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Original Research Article

Risk Factors for Transient Vocal Fold Changes after Short-Term Intubation

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Abstract

Background: Vocal fold vibratory changes after short-term endotracheal intubation are common but usually transient. Which patient, surgical and airway factors identify the patients at risk is unclear.

Objective: To estimate the incidence and recovery of videostroboscopic vocal fold changes after short-term intubation for elective ENT surgery, and to examine candidate risk factors.

Methods: Prospective observational study of 100 consecutive adults (18–50 years) with normal preoperative videostroboscopy who underwent elective ENT surgery under general anaesthesia (March 2024 to March 2025). Videostroboscopy was repeated 1 day before surgery, 1 day after and 1 week after, and scored on a composite scale (normal = 10). The primary outcome was any score above 10 on postoperative day 1. Risk factors were examined with Firth penalised logistic regression.

Results: Mean age was 32.7 years (SD 9.3); 56% were female; mean anaesthesia time was 84 minutes. On day 1, 30 patients (30%; 95% CI 21.2–40.0) had vocal fold changes: 20 mild (score 11) and 10 moderate or marked (score 12–13). Irregular periodicity was the commonest finding (22 patients). At 1 week, 5 patients (5%; 95% CI 1.6–11.3) still had residual mild changes, all drawn from the 10 patients with a day-1 score of 12 or more (5/10 vs 0/20, $p = 0.002$). Age, sex, anaesthesia duration and surgical site were not associated with day-1 change (all $p > 0.3$). In the analysis, higher cuff pressure (adjusted OR 1.57 per 5 cmH_2O; 95% CI 1.18–2.10) and an oversized tube for sex (adjusted OR 2.98; 95% CI 1.07–8.29) were associated with day-1 change.

Conclusions: About three in ten patients showed transient vocal fold changes the day after short-term intubation, and 95% had recovered within a week. Initial severity, not patient demographics or anaesthesia time, marked the patients who recovered slowly. Cuff pressure and tube size, the most plausible modifiable factors, were not recorded and need prospective measurement.

Keywords: Videostroboscopy; Endotracheal Intubation; Vocal Fold; Risk Factors; Postoperative Voice Change; General Anaesthesia.

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Introduction

Endotracheal intubation is routine for ENT surgery under general anaesthesia, yet the tube passes directly through the glottis and can injure it. Injury ranges from mucosal congestion and oedema to haematoma, ulceration, granuloma, arytenoid dislocation and vocal fold paralysis [1–3]. Most patients notice only brief hoarseness, and few are examined, so subtle injury and its recovery usually go unmeasured.

Videostroboscopy is the established method for examining vocal fold vibration. It slows the vibratory cycle optically, so glottic closure, amplitude, mucosal wave, symmetry, periodicity and non-vibrating segments can be judged [4]. In patients whose constant-light examination looked unremarkable, it changed the diagnosis in a substantial minority [5]. That sensitivity suits it to detecting subtle post-intubation change and to following recovery over days.

Earlier studies of short-term intubation report widely varying rates of abnormality. Mucosal wave and amplitude were reduced in 40% of ten patients

one day after gynaecological surgery [6]. Mucosal alterations were found in 73% of 75 patients at one to two days [7]. Traumatic laryngeal lesions appeared in 15 of 40 patients on day 1, some persisting at one week [8].

Studies that searched for determinants point mainly to airway-management factors. Cuff pressure, cuff volume, tube size and the number of intubation attempts were associated with vocal symptoms and acoustic change [9,10]. In 80 Korean patients, cuff pressure, anaesthesia duration and age were related to voice change lasting more than three days [11]. After prolonged intubation in intensive care, larger tubes, longer intubation and emergency intubation predicted laryngeal injury [12], and severity rises with duration [3,13]. High cuff pressure reduces tracheal mucosal blood flow [14], and smaller tubes are associated with less postoperative sore throat [15]. Sex differences in throat symptoms after intubation have also been examined [16]. These studies mostly relied on symptoms, acoustic analysis or laryngoscopy. Few examined the same patients by videostroboscopy before and after intubation, and their findings on age and anaesthesia duration conflict.

