Effects of decreasing endotracheal tube cuff pressures during neck retraction for anterior cervical spine surgery

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Object. The authors’ goal was to determine whether the incidence of postoperative sore throat, hoarseness, and dysphagia associated with anterior spine surgery is reduced by maintaining endotracheal tube cuff pressure (ETCP) at 20 mm Hg during the period of neck retraction.

Methods. Fifty-one patients scheduled for anterior cervical spine surgery were enrolled. After intubation, ETCP was adjusted to 20 mm Hg in all patients. Following placement of neck retractors, ETCP was measured. Patients were randomized to a control (no adjustment) or treatment group (ETCP adjusted to 20 mm Hg). A blinded observer questioned the patients about the presence of sore throat, dysphagia, and hoarseness at 1 hour, 24 hours, and 1 week postoperatively.

No differences between groups at 1 hour postoperatively were demonstrated. At 24 hours, 51% of patients in the treatment group complained of sore throat compared with 74% of control patients (p < 0.05). Sixty-five percent of the women experienced sore throat compared with 35% of the men (p < 0.05). At 24 hours, longer retraction time correlated with development of dysphagia (p < 0.05, r² = 0.61). At 24 hours, hoarseness was present in 65% of women and 20% of men (p < 0.05).

Conclusions. The results of this study suggest the following three predictors of postoperative throat discomfort following anterior cervical spine surgery in which neck retraction is performed: increased ETCP during neck retraction (sore throat), neck retraction time (dysphagia), and female sex (sore throat and hoarseness). The simple maneuver of decreasing ETCP to 20 mm Hg may be helpful in improving patient comfort following anterior cervical spine surgery.

KEY WORDS • cervical spine • endotracheal cuff pressure • sore throat • dysphagia • hoarseness

Inflation of the endotracheal tube cuff aids the proper positioning of the tube in the trachea, and it prevents aspiration of gastric contents. The pressure exerted by the cuff on the tracheal mucosa, however, can cause ischemia if it exceeds capillary pressure, or if there are hypotensive periods. Review of previously published work suggests that ETCP should be kept between 20 and 22 mm Hg to prevent tracheal ischemia.6,8 Similarly, during hypothermic cardiopulmonary bypass, Inada, et al.,3 have observed lowered ETCPs and low rates of tracheal ischemic injury despite periods of relative hypotension. They concluded that the decrease in ETCP during the hypothermic phase of cardiopulmonary bypass may have been protective against mucosal ischemia.

Ischemic changes in tracheal mucosa may manifest as sore throat, hoarseness, and/or dysphagia. After anterior spine surgery requiring neck retraction, the incidence of these complications has been reported to range from 2 to 44%.1,4 Endotracheal cuff pressures have been demonstrated to increase significantly during anterior cervical fusion, from a baseline of 15.2 ± 1.6 to 43.2 ± 5 mm Hg when using Caspar instrumentation.10 In a recent study the authors reported an association between prolonged retraction (207 ± 20 minutes), increased ETCP (> 35 mm Hg), and postoperative complications including sore throat and hoarseness.3 These results suggest that decreasing ETCP during the period of neck retraction may reduce the incidence of postoperative sore throat, hoarseness, and dysphagia after anterior spine surgery.

The purpose of this study was to determine whether the incidence of postoperative sore throat, hoarseness, and dysphagia would be reduced by maintaining the ETCP at 20 mm Hg during neck retraction in anterior cervical spine surgery.

Clinical Material and Methods

After receiving approval from the Human Studies Committee, informed consent was obtained from patients (American Society of Anesthesiologists physical status 1–3) scheduled for anterior cervical spine procedures.
Endotracheal tube cuff pressure and throat discomfort

Demographic Data

Fifty-one patients (22 men and 29 women) were recruited. Twenty-four patients (11 men and 13 women) were randomized to the control group; one patient in the control group was excluded from the study because prolonged postoperative ventilatory support was required. Twenty-seven patients (11 men and 16 women) were randomized to the treatment group.

There were no statistically significant demographic differences between groups in terms of age (53 ± 10 and 51 ± 12 years [control and treatment groups, respectively]), weight (81 ± 15 and 85 ± 18 kg [control and treatment groups, respectively]), or height (168 ± 14 and 164 ± 16 cm [control and treatment groups, respectively]). There were no significant differences in operative disc levels between groups.

