residual volume cuffs induced fewer sequelae than did similar cuffed tubes moulded to the pharyngeal contour, possibly because of differences in mucosal contact area throughout the upper airway (Loeser, Machin et al., 1978).

That intubation trauma per se causes postoperative throat symptoms is further demonstrated by the fact that intubation with uncuffed tubes induced sore throat in 40% of patients (Loeser, Stanley et al., 1980). Lubrication of tracheal tubes provides no advantage in terms of reducing sore throat after operation. It was reported that lubrication with 4% lignocaine jelly containing polyethylene and propylene glycols was associated with increased complaints after operation (Loeser, Stanley et al., 1980). However, it had been shown earlier that patients might benefit from lubrication of tracheal tubes with 1% cinchocaine jelly (Winkel and Knudsen, 1971).

The fact that a mask technique is followed by sore throat is usually ascribed to the drying of mucous membranes after ventilation with dry gases and to the use of antisialagogues (Loeser et al., 1976).

The role of cuff to tracheal wall pressure in inducing sore throat is minor. Loeser, Machin and others (1978) were able to demonstrate a high frequency of sore throat after intubation with tracheal tubes with Kamen–Wilkinson foam-filled cuffs. Furthermore,
it was shown that changes in intracuff volume or pressure during anaesthesia were poorly correlated with the occurrence of sore throat, as was intubation time (Loeser et al., 1976).

Nitrous oxide diffuses into cuffs of tracheal tubes, thereby increasing cuff volume and pressure (Stanley, Kawamura and Graves, 1974; Stanley, 1975; Revenås and Lindholm, 1976; Bernhard et al., 1978). In some studies (Loeser et al., 1976; Loeser, Machin et al., 1978) cuffs were filled with air. One might believe that high-volume, low-pressure cuffs would sustain greater volume increases than low-volume, high-pressure cuffs, when filled with air and exposed to nitrous oxide, thereby causing an increased frequency of sore throat. However, it has been demonstrated that changes in cuff volume and pressure are similar in the two groups when intubation time is about 120 min (Stanley, 1975).

The minor role of cuff pressure per se was further reported in a study confirming that the frequency of postoperative sore throat after tracheal intubation with high residual volume, low-pressure cuffs is independent of cuff-filling with a sample of the inspired mixture of gases, room air or saline (Stanley and Loeser, 1979). Although the minor role of pressure seems to be established, it is known that cuff inflation beyond the seal point significantly increases the measured intracuff/lateral wall pressures and thereby possibly the cuff–tracheal contact area too (Wu et al., 1973).

We have confirmed that low-volume, high-pressure cuffs induced sore throat to a lesser extent than did high-volume, low-pressure cuffs, provided that intracuff volumes were maintained at the level of "just-seal" throughout anaesthesia. When intracuff pressure in the low-volume, high-pressure cuffed tubes was high and allowed to increase, this advantage disappeared.

The relative overinflation of cuff in our group C probably increased the cuff–tracheal wall contact area as was observed in the experimental part of the study. However, it is obvious that direct comparison of cuff length in the experimental model with the clinical situation can be questioned, in as much as tracheal compliance differs in the two situations. Many factors are involved in the aetiology of sore throat. To minimize the occurrence of this phenomenon after short-term intubation with cuffed tubes, it seems that the use of low-volume cuffed tubes is preferable, provided that intracuff pressures are kept as low as possible to establish the minimum seal either by serial adjustments or by use of the anaesthetic mixture when inflating the cuff.

REFERENCES


MAL DE GORGE APRES L'INTERVENTION INFLUENCE DE L'INTUBATION TRACHEALE, DE LA PRESSION DANS LE BALLONNET ET DU TYPE DE BALLONNET

RESUME

Nous avons étudié 184 patients pour préciser le rôle de la pression dans le ballonnet et du type de ballonnet dans la survenue d'un mal de gorge et d'une raucité de la voix après une intervention. Les patients ont été classés dans l'un des groupes suivants. A = masque seul; B = sonde de Rüsch réutilisable sans réajustement intermittent du volume du ballonnet; C = sonde de Rüsch réutilisable sans réajustement du volume du ballonnet; D = sonde Portex jetable à filet bleu avec réajustement intermittent du volume du ballonnet; E = sonde de Shiley basse pression jetable avec réajustement intermittent du volume du ballonnet. Le pro-
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toxyde d’azote a été utilisé comme adjuvant de l’anesthésie chez tous les patients. Des symptômes modérés ou sévères ont été rapportés chez 30–33% des patients des groupes C, D et E, alors que dans le groupe B, ces séquelles n’étaient retrouvées que chez 10% des patients (P<0.025). C’est dans le groupe A que les séquelles sont survenues les plus rarement (P<0.025). Les femmes avaient plus de risque de développer un mal de gorge après intubation que les hommes (P<0.01). On évoque l’existence d’une influence possible de différences de surface de contact entre le ballonnet et la trachée.

HALSENTZUNDUNG NACH OPERATION: DER EINFLUSS DER TRACHEALEN INTUBATION, DES DRUCKES IN DER BLOCKERMANSCHETTE UND DER ART DER MANSCHETTE

ZUSAMMENFASSUNG

IRRITACION DE GARGANTA DESPUES DE LA OPERACION QUIRURGICA: INFLUENCIA DE LA INTUBACION TRAQUEAL, DE LA PRESION INTRACOLLARIN Y DEL TIPO DE COLLARIN

SUMARIO
Se estudiaron ciento cuatro pacientes con el fin de elucidar la contribución de la presión intracollarín y del tipo de collarín, a la aparición de irritaciones de garganta y ronquera después de la operación. A los pacientes se les asignó a uno de los siguientes grupos: A: solo máscara; B: tubo Rüsch reutilizable con ajuste intermitente del volumen del collarín; C: tubo Rüsch reutilizable con ajuste del volumen del collarín; D: tubo Portex Blue Line no reutilizable con ajuste del volumen del collarín; E: tubo Shiley no reutilizable y de baja presión con ajuste intermitente del volumen del collarín. El óxido nitroso fue un componente de la anestesia administrada a todos los pacientes. Se registraron síntomas moderados o graves en el 30–33% de los pacientes pertenecientes a los grupos C, D y E; en contraste con los del grupo B en los que estas secuelas sólo se apreciaron en el 10% de los pacientes (P < 0,025). Todas las secuelas aparecieron con menos frecuencia en el grupo A que en ninguno de los otros grupos (P < 0,025). Las mujeres fueron más propensas a desarrollar irritación de garganta después de la intubación de lo que lo fueron los hombres (P < 0,01). Se postula una posible relación entre la diferencia del contacto entre la tráquea y el collarín.