The Journal of Laryngology & Otology (2015), ***129***, *996–999*.

doi:10.1017/S0022215115002029

MAIN ARTICLE

Endotracheal tube positioning during neck extension in thyroidectomy

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Abstract

Objective: To evaluate the effect of body mass index and neck length on endotracheal tube movement during neck extension in thyroidectomy.

Methods: A prospective study was conducted of 30 patients undergoing thyroidectomy during an 8-month period. Patient characteristics were recorded and endotracheal tube displacement was determined.

Results: Mean body mass index was 27.8 kg/m^2 (range, 17.5–34.7 kg/m^2) and mean neck circumference was 43.2 cm (range, 28–56 cm). The mean (± standard deviation) upward displacement of the endotracheal tube during neck extension was 7.17 ± 5.87 mm. Patients with a larger body mass index had a significantly greater amount of tube displacement ($R^2 = 0.67$, $p < 0.0001$), as did patients with a smaller neck length ($R^2 = 0.48$, $p < 0.0001$).

Conclusion: Neck extension results in upward displacement of the endotracheal tube. The amount of displacement is significantly higher in patients with a larger body mass index or shorter neck length. This has particular relevance for nerve monitoring in thyroidectomy.

Key words: Thyroidectomy; Recurrent Laryngeal Nerve; Endotracheal Intubation

Introduction

Thyroid surgery is the most commonly performed endocrine operation in the UK. Approximately 8000 operations are performed across the UK every year.[1] One of the most significant complications of thyroidectomy is recurrent laryngeal nerve (RLN) damage, which is associated with potential voice changes. The reported national incidence of RLN damage in 2010–2011 was 1.8 per cent.[1]

The actual incidence of post-thyroidectomy RLN injury is likely to be more than the reported figures, as many patents may have unnoticed voice changes, and many patients do not undergo vocal fold assessment either pre- or post-operatively. The Fourth National Audit Report by the British Association of Endocrine and Thyroid Surgeons states that pre-operative laryngoscopy was performed in 60.9 per cent of cases, whilst post-operative laryngoscopy was performed in less than 20 per cent of cases.[1] Furthermore, the data are very variable and not complete with regards to this complication. Despite this, damage to the RLN remains the most common cause for litigation following thyroid surgery, but the National Health Service Litigation Authority only reported 17 cases of damage to vocal folds as a result of thyroid surgery between 1995 and 2005.[2,3]

Identifying the RLN during thyroid surgery remains a vital step of the operation. Using a nerve monitor during surgery has become a widely accepted practice during thyroidectomy, particularly in revision surgery, and in large goitre or thyroid cancer cases. In addition, intra-operative nerve monitoring acts as a useful educational tool for trainees. The National Institute for Health and Clinical Excellence guidelines state that 'The evidence on intraoperative nerve monitoring (IONM) during thyroid surgery raises no major safety concerns. In terms of efficacy, some surgeons find IONM helpful in performing more complex operations such as reoperative surgery and operations on large thyroid glands. Therefore, it may be used with normal arrangements for consent, audit and clinical governance'.[4]

The senior authors have been using intra-operative nerve monitoring for the past four years. In their experience, the most common reason for intra-operative nerve monitoring failure is tube displacement during patient positioning and neck extension. This can give rise to false signals, which has potential patient safety implications.[3] This study therefore aimed to identify

Presented at the American Academy of Otolaryngology – Head and Neck Surgery Annual Meeting, 21 September 2014, Orlando, Florida, USA.
Accepted for publication 19 March 2015

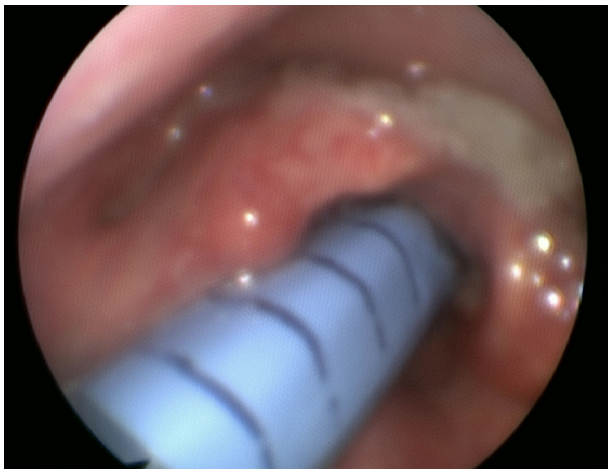

FIG. 1
Position of endotracheal tube (with markings) in neutral position, photographed with flexible endoscope.

the risk factors for endotracheal tube (ETT) displacement during neck extension in thyroidectomy. We have included variables that are well known to correlate with difficult endotracheal intubation, such as Mallampati score (a predictor of intubation difficulty) and thyromental distance, and variables determining body habitus, namely body mass index (BMI) and neck circumference.

Materials and methods

This study was approved by the Barking, Havering and Redbridge University Hospitals NHS Trust Clinical Governance Department.