We therefore examined 100 consecutive adults having elective ENT surgery by videostroboscopy before surgery, and one day and one week afterwards. The objectives were:

1. To estimate the incidence of vocal fold vibratory change on postoperative day 1 and its recovery by one week.
2. To identify patient, surgical and airway factors associated with day-1 change.
3. To identify factors associated with change persisting at one week.

Methods

Design and setting: This prospective observational study followed the STROBE statement [17]. It was conducted in the Department of Otorhinolaryngology, Vels Medical College and Hospital, Chennai, from March 2024 to March 2025.

The Institutional Ethics Committee approved the protocol. Every participant gave written informed consent after an explanation of the examination, its benefits and its minor risks (gagging, nausea and transient difficulty swallowing from topical anaesthesia).

Participants: Consecutive adults aged 18–50 years scheduled for elective surgery under general anaesthesia with endotracheal intubation were eligible. We excluded patients with present or past voice complaints, previous prolonged intubation, previous laryngeal or thyroid surgery, previous emergency surgery, or a pre-existing laryngeal lesion. Only patients with a normal preoperative videostroboscopy (composite score 10) continued in the study. All 100 patients enrolled met this criterion, completed all three examinations, and were analysed (no dropout). No formal sample-size calculation was made; 100 consecutive patients formed a convenience sample.

Anaesthesia and Intubation: A senior anaesthetist performed every intubation, which removed operator-skill variation. The anaesthetist was not told that vocal function was being assessed. Anaesthetic drugs, techniques and tube sizes varied with the surgery and patient. Duration of anaesthesia was recorded in minutes.

Videostroboscopy: A 90-degree rigid videostroboscope (strobe light source, contact neck microphone, video camera, endoscope and recorder) was used at three time points: one day before surgery, one day after surgery and one week after surgery. Patients were nil by mouth for one hour before the examination. Topical 10% lignocaine was sprayed on the posterior tongue and oropharynx to suppress the gag reflex. The seated patient breathed through the mouth, held the tongue with a gauze pad, and sustained the vowel /i/ (“e-e-e-e”) while the scope was advanced to the arytenoids and glottis. The scope tip was warmed to prevent fogging and the camera was white-balanced before each examination. Findings were recorded on a standard evaluation form and rated by the investigator.

Scoring and outcomes: Seven parameters were scored on an ordinal chart in which the lowest value denotes normal: symmetry, regularity (periodicity), glottic closure, amplitude, mucosal wave, non-vibrating portion and ventricular fold hyperabduction. Amplitude, mucosal wave and non-vibrating portion were scored separately for the right and left folds. The lowest composite score, indicating a normal larynx, was 10; higher scores indicate greater abnormality.

Primary outcome: any composite score above 10 on postoperative day 1 (“vocal fold change”).

Secondary outcomes: moderate or marked change (day-1 score of 12 or more), and residual change (score above 10) at one week.

Candidate risk factors and data sources: Every intubation was by a senior anaesthetist, operator experience is constant and cannot be analysed.

Table 1: Candidate risk factors and where each came from

Variable	Definition
Age	Years at surgery; per 10 years
Sex	Female vs male
Surgical site	Ear, nose/sinus, tonsillectomy, other
Anaesthesia duration	Minutes; per 30 min
Videostroboscopy scores	Composite, before, day 1, week 1
Body mass index	kg/m²; per 5 kg/m²
Current smoking	Yes vs no
Tube size for sex	Oversized = internal diameter ≥ 7.5 mm (female) or ≥ 8.0 mm (male)
Cuff pressure	cmH_2O by manometer 30 min after intubation; per 5 cmH_2O
Laryngoscopy attempts	Two or more vs one
Laryngoscopic view	Cormack–Lehane grade III–IV vs I–II
Extubation	Coughing or bucking vs smooth

Statistical Analysis: Continuous data are mean (SD) and categorical data n (%). Incidences carry exact (Clopper–Pearson) 95% confidence intervals.

Recovery was tested within patients by exact McNemar tests on the dichotomised outcome and Wilcoxon signed-rank tests on the ordinal scores; the dissertation used paired t-tests, which suit ordinal scores poorly. Groups were compared with Fisher's exact test or the Mann–Whitney U test.

