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Original Article

Intraoperative nerve monitoring in thyroid surgery: analysis of United Kingdom registry of endocrine and thyroid surgery database

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Abstract

Background: Intraoperative nerve monitoring (IONM) is used increasingly in thyroid surgery to prevent recurrent laryngeal nerve (RLN) injury, despite lack of definitive evidence. This study analysed the United Kingdom Registry of Endocrine and Thyroid Surgery (UKRETS) to investigate whether IONM reduced the incidence of RLN injury.

Methods: UKRETS data were extracted on 28 July 2018. Factors related to risk of RLN palsy, such as age, sex, retrosternal goitre, reoperation, use of energy devices, extent of surgery, nodal dissection and IONM, were analysed. Data with missing entries for these risk factors were excluded. Outcomes of patients who had preoperative and postoperative laryngoscopy were analysed.

Results: RLN palsy occurred in 4.9 per cent of thyroidectomies. The palsy was temporary in 64.6 per cent and persistent in 35.4 per cent of patients. In multivariable analysis, IONM reduced the risk of RLN palsy (odds ratio (OR) 0.63, 95 per cent confidence interval (CI) 0.54 to 0.74, $P < 0.001$) and persistent nerve palsy (OR 0.47, 0.37 to 0.61, $P < 0.001$). Outpatient laryngoscopy was also associated with a reduced incidence of RLN palsy (OR 0.50, 0.37 to 0.67, $P < 0.001$). Bilateral RLN palsy occurred in 0.3 per cent. Reoperation (OR 12.30, 2.90 to 52.10, $P = 0.001$) and total thyroidectomy (OR 6.52, 1.50 to 27.80; $P = 0.010$) were significantly associated with bilateral RLN palsy.

Conclusion: The use of IONM is associated with a decreased risk of RLN injury in thyroidectomy. These results based on analysis of UKRETS data support the routine use of RLN monitoring in thyroid surgery.

Introduction

Recurrent laryngeal nerve (RLN) injury is one of the most serious complications of thyroid surgery, leading to voice change and significant impairment in quality of life. It is, moreover, a common cause of malpractice litigations against surgeons[1] .The incidence of transient RLN injury in thyroidectomy is 2–11 per cent, and permanent injury occurs in 0.6–1.6 per cent[2–4].

Specifically, thyroid surgery for malignant tumours, previous history of neck surgery, and operations for toxic or retrosternal goitre are associated with a higher risk of nerve injury[5,6]. Bilateral vocal cord paralysis secondary to nerve injury is a major but rare complication of thyroid surgery that requires tracheotomy or acute surgical airway intervention in almost half of patients[7].

Visual identification of the RLN during thyroid surgery is recommended as a routine measure to reduce vocal cord paralysis[8]. Intraoperative nerve monitoring (IONM) has been advocated as an aid to localize the nerve and predict vocal cord function after the operation[9]. Moreover, it helps to prevent bilateral recurrent laryngeal nerve paralysis, by adopting strict operative protocols for two-stage thyroidectomy[10].

Although IONM has been adopted by many surgeons to reduce the incidence of nerve injury, its efficacy in preventing RLN injury remains controversial[11,12]. Several meta-analyses have been conducted; however, most of these indicated that IONM was no better than visual identification in preventing permanent RLN injury[12–14]. Some studies, however, have shown that IONM may decrease nerve injury in high-risk thyroid surgery such as cancer operations or reoperations[13].Nevertheless, a substantial number of the studies included in systematic reviews and meta-analyses showed conflicting results and were of low methodological quality[15].

Bearing in mind this current controversy, analysis of the United Kingdom Registry of Endocrine and Thyroid Surgery (UKRETS) data was conducted to clarify the potential benefits and outcome of IONM use in thyroidectomy.

Methods

Permission to analyse data from UKRETS was granted by the Executive Committee of the British Association of Endocrine and Thyroid Surgeons (BAETS). Patient consent is required to collect data in UKRETS and for its anonymous use for research and audit purposes, in compliance with the General Data Protection

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Regulations. All outcomes are anonymous, and therefore specific ethical approval was not sought. An extract of UKRETS data was taken on 28 July 2018.

The following risk factors for RLN palsy were considered: patient age, sex, goitre type, reoperation, use of energy device, extent of surgery, nodal dissection, and the use of IONM. Patients at the extremes of age range (aged less than 16 years and more than 90 years) were excluded.