A prospective study of 30 patients undergoing thyroidectomy between January and August 2014 was performed. Any adult patients (aged over 16 years) undergoing hemithyroidectomy or total thyroidectomy during the study period were included in the study.

Patient demographics, BMI, neck circumference, thyromental distance and Mallampati score were recorded. Anaesthesia was induced intravenously or via inhalation, without complete neuromuscular block. In all cases, endotracheal intubation was performed by the consultant anaesthetist, using a 6.0 or 7.0 mm internal diameter neural integrity monitor electromyogram ETT with 30 mm electrodes (Medtronic, Jacksonville, Florida, USA). Endotracheal tube placement and checks were performed in accordance with the manufacturer's recommendations. At the point of endotracheal intubation, the depth of the tube was set so that the position of the true vocal folds was at the mid-point of the electrode. The cuff was then inflated and the tube was secured in the midline to the maxilla and forehead with 3M™ Transpore tape.

The same technique was used in all patients by the same senior anaesthetist. The tubes were marked at 0.5 cm intervals with permanent marker along the pre-fabricated blue sticker that denotes the position of the electrodes on the ETT (Figure 1). The position of the glottis against the markers on the tube when the neck was in the neutral position was recorded using a fibre-optic endoscope passed transorally, and a photograph was taken (Figure 1). The neck was then extended (as tolerated) using a head ring and shoulder bolster. The fibre-optic endoscope was once again passed transorally and used to photograph the new position of the glottis against the markers on the tube. The difference between the two positions was calculated using the 0.5 cm markers to determine any displacement of the ETT.

Statistical analysis and comparisons were carried out using a linear regression model (GraphPad Software, La Jolla, California, USA);[5] significance was set at $p < 0.05$.

Results

The study comprised 24 females and 6 males. Patients' median age was 54.5 years (range, 28–87 years) (Table I). Mean BMI was 27.8 kg/m^2 (range, 17.5–34.7 kg/m^2) and mean neck circumference was 43.2 cm (range, 28–56 cm). Mean thyromental distance was 56 mm (range, 38–84 mm).

The mean (± standard deviation) upward displacement of the ETT during neck extension was 7.17 ± 5.87 mm. In 14 cases (47 per cent), the displacement was 10 mm or more. Patients with a larger BMI had a significantly greater amount of tube displacement than patients with a smaller BMI ($R^2 = 0.67$, $p < 0.0001$) (Figure 2). In addition, patients with a smaller neck length (as represented by thyromental distance) had a significantly greater amount of tube displacement than those with a larger neck length ($R^2 = 0.48$, $p < 0.0001$) (Figure 3). There was no significant difference in tube displacement between those patients with a larger versus a smaller neck circumference ($R^2 = 0.0004$, $p = 0.92$) or between those patients with a lower versus a higher Mallampati score ($R^2 = 0.005$, $p = 0.71$).

Discussion

The importance of accurate positioning of intra-operative nerve monitoring electrodes during thyroid surgery is of paramount importance.[4] If the ETT electrodes are not positioned at the glottis then the monitor can give false signals or not stimulate at all.

Previous studies have investigated the influence of head-neck extension and flexion on ETT position in adult patients and in children.[6–10] Neck extension causes cranial displacement of the ETT, which can cause balloon-induced vocal fold damage or unintentional extubation. Conversely, neck flexion can lead to carinal stimulation or endobronchial intubation.[10] The extent of tube displacement reported varies between papers. In adults, neck extension has been reported to cause 1.7 ± 0.8 cm cranial displacement. In the same paper, in children the upward displacement on neck extension was 1.8 ± 0.8 cm (with uncuffed tubes).[10] Another paper reported 6.3 mm mean

https://doi.org/10.1017/S0022215115002029 Published online by Cambridge University Press

TABLE I
PATIENT DATA SUMMARY

Case number	Age (years)	BMI (kg/m^2)	Mallampati score	Neck circumference (cm)	Thyromental distance (mm)	ETT displacement (mm)
1	42	34.7	2	47	38	15
2	53	27.5	2	28	52	5
3	60	33.8	1	30	39	15
4	56	32	1	47	40	15
5	27	29	2	40	64	10
6	31	22.8	1	53	84	5
7	34	18.5	2	51	77	0
8	61	27	2	44	52	5
9	67	26	3	56	55	0
10	51	31.5	1	46	42	10
11	61	34.1	3	46	38	15
12	78	26.4	2	50	66	0
13	57	32	2	45	52	10
14	71	34	3	47	38	15
15	62	23.1	1	54	72	5
16	39	31.8	2	28	41	15
17	31	22.3	1	34	61	0
18	45	29	2	51	44	15
19	87	21.8	2	48	58	5
20	52	17.5	1	31	75	0
21	65	32	2	33	45	10
22	43	31	2	52	60	5
23	28	27	2	42	50	0
24	51	28	2	32	80	10
25	41	23.6	2	40	60	5
26	38	31	1	51	45	10
27	67	22	2	35	80	0
28	71	27	3	42	58	0
29	46	34	1	51	40	15
30	53	24	2	41	70	0

BMI = body mass index; ETT = endotracheal tube

upward displacement for neck extension in adult patients and 7.4 ± 5.2 mm cranial displacement in low birth weight infants.[8] Kim *et al*. also looked at the effect of head rotation on tube positioning.[10] They found that head rotation towards the side of tube fixation resulted in partial withdrawal of the tube tip away from the carina, whilst head rotation to the other side resulted in tube displacement in an unpredictable manner. Though not relevant for thyroid surgery, this can be important in other forms of lateral neck surgery, such as salivary gland or neck dissection operations.