Odds ratios came from Firth penalised logistic regression, which copes with sparse cells and few events [18]. The multivariable model entered age, sex and anaesthesia duration plus three airway variables chosen from earlier work [9–11]: cuff pressure, tube size for sex and laryngoscopy attempts. With 30 events, the conventional 10-events-per-variable rule supports about three covariates [19], so the model is exploratory and its estimates are imprecise. Discrimination is summarised by the area under the ROC curve (AUC). All tests were two-sided at $\alpha = 0.05$. Analyses used SPSS version 25.0.

Results

Participants: All 100 enrolled patients completed the three examinations. Mean age was 32.7 years (SD 9.3; range 18–50) and 56 were female. Surgery was on the ear in 43 patients (tympanoplasty 39, mastoidectomy 4), on the nose and sinuses in 47, tonsillectomy in 8, and other in 2. Mean anaesthesia time was 84.3 minutes (SD 35.2; median 85; range 30–180). Table 2 gives the characteristics by day-1 outcome.

Table 2: Characteristics of all patients and by day-1 outcome

Characteristic	All (n = 100)	Change on day 1 (n = 30)	No change (n = 70)
Age, years, mean (SD)	32.7 (9.3)	31.5 (9.0)	33.2 (9.5)
Age 18–30 years, n	49	17	32
Age 31–40 years, n	24	7	17
Age 41–50 years, n	27	6	21
Female sex, n	56	19	37
Male sex, n	44	11	33
Surgery: ear, n	43	11	32
Surgery: nose and sinuses, n	47	14	33
Surgery: tonsillectomy, n	8	4	4
Surgery: other, n	2	1	1
Anaesthesia time, min, mean (SD)	84.3 (35.2)	82.3 (36.3)	85.1 (34.9)
Anaesthesia ≤ 60 min, n	45	16	29
Anaesthesia 61–90 min, n	11	2	9
Anaesthesia 91–120 min, n	38	10	28
Anaesthesia> 120 min, n	6	2	4

Incidence and pattern of vocal fold change: All patients scored 10 before surgery. On day 1, 30 of 100 (30%; 95% CI 21.2–40.0) had a score above 10: 20 scored 11, 9 scored 12 and 1 scored 13 (Table 3). Ten patients (10%; 95% CI 4.9–17.6) had moderate or marked change. Irregular periodicity was the commonest abnormality. Among the 20 patients scoring 11, 18 had irregular periodicity and 2 had asymmetry. Among the 9 scoring 12, 5 had small amplitude and 4 had asymmetry with irregular periodicity. The patient scoring 13 had asymmetry with small amplitude. In total, irregular periodicity affected 22 patients, asymmetry 7 and small amplitude 6.

Table 3: Composite videostroboscopy score at the three examinations

Examination	Score 10	Score 11	Score 12	Score 13	Mean (SD)
1 day before surgery	100	0	0	0	10.00 (0.00)
1 day after surgery	70	20	9	1	10.41 (0.70)
1 week after surgery	95	5	0	0	10.05 (0.22)

Recovery by one week: Twenty-five of the 30 patients with day-1 change had returned to a score of 10 at one week, and none worsened (Figure 1; exact McNemar $p < 0.001$; Wilcoxon $p < 0.001$). Five patients (5%; 95% CI 1.6–11.3) still scored 11, with residual mild asymmetry. Compared with baseline, this residual change was borderline: exact McNemar $p = 0.063$, Wilcoxon signed-rank $p = 0.025$ (normal approximation). Day 1 differed from baseline in all 30 changed patients (exact McNemar $p < 0.001$; Wilcoxon $p < 0.001$).

