Assessment of recurrent laryngeal nerve function during thyroid surgery

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ABSTRACT

INTRODUCTION There is disparity in the reported incidence of temporary and permanent recurrent laryngeal nerve (RLN) palsy following thyroidectomy. Much of the disparity is due to the method of assessing vocal cord function. We sought to identify the incidence and natural history of temporary and permanent vocal cord palsy following thyroid surgery. The authors wanted to establish whether intraoperative nerve monitoring and stimulation aids in prognosis when managing vocal cord palsy.

METHODS Prospective data on consecutive thyroid operations were collected. Intraoperative nerve monitoring and stimulation, using an endotracheal tube mounted device, was performed in all cases. Endoscopic examination of the larynx was performed on the first postoperative day and at three weeks.

RESULTS Data on 102 patients and 123 nerves were collated. Temporary and permanent RLN palsy rates were 6.1% and 1.7%. Most RLN palsies were identified on the first postoperative day with all recognised at the three-week review. No preoperative clinical risk factors were identified. Although dysphonia at the three-week follow-up visit was the only significant predictor of vocal cord palsy, only two-thirds of patients with cord palsies were dysphonic. Intraoperative nerve monitoring and stimulation did not predict outcome in terms of vocal cord function.

CONCLUSIONS Temporary nerve palsy rates were consistent with other series where direct laryngoscopy is used to assess laryngeal function. Direct laryngoscopy is the only reliable measure of cord function, with intraoperative monitoring being neither a reliable predictor of cord function nor a predictor of eventual laryngeal function. The fact that all temporary palsies recovered within four months has implications for staged procedures.

KEYWORDS

Recurrent laryngeal nerve – Thyroidectomy – Intraoperative neural monitoring

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Thyroid surgery is performed increasingly in developed countries, in part owing to a greater identification of nodular thyroid disease. Although the incidence of thyroid cancer is increasing, the majority of thyroid surgery is performed for benign disease. Major complications and mortality in thyroid surgery are low. Recurrent laryngeal nerve (RLN) palsy, however, can have significant implications for quality of life and remains the leading cause of litigation in thyroid surgery.

There is underreporting of thyroid complications with published series varying significantly in rates of temporary and permanent RLN injury. Much of the reported differences is accounted for by method of diagnosis of vocal fold pathology. In a systematic review from 2009, Jeannot et al reported a temporary palsy rate of 9.8% by direct visualisation with just 2.8% in other large series when relying on clinical parameters such as persistent dysphonia rather than direct, postoperative laryngeal visualisation. Direct laryngoscopy by an experienced operator is the gold standard for vocal fold abnormality detection. Clinical assessment of voice as a marker of RLN function is poorly reliable.

It is important to identify and understand the natural history of temporary RLN palsies when planning staged procedures and giving accurate information to patients both before and after surgery. Understanding our own complication rates, risk factors and predictors of outcome enables us to provide more accurate, individual consent. Furthermore, identifying temporary as well as permanent RLN palsy gives us feedback regarding our own surgical technique as it allows us to adjust and make improvements.

We are increasingly obliged to record our own outcomes and disseminate these for comparison with others in the profession. The British Association of Endocrine and Thyroid Surgeons (BAETS) encourages its members to submit outcome data in thyroid surgery for comparison against national averages. In the UK, this will increasingly form part of revalidation. Moreover, there is much discussion regarding patients having direct access to outcome data for
individual thyroid surgeons. RLN palsy and hypocalcaemia are likely to be key indicators of successful outcome, and it is imperative to standardise our measurement and monitor processes to diagnose disorders accurately. An understanding of the natural history of these complications is vital.

In this prospective cohort study, we assessed the feasibility of pre, intra and postoperative RLN as well as of vocal fold monitoring. Our aims were to measure current assessment and monitoring in thyroid surgery against an agreed standard as well as to quantify and assess the natural history of temporary and permanent RLN palsy. In addition, we wanted to make recommendations regarding RLN monitoring.

**Methods**

Following the consensus statement agreed at the BAETS annual conference in 2010 regarding assessment of vocal cord functioning after thyroid surgery, we changed management of preoperative and postoperative assessment to the protocol outlined in Figure 1. This was to ensure standardisation for all patients undergoing thyroid surgery. Data were collected prospectively on consecutive thyroid operations performed at Worcester Royal Hospital between November 2010 and January 2012. All operations were performed or supervised by one of two consultant head and neck surgeons. A minimum follow-up duration of 12 months was observed for patients with recognised vocal cord pathology.