Various methods have been described for assessing tube positioning, including fluoroscopy, fibre-optic bronchoscopy and post-mortem radiographs. However, we believe that direct visualisation with the fibre-optic endoscope is the most accurate method of determining tube positioning in relation to the glottis.[9,10]

To the authors' knowledge, no previous reports have investigated ETT movement during thyroid surgery. Moreover, there is no literature regarding the impact of body habitus on ETT displacement. This is important as it can aid pre-operative planning relating to ETT positioning for accurate intra-operative nerve monitoring.

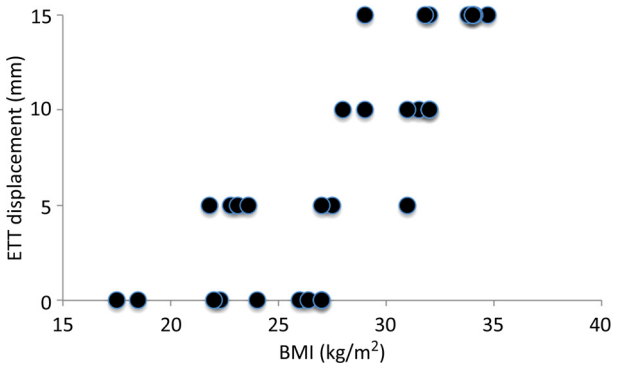

FIG. 2
Correlation between body mass index (BMI) and endotracheal tube (ETT) displacement.

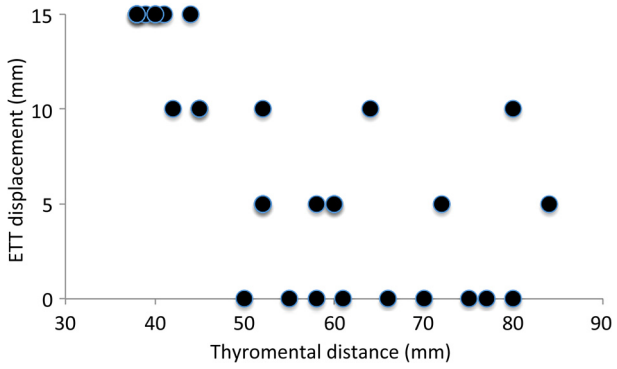

FIG. 3
Correlation between thyromental distance and endotracheal tube (ETT) displacement.

https://doi.org/10.1017/S0022215115002029 Published online by Cambridge University Press

In this study, we demonstrated that patients with a larger BMI and shorter neck length have a significantly greater amount of tube displacement. This must be considered when positioning patients of a larger body habitus for thyroid surgery. One possible explanation is that patients with a larger body habitus tend to have more limited head extension and shorter neck lengths, resulting in greater ETT displacement.

In our series, nearly half of the patients had displacement of 10 mm or more. This increases the likelihood of the vocal folds losing contact with the electrodes and requiring repositioning before surgery is undertaken. Therefore, we recommend fibre-optic endoscope examination to check the position of the electrodes once the patient is in the final operating position.

- **Thyroid surgery is the most common endocrine surgical operation**
- **Accurate positioning of intra-operative recurrent laryngeal nerve monitoring electrodes is essential in thyroid surgery**
- **Neck extension results in upward displacement of the endotracheal tube, which can lead to false signals from the nerve monitor**
- **Displacement is significantly greater in patients with a larger body mass index or shorter neck length**
- **This has particular relevance for thyroidectomy patients in whom accurate tube positioning is essential for nerve monitoring**
- **Fibre-optic endoscope examination is recommended to check electrode position once the patient is in final operating position**

To our knowledge, this is the first and largest study of the effect of body habitus on ETT displacement during neck extension in thyroid surgery. Nevertheless, the number of cases is relatively small, which makes it difficult to draw meaningful statistical conclusions. However, our results correlate well with those of previous studies. Furthermore, the findings provide additional information on the risk factors of significant ETT displacement.

Conclusion

Neck extension results in upward displacement of the ETT. The amount of displacement is significantly higher in patients with a larger BMI or shorter neck length, possibly due to the limitation of neck extension in these patients. This has particular relevance for thyroidectomy patients in whom accurate positioning of the tube is essential for nerve monitoring. We therefore recommend fibre-optic endoscope examination to check the position of the electrodes once the patient is in the final operating position.

Acknowledgement

Grateful thanks to the administrative staff in the ENT Department at Queens Hospital, Romford, UK.

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Mr S D Sharma takes responsibility for the integrity of the content of the paper
Competing interests: None declared

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