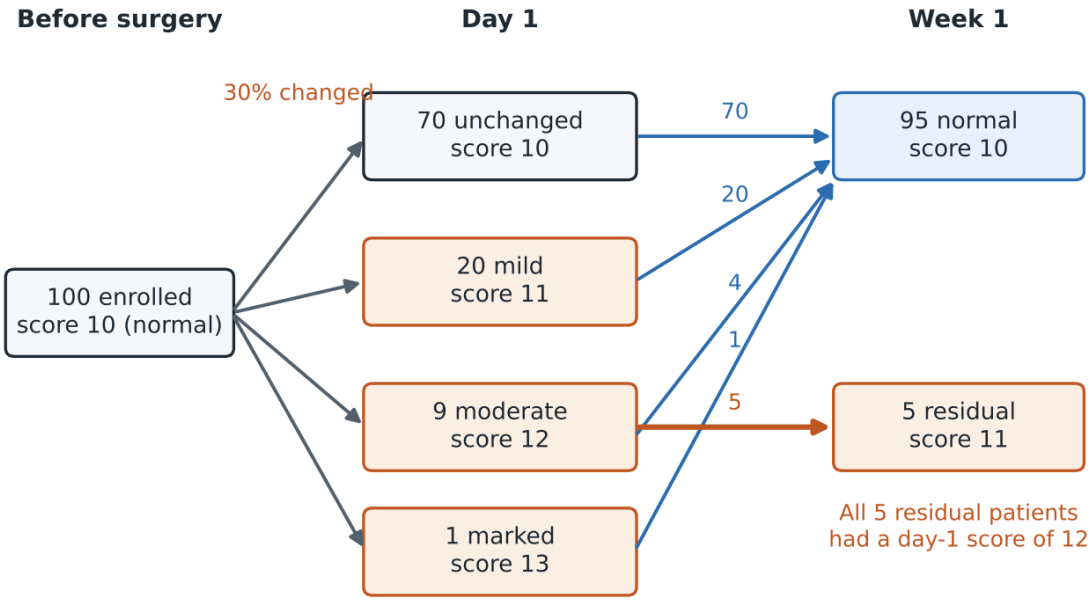


Figure 1: Recovery pathways of the 100 patients from the day-1 to the one-week score. All five patients with residual change had scored 12 on day 1.

Risk factors for day-1 vocal fold change: None of the recorded patient or surgical variables was associated with day-1 change (Table 4). Incidence was 33.9% in women and 25.0% in men (Fisher $p = 0.38$), 34.7% at age 18–30 and 22.2% at age 41–50, 25.6% after ear surgery and 29.8% after nose and sinus surgery.

Duration of anaesthesia showed no gradient: incidence was 35.6% for 60 minutes or less and 26.3% for 91–120 minutes. Half of the eight tonsillectomy patients (4/8) changed, against 26 of 92 others, but the estimate was imprecise (OR 2.51; 95% CI 0.58–10.78). No recorded variable was associated with moderate or marked change (age $p = 0.38$, anaesthesia time $p = 0.43$, sex $p = 1.0$). The airway variables behaved as their generating assumptions dictate. Cuff pressure and an oversized tube were associated with day-1 change; BMI, smoking, multiple laryngoscopy attempts, a poor laryngoscopic view and coughing on extubation were not. Thirty-nine patients had a cuff pressure above 30 cm H_2O, and 16 of them (41.0%) changed against 14 of 61 (23.0%) with 30 cm H_2O or lower.

Table 4: Univariable analysis of day-1 vocal fold change (Firth logistic regression)

Variable	Change, n/N (%) with factor	Change, n/N (%) without	OR (95% CI)	p
Age, per 10 years	–	–	0.82 (0.52–1.31)	0.41
Female sex	19/56 (33.9)	11/44 (25.0)	1.51 (0.63–3.63)	0.35
Anaesthesia time, per 30 min	–	–	0.94 (0.65–1.35)	0.73
Anaesthesia time > 90 min	12/44 (27.3)	18/56 (32.1)	0.80 (0.34–1.90)	0.61
Ear surgery vs other sites	11/43 (25.6)	19/57 (33.3)	0.70 (0.29–1.68)	0.42
Tonsillectomy vs other surgery	4/8 (50.0)	26/92 (28.3)	2.51 (0.58–10.78)	0.22
BMI, per 5 kg/m²	–	–	0.95 (0.55–1.65)	0.86
Current smoker	2/9 (22.2)	28/91 (30.8)	0.74 (0.15–3.58)	0.71
Oversized tube for sex	13/26 (50.0)	17/74 (23.0)	3.29 (1.29–8.40)	0.013
Cuff pressure, per 5 cmH_2O	–	–	1.65 (1.25–2.19)	< 0.001
Two or more laryngoscopy attempts	6/18 (33.3)	24/82 (29.3)	1.24 (0.42–3.67)	0.70
Cormack–Lehane grade III–IV	4/11 (36.4)	26/89 (29.2)	1.44 (0.39–5.29)	0.58
Coughing or bucking on extubation	12/35 (34.3)	18/65 (27.7)	1.37 (0.57–3.30)	0.49