Patients were prepared for surgery in the usual manner—that is, with peripheral intravenous cannula, electrocardiographic monitoring, pulse oximetry, and blood pressure cuff. Depending on the spinal pathological entity, the patient was either intubated with a No. 7.5 endotracheal tube by direct laryngoscopy after induction of anesthesia; or fiberoptically after application of topical oral anesthetic with 4% lidocaine followed by induction of general anesthesia. The endotracheal tube cuff was inflated to a pressure of 20 mm Hg measured at end-expiration. Anesthesia was induced with propofol (2 mg/kg), fentanyl (≤ 2 µg/kg), and rocuronium (1 mg/kg). Standardized maintenance anesthetic consisted of 50% O2 in air, desflurane (< 1 minimal alveolar concentration), fentanyl (1 µg/kg/hr), and rocuronium as needed. Surgery proceeded as usual.

Following placement of the retractors, ETCP was measured again, and air was removed from the cuff until the ETCP was 20 mm Hg (treatment group), or no air was removed (control group). The total time of neck retraction was recorded. At the conclusion of neck retraction, the ETCP was returned to 20 mm Hg in patients in the treatment group; no adjustment was necessary in those in the control group. The total amount of air removed and added in the treatment group was recorded.

Patients were blinded to their group assignments. They were questioned about the presence of sore throat, dysphagia, and hoarseness postoperatively at three different time points: 1 hour, 24 hours, and 1 week postoperatively. These questions were asked by a team member blinded to treatment group. Discomfort was graded by the patient on a verbal analog scale of 1 to 10. A score greater than 3 was considered to indicate significant discomfort.

Statistical Analysis

Demographic data, endotracheal tube pressures, and duration of retraction were compared using analysis of variance. Other analyses were conducted using the Fisher exact test (comparison of proportions) and logistic regressions to model outcome (for example, sore throat at 24 hours) as a function of key covariates (for example, sex, operative time in minutes).

Results

Cuff Pressure

Endotracheal tube cuff pressure increased significantly from baseline (20 mm Hg) in both groups after neck retractors were positioned: 32 ± 9 mm Hg (control group, p < 0.05) and 33 ± 10 mm Hg (treatment group, p < 0.05). This increase was not significant between groups (p > 0.05). A mean of 1.1 ± 1.0 ml of air was removed from the cuff to maintain an ETCP of 20 mm Hg in the treatment group. The mean retraction time was 97 ± 51 minutes (control patients) and 133 ± 65 minutes (treatment patients), which was statistically significant between groups (p < 0.05).

Discomfort Data

The raw data at 1-hour, 24-hours, and 1-week after extubation are shown in Table 1. Logistical analysis was performed, and factors included treatment group, effective pressure during retraction, total retraction time, and sex.

Sore Throat. There was no effect of any covariates at 1 hour or 1 week postoperatively. At 24 hours, a lower percentage of patients in the treatment group (17 [74%] of 23) complained of sore throat than in the control group (17 [74%] of 27) (p < 0.05). Female sex (24 [83%] of 29) was associated with a significantly higher rate of sore throat than male sex (seven [35%] of 21) (p < 0.05) independent of treatment group, weight, and height (Table 2).

Dysphagia. There was no effect of any covariates at 1 hour. At 24 hours, longer retraction time correlated with dysphagia (p < 0.05, r² = 0.61) independent of treatment group. At 1 week, the effect of retraction time was no longer present. Female sex (13 [49%] of 29) was associated with a higher percentage of dysphagia at 1 week than male sex (four [18%] of 21) independent of treatment group (p < 0.05).

Hoarseness. There was no effect of any covariates at 1 hour or 1 week postoperatively. At 24 hours, a lower percentage of patients in the treatment group (11 [48%] of 23) had hoarseness than in the control group (13 [57%] of 27) (p < 0.05). Female sex (24 [83%] of 29) was associated with a substantially higher rate of hoarseness than male sex (seven [35%] of 21) (p < 0.05) independent of treatment group, group, weight, and height (Table 2).

### TABLE 1

<table>
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<tr>
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<th>Sore Throat</th>
<th>Dysphagia</th>
<th>Hoarseness</th>
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<td></td>
<td>1 Hr</td>
<td>24 Hrs</td>
<td>1 Wk</td>
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<tr>
<td>control (23 cases)</td>
<td>17 (74)</td>
<td>17 (74)</td>
<td>6 (26)</td>
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<tr>
<td>treatment (27 cases)</td>
<td>18 (67)</td>
<td>14 (51)†</td>
<td>6 (26)</td>
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* Discomfort was rated using a visual analog scale. Score of 3 or greater indicated significant discomfort. Grades of 3 or greater were present in all cases cited in this table.
† Statistically significant compared with control (p < 0.05).
hour or 1 week. At 24 hours, there was a significantly higher incidence of hoarseness in female (19 [65%] of 29) than in male patients (four [20%] of 21) (p < 0.05) independent of treatment group, retraction time, and retraction pressure.