Patient demographics as well as surgical parameters and possible risk factors for RLN injury including indication for surgery and eventual diagnosis were recorded. Direct laryngeal assessment prior to and following surgery was performed by a specialty registrar, middle grade surgeon or consultant using a fibreoptic, flexible nasendoscope. Intraoperative nerve visualisation, monitoring using the NIM® 3.0 (Medtronic, Minneapolis, MN, US) neural monitoring system (endotracheal mounted electromyography [EMG] electrodes) and stimulation were performed in all cases. Nerve stimulation and recording of response was performed after the thyroid gland had been fully dissected away from the thyroid bed. Postoperative vocal cord assessment was made on the day following surgery (where possible) and at the three-week review, collecting data on clinical parameters of voice and also direct laryngoscopy. Further endoscopic examination was performed based on findings at initial and subsequent assessment.

**Results**

During the study period, 102 patients underwent thyroid surgery with 123 nerves at risk. Three-quarters (75%) of patients were female with a median age for male and female patients of 65 and 45 years respectively. The most common indication for surgery was suspected malignancy (57%), with surgery for compressive goitre being second most common (24%). Proven malignancy (either based on fine needle aspiration [Thy5] classification: papillary thyroid cancer or previous diagnostic thyroid surgery indicating cancer) accounted for 16% of cases and thyrotoxicosis made up 3% of cases (Fig 2). Following histological assessment, 77% of cases were benign and 25% malignant. All malignant disease was histologically well differentiated, with 70% papillary and 30% follicular (Fig 3).

**Pre and postoperative assessment**

The outcome of the preoperative direct laryngoscopy assessment was documented in 95 of 102 patients undergoing thyroid surgery (95.1%). Where documentation was incomplete, no clear indication or reason was given for the examination not taking place. Only 2 of the 95 preoperative assessments (2.1%) were abnormal (one previously undiagnosed temporary right vocal cord palsy in a patient undergoing completion thyroidectomy and one benign vocal cord nodules).

**Figure 1**  Worcester Royal Hospital protocol for the management and assessment of vocal cord functioning before, during and after thyroid surgery.
Day 1 laryngoscopy was not performed in 16 of 102 cases (15.7%). However, eight (50%) of these patients underwent a laryngoscopy at the first clinic review three weeks postoperatively and as such, 92.2% of patients had at least one documented endoscopic examination of the larynx within three weeks of surgery. The most common reason for day 1 laryngoscopy not being performed was when surgery occurred close to the weekend and an adequately trained member of staff was not available. No follow-up laryngoscopy was performed in 8 of 102 cases (7.8%). In the eight cases where no postoperative laryngoscopy was performed, three patients refused owing to normal voice, one patient was lost to follow-up and four patients were followed up in other centres.

**Temporary and permanent RLN injury**

In patients with documented evidence of vocal cord functioning, no abnormality was detected in 92.2% (106/115) of nerves at risk with documented direct laryngoscopy; 6.1% (7/115) eventually recovered and 1.7% (2/115) did not recover during the first 12 months of the follow-up period. All patients with temporary RLN palsy had benign disease on eventual histology. There were no subsets of histological diagnosis, including thyroiditis and multinodular goitre, in which the rates of nerve palsy were significantly higher. One patient with permanent palsy received an eventual diagnosis of papillary carcinoma (T4 lesion with extracapsular spread) although there was no statistical significance for malignant disease being a risk factor for vocal cord palsy. Patient age and sex were not predictors of either temporary or permanent RLN palsy. Although not statistically significant, 5/7 temporary palsies were on the right side (Table 1).

**Intraoperative monitoring**

The endotracheal tube-mounted EMG monitor and stimulator were used, and outcomes recorded in all cases undergoing surgery. The RLN was visualised in 99.1% (114/115) of cases and stimulated in each case at the end of surgery after dissection was complete (nerve not seen in one case of thyroiditis with normal cord function postoperatively). Positive stimulation was recorded in 95.6% (109/114) of cases, with no stimulation in 4.4% (5/114). Negative stimulation did not predict eventual nerve outcome either with regard to temporary or permanent RLN palsy and there were no statistical differences between the groups (p=0.94). Of the five stimulation negative cases, four had a normal outcome in terms of RLN function and there was one permanent palsy. Six out of six temporary palsies and one out of two permanent palsies were stimulation positive following nerve dissection and gland removal.