To determine any potential benefit of IONM, only patients that had preoperative and postoperative laryngoscopy were analysed, as otherwise the presence or absence of RLN palsy due to surgery could not be established accurately. This 'laryngoscopy' group was then subdivided into patients who were operated on by surgeons who undertook laryngoscopy in more than 80 per cent of cases, termed the 'routine laryngoscopy' group, and those who did so in less than 80 per cent of cases, referred to as the 'selective laryngoscopy' group. The threshold of 80 per cent was chosen as data from the Fifth National Audit report[16] showed that this captures the majority of surgeons performing laryngoscopy routinely, a proportion of whom would not have been captured if a higher threshold had been chosen. Further analysis of the routine laryngoscopy subgroup was undertaken as this group most closely demonstrates any potential benefit of IONM in routine thyroid practice.

Temporary RLN palsy was defined as an abnormal vocal cord check found on first postoperative laryngoscopy that recovered on subsequent laryngoscopy. Persistent RLN palsy was defined as palsy found on first postoperative laryngoscopy that did not resolve at final vocal cord check. Patients with a pre-existing palsy were excluded, where this information was available. Those with missing data in this field were excluded from the analysis.

Although data regarding the vocal cord palsy was recorded in UKRETS throughout, these data fields changed over the study period. Before October 2014, the date and details, but not laterality, of the final vocal cord check were recorded, whereas after October 2014, the date of the first vocal cord check, outcome of any subsequent vocal cord check at 6 months, and laterality of recurrent nerve palsy were recorded. Before October 2014 it was therefore possible to calculate the time from operation to final vocal cord check, at which the persistence or recovery of the RLN palsy was recorded, and for operations added after October 2014 the final vocal cord check was assumed to be at 6 months after surgery.

Statistical analysis

Statistical analysis was undertaken using SPSS® version 25 (IBM, Armonk, NY, USA). Univariable analysis was done to establish whether risk factors were independently correlated. Binary multivariable analysis of risk factors for recurrent nerve palsy was undertaken, and the χ^2 test was used to compare outcomes within groups. Odds ratios (ORs) and 95 per cent confidence intervals (CI) were calculated for multivariable analysis. Statistical difference was considered significant for $P < 0.050$.

Results

After excluding patients with missing data for the potential risk factors for RLN palsy, 42 341 thyroidectomies remained in the cohort to be analysed, representing 62.5 per cent of the complete data set in the UKRETS (*Fig. 1*).

Use of IONM in thyroidectomy in the UK has been increasing over the past decade and was used in 58.6 per cent (3204 of 5463) of thyroidectomies recorded in UKRETS in 2017 (*Fig. 2*).

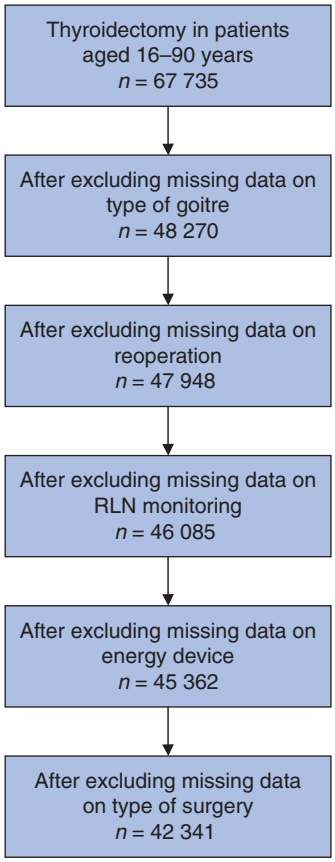

Fig. 1 Inclusion of patients in the study

RLN, recurrent laryngeal nerve.

Overall, RLN palsy was recorded in 3.0 per cent (1250 of 42 341) thyroidectomies, representing a RLN palsy rate, per nerves at risk, of 2.1 per cent (1250 of 58 267). A total of 16 097 patients underwent preoperative and postoperative laryngoscopy, representing 38.0 per cent of the 42 341 thyroidectomies, and 15 881 of these patients had a documented postoperative laryngoscopy with details of any abnormal vocal cord findings. These patients constitute the 'laryngoscopy' group in the subsequent analysis.

Some 269 surgeons undertook 42 341 thyroidectomies in the data set with a median of 102 recorded operations. Of these, 52 surgeons (19.3 per cent) had ordered both preoperative and postoperative laryngoscopy in more than 80 per cent of patients. These surgeons performed 7646 thyroidectomies and constitute the 'routine laryngoscopy' group in the subsequent analysis. Most surgeons (217, 80.7 per cent) undertook preoperative and postoperative laryngoscopy in