Recurrent Laryngeal Nerve Palsy

None of the patients enrolled in this study suffered recurrent laryngeal nerve palsy.

Discussion

Airway complications related to general anesthesia with endotracheal intubation include sore throat, tracheal edema, or stenosis, and injury to the larynx. In the specific subset of patients undergoing anterior cervical spine surgery, ETCPs have been found to increase during neck retraction. Clinically, Jellish, et al., found that postoperative hoarseness with sore throat was correlated with longer intubation time and higher ETCP during neck retraction. In the present study we describe the effects of prophylactically decreasing the ETCP during the period of neck retraction on postoperative incidence of sore throat, dysphagia, and hoarseness in this same population.

Results at 1 hour postoperatively were difficult to obtain because of the effects of residual anesthetics as well as pain medications. At 24 hours postoperatively in the control group (23 patients) the incidences of dysphagia (48%) and hoarseness (48%) did not differ significantly from those (48 and 30%, respectively) in the treatment group (27 patients). The overall incidence of sore throat in our study was 60%, which is in agreement with the reported rate of 67% by Jellish, et al., and 60% by Sperry, et al., in the same patient populations.

The incidence of sore throat was significantly lower in our treatment than in our control group at 24 hours (51 and 74%, respectively) (p < 0.05). This difference was not related to total duration of neck retraction or sex. Placement of neck retractors increased the ETCP from our standardized baseline of 20 mm Hg to 32 ± 9 mm Hg (control patients) and 33 ± 10 mm Hg (treatment patients). For our treatment group, we chose to lower ETCP to an objective standardized 20 mm Hg rather than using a more subjective “just seal” pressure as reported in previous studies. Sperry, et al., reported a “just seal” pressure of 15.2 ± 1.6 mm Hg, which is relatively lower than our target of 20 mm Hg. Evaluation of our results suggests a role for decreasing ETCP to 20 mm Hg during the period of neck retraction. It has been proposed that decreasing ETCP to this level during neck retraction may help prevent tissue ischemia that manifests as sore throat. Unfortunately, we did not collect any direct visual data regarding the condition of the mucosa after extubation to confirm this theory.

Although retraction time did not have any effect on the incidence of sore throat or hoarseness in our series, it was a significant risk factor for dysphagia at 24 hours independent of the treatment group. This is similar to the findings of Jellish, et al., although they reported the correlation between hoarseness, rather than dysphagia, and retraction time. It is likely that postoperative dysphagia is a result of the neck retraction itself rather than that in conjunction with the effects of the endotracheal tube and its cuff pressure, because lowering cuff pressure did not lower rates of dysphagia in our series. These results suggest that decreasing the period of neck retraction may be helpful in reducing postoperative complaints of dysphagia at 24 hours postoperatively.

Similar to previously reported results, female sex was a risk factor for both sore throat and hoarseness at 24 hours postoperatively independent of treatment group. This type of sex variation has been reported previously. Sore throat and hoarseness are likely due to stretching of the recurrent laryngeal nerve. Suggested reasons for the sex difference are variations between the sexes with regard to relative airway caliber, height, and weight. Women in our study had significantly lower weight and height compared with men (p < 0.05 for both). In the present series, we chose a No. 7.5 endotracheal tube for all patients to standardize treatment. Surprisingly, there were no differences in height or weight between the females who became symptomatic and those who did not. It is possible that the unavoidable subjective aspect of our postoperative survey may have resulted in women rating their discomfort higher than the men. Supporting this hypothesis is evidence by Sheffield, et al., who administered unpleasant cutaneous stimuli to groups of men and women and found that the women rated the stimuli as more unpleasant and more intense than men. This potential bias may be remedied in future studies by using objective measures of ischemia.

Conclusions

Evaluation of our results suggests the following three
predictors of postoperative throat discomfort following anterior cervical spine surgery with neck retraction: increased ETCP during neck retraction (sore throat), neck retraction time (dysphagia), and female sex (sore throat and hoarseness). The cost-benefit ratio of decreasing ETCP to 20 mm Hg is low, and the treatment is logistically simple to perform. This easily-performed maneuver may be helpful in improving patient comfort following anterior cervical spine surgery.

References


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