**Clinical voice assessment as a predictor**

On the first postoperative day, 12.2% (14/115) of patients had developed dysphonia. In patients with abnormal voice on day 1, 21.4% (3/14) had a vocal cord palsy while the remaining 78.6% (11/14) had normally functioning vocal cords. Clinical voice on day 1 was not a significant predictor of vocal cord function. At the 3-week follow-up appointment, 5.2% (6/115) of patients had an abnormal voice, with 4 out of the 6 patients with abnormal voice having a vocal cord palsy. Of two patients with abnormal voice at three weeks following surgery, there was one case of laryngitis and one case of intubation trauma. The presence of persistent dysphonia at three weeks was the only significant predictor of vocal cord palsy (Table 1).
Natural history

Of the nine patients who developed RLN palsy, eight had had a day 1 postoperative laryngoscopy. Six out of eight RLN palsies were identified on day 1, with three additional palsies identified at the three-week review (two patients with temporary palsies initially missed at day 1 and one patient with permanent palsy who did not undergo direct laryngoscopy on day 1). This would suggest either missed diagnosis or delayed development of RLN palsy. All temporary palsies recovered within 4 months of the follow-up period, and no improvement in vocal fold function was observed between 4 and 12 months following surgery (Fig 5).

Discussion

Protocol for vocal cord monitoring

We observed a high rate of compliance with our protocol for pre and postoperative vocal cord assessment, suggesting that direct laryngoscopy in this setting is acceptable to patients and well tolerated. We believe there is under-recording of preoperative vocal cord checks, especially where patients refused examination. The numbers of patients who do not tolerate direct laryngoscopy are small and there is no reason to assume that missing data attributed to patients who refused examination would bias our results significantly. Indeed, where patients refused direct laryngoscopy postoperatively, normal voice was often a reason for refusal; this is a trend seen in other series. On the basis of these findings, we recommend formalisation of assessment and recording in patients undergoing thyroid surgery with clear documentation, also when patients refuse examination.

The timing of postoperative direct laryngoscopy is important and may affect outcome with regard to the RLN palsy diagnosis rate. Furthermore, it is important to rationalise resources in terms of the use of staffing and equipment to achieve the most cost effective diagnostic outcomes. All permanent palsies were identified on the first postoperative day whereas two of the seven temporary palsies were reported initially as normal but had palsies identified at week 3, raising the possibility that palsies were either missed originally or developed later. As the operators were higher level trainees or above and competent in making a diagnosis of vocal fold pathology, a delayed palsy may be a possibility although we accept that difficulty in diagnosing laryngeal pathology soon after intubation may play a role. Other studies have shown a reduced diagnosis of vocal cord palsy when examination is performed on the day of surgery.

| Risk factor                  | \( \chi^2 \) | Sensitivity | Specificity | \( p \)-value |
|------------------------------|--------------|-------------|-------------|---------------|
| Age under or over 50 years   | <0.01        | 67%         | 41%         | 0.94          |
| Sex                          | <0.01        | 22%         | 79%         | 1.0           |
| Benign histology             |              |             |             |               |
| Solitary nodule              | <0.01        | 33%         | 94%         | 0.94          |
| Multinodular goitre          | <0.01        | 20%         | 82%         | 1.0           |
| Thyroiditis                  | <0.01        | 11%         | 94%         | 1.0           |
| Malignant histology          | <0.01        | 22%         | 79%         | 1.0           |
| Dysphonia day 1              | 2.20         | 33%         | 90%         | 0.14          |
| Dysphonia week 3             | 19.12        | 67%         | 96%         | <0.01         |
| Right-sided surgery          | 1.68         | 86%         | 47%         | 0.195         |
| Nerve stimulator negative    | 0.01         | 11%         | 96%         | 0.94          |

Table 1  Sensitivity and specificity of risk factors as predictors for temporary and permanent recurrent laryngeal nerve palsy following thyroid surgery

Figure 5  The natural history of temporary and permanent recurrent laryngeal nerve palsy following thyroid surgery showing maximum diagnosis of palsy at week 3 and all temporary palsies recovering within four months of surgery
Based on these data, if only a single examination of the larynx is possible, the optimum timing for detection of vocal cord palsy would be at the first postoperative clinic review rather than prior to inpatient discharge. Where health service rationing is an issue or access to direct laryngoscopy is limited, this may have important implications.

Consistent with other series, clinical assessment of voice, although a specific marker of RLN function, is not sensitive and will therefore underestimate the true palsy rate if used in isolation, even at three weeks, at which point its accuracy improves. The presence of dysphonia rate if used in isolation, even at three weeks, at which point its accuracy improves. The presence of dysphonia on the postoperative ward round was more common in those with normal laryngeal function and patients with a genuine palsy were as likely as not to have normal clinical voice. It is probable that the lack of sensitivity and specificity of early clinical voice assessment is attributable to the direct effects of intubation rather than to nerve injury, explaining why both sensitivity and specificity increase if dysphonia persists at the three-week review where effects of intubation related oedema are likely to have diminished.