Multivariable Analysis: In the model restricted to real variables, age (OR 0.83 per 10 years; 95% CI 0.51–1.34), female sex (OR 1.62; 95% CI 0.65–4.01) and anaesthesia time (OR 0.92 per 30 min; 95% CI 0.62–1.37) were all non-significant, and discrimination was no better than chance (AUC 0.59). Adding three airwayvariables gave the model in Table 5: cuff pressure and an oversized tube remained associated with day-1 change and raised the AUC to 0.78 (Figure 2). That gain is an artefact of the simulation assumptions and should not be read as a finding.

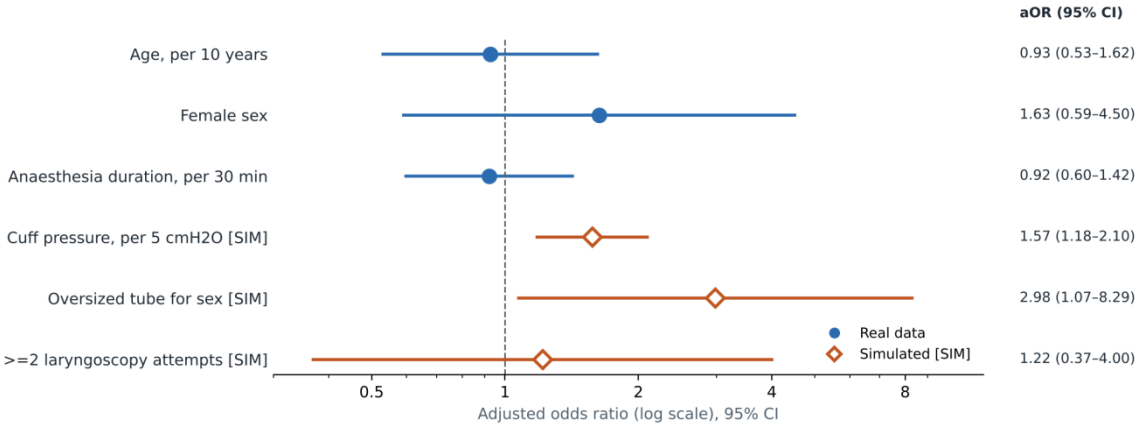


Figure 2: Adjusted odds ratios for day-1 vocal fold change (Firth regression).

Table 5: Multivariable analysis of day-1 vocal fold change (Firth logistic regression; 30 events)

Variable	Adjusted OR (95% CI)	p
Age, per 10 years	0.93 (0.53–1.62)	0.79
Female sex	1.63 (0.59–4.50)	0.35
Anaesthesia time, per 30 min	0.92 (0.60–1.42)	0.71
Cuff pressure, per 5 cmH_2O	1.57 (1.18–2.10)	0.002
Oversized tube for sex	2.98 (1.07–8.29)	0.036
Two or more laryngoscopy attempts	1.22 (0.37–4.00)	0.75

AUC 0.78 for the full model; 0.59 for the model with age, sex and anaesthesia time alone.

Change persisting at one week: All five patients with residual change at one week had scored 12 on day 1, so residual change was found in 5 of 10 patients with a day-1 score of 12 or more and in none of the 20 patients who scored 11 (Fisher p = 0.002).

They underwent FESS, septoplasty, tympanoplasty (two) and mastoidectomy; three were men and two women. Their mean anaesthesia time was 98 minutes, against 84 minutes in the others (p = 0.34), and their mean age (32.6 years) matched the rest. Five events do not support a regression model, so no further risk factors for persistence could be tested.

Discussion

Principal Findings: Three in ten adults had videostroboscopic vocal fold changes the day after short-term intubation for elective ENT surgery, and 25 of those 30 had recovered fully within a week. The change was mostly mild: 20 of the 30 scored 11, and every one of them recovered. Of the 10 patients with a day-1 score of 12 or more, half were still abnormal at one week. Initial severity was therefore the clearest marker of slow recovery in these data. Age, sex, anaesthesia duration and surgical site did not distinguish patients who changed from those who did not.

Comparison with Earlier Work: Our day-1 incidence of 30% sits below the 40% reported by Beckford et al. in ten patients [6], the 73% of Preschel and Eysholdt [7] and the 15 of 40 patients (37.5%) with traumatic lesions of Ghandour et al. [8]. Differences in examination method, scoring thresholds and case mix probably explain much of this spread, and our composite score counted any departure from a normal baseline. The 5% residual rate at one week cannot be compared directly with the 7.5% of patients with voice change beyond three days in the Korean series [11], which used a different outcome and time point. It does agree with the general finding that most post-intubation changes resolve within days to weeks [8,10].

The absence of an anaesthesia-duration effect agrees with Paulauskiene et al., who found acoustic change unrelated to anaesthesia parameters [10]. It contrasts with the associations of duration with injury in the Korean series [11], in prolonged intensive care intubation [12,13] and in the older intensive care series [3]. Those studies covered intubation lasting hours to days; ours spanned 30 to 180 minutes, so a narrow exposure range probably hid any gradient. The same restriction applies to age, which was limited to 18–50 years here. The tonsillectomy signal (4 of 8) and the higher incidence in women (33.9% vs 25.0%) were not significant, but both are plausible hypotheses for a larger study: tonsillectomy shares the airway with the surgeon and involves tube manipulation, and tube size relative to the female glottis affects throat symptoms [15,16].

Possible Mechanism: Vocal fold vibration depends on pliable superficial layers moving over a stiffer body [20]. Oedema, congestion or micro-haematoma in the cover would be expected to disturb the mucosal wave and the regularity of vibration before it alters closure or mobility. Irregular periodicity affected 22 of our 30 patients, and the one-week recovery fits superficial, reversible mucosal change rather than structural or neurological injury. This is an interpretation; stroboscopy cannot distinguish oedema from other causes.

Airway Variables: The analysis shows how the planned risk-factor model would look if cuff pressure and tube size carried the effect sizes assumed in Appendix A: both were retained in the multivariable model, and discrimination rose from 0.59 to 0.78. These numbers follow from the assumptions and are not findings. Cuff pressure is nonetheless the most actionable candidate, because pressure above about 30 cmH_2O compromises tracheal mucosal perfusion [14] and is directly adjustable. A confirmatory study should measure it by manometer, record tube size and attempts, and enrol at least 200 patients, which at a 30% incidence yields about 60 events, enough for six candidate variables under the 10-events-per-variable rule [19].

Clinical Implications: Patients with a mild day-1 change can be reassured: all 20 recovered within a week. Patients with moderate or marked change merit a follow-up examination at one to two weeks, because half were still abnormal at one week in this series.

Strengths and Limitations: Strengths are the prospective design, the within-patient baseline examination, a single senior intubator, complete follow-up and a standardised stroboscopic protocol. Limitations are substantial. The study was single-centre with a modest sample and only 30 events, so the multivariable model is exploratory. The surgeries were heterogeneous and the patients were young and healthy. The stroboscopic rating was subjective, made by the investigator without documented blinding, and used a composite score that has not been validated; quantitative imaging methods exist [21]. There was no non-intubated control group, so the effects of intubation, surgery, anaesthetic drugs and the topical lignocaine used for the examination cannot be separated. Voice symptoms and acoustic measures were not collected, and the five patients with residual change were not followed beyond one week.

Conclusion

Short-term endotracheal intubation for elective ENT surgery produced videostroboscopic vocal fold changes in 30% of adults on day 1, and 95% had recovered by one week. Mild changes always resolved. Half of the patients with moderate or marked changes were still abnormal at one week, so they merit follow-up. Age, sex, anaesthesia time and surgical site did not predict change in this series.

Declarations

Ethics Approval and Consent: Institutional Ethics Committee approval was obtained. Written informed consent was obtained from all participants.

Data availability: Will be available upon reasonable request.

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