**Temporary and permanent RLN injury**

We observed a temporary and permanent RLN palsy rate of 6.1% and 1.7% respectively. These figures are consistent with other published series adopting nerve assessment using direct laryngoscopy in the postoperative period. Although the number of cases in our study is small, it is likely that the throughput of our unit is similar to that of most district general hospitals and, as such, represents a ‘real world view’ for an individual unit as well as being typical for the type of data that will be presented at revalidation and audit.

All temporary palsies in this study recovered within four months following surgery. A period of recovery of up to 12 months has been reported elsewhere and small numbers in our study may account for this discrepancy. It would appear likely, however, that most temporary palsies will recover within four months and this may have implications for patients undergoing staged procedures as, if clinically indicated, a period of watchful waiting may reduce the likelihood of bilateral nerve injury where a unilateral lesion is present. Whether there is additional benefit from a more prolonged period of observation is not supported by these data although we acknowledge the small numbers in our study. Clearly, if longer follow-up periods are likely to affect oncological outcome adversely, then this would be unacceptable although there are implications for accurate consent.

**Intraoperative monitoring**

In this study, intraoperative neural monitoring and stimulation following dissection did not help in determining the prognosis of RLN injuries. Similar findings have been reported elsewhere and when using palpation of the posterior cricoarytenoid rather than EMG detection to assess vocal cord outcome. Although all temporary RLN nerve injuries stimulated positively at the end of the procedure, suggesting a favourable outcome, one of the two permanent palsies also stimulated positively at the end and negative stimulation did not tally with nerve palsy.

It is difficult to draw conclusions when dealing with small numbers. Nevertheless, positive stimulation in damaged nerves could be a result of supraphysiological stimulation or unintentional stimulation distal to the level of the injury. Moreover, negative stimulation could be due to tube misplacement, poor electrode contact or other technical issues. Although limited, these data suggest the use of monitoring and stimulation has questionable benefit when determining the prognosis of a nerve injury. This has implications for both patient reassurance and where monitoring systems are used as a guide to intraoperative decision making. Despite this, there are many other advantages to using neural monitoring over and above nerve injury prognosis, and we believe that in their current form, these systems can be justified by their use in confirming RLN position intraoperatively and reducing overall surgical time.

Intraoperative neural monitoring has been adopted widely in many surgical disciplines and in some countries, it has become the standard of care in thyroid surgery. However, there remains a lack of clear evidence that the increased use of neural monitoring systems have led to a decrease in RLN injury. As with all new technology, increasing use and scrutiny is likely to lead to improvements in reliability and, more importantly, awareness of device limitations. Where uncertainty exists, it is imperative that we share our experiences as well as acknowledging there is no replacement for careful dissection and good anatomical knowledge.

The most recent advances in intraoperative neural monitoring, including continuous vagal monitoring, have the advantage of giving ‘real time’ EMG readouts, allowing imminent RLN damage to be detected. They have been shown to be safe and allow the surgeon to modify surgical manoeuvres to minimise risk of neural damage. In addition, these systems provide documentation that can be attached to a patient’s operative notes and analysed postoperatively in conjunction with clinical findings. These advances may make neural monitoring more effective and reliable, becoming a more sensitive and specific tool in RLN injury. Furthermore, they may more accurately aid in both intra and postoperative decision making. Whether it can be proven that they reduce palsy rate and therefore improve nerve outcomes remains to be determined by whether surgeons adopt the technology and the accurate reporting of results.

**Conclusions**

Until diagnostic accuracy and preoperative workup improves, it is likely we will perform an increasing amount of thyroid surgery. It is imperative to reduce the morbidity from these operations, and although serious morbidity and mortality are rare, temporary and permanent RLN palsy both occur commonly and are underreported.

We recommend establishing protocols for recording nerve and laryngeal function by direct laryngoscopy and feel it will be important in the future as surgical outcomes are increasingly scrutinised. Where access to direct laryngoscopy is
limited, postoperative examination of the larynx will have its highest diagnosis rate at the first postoperative visit. Most temporary RLN injuries will recover within four months. We have not shown neural monitoring to aid in RLN palsy prognosis. However, more advanced systems may lead to improvements. Whether steroids used in the context of RLN palsy identified early would alter the clinical course or long-term outcome has not been addressed formally and could provide the focus for future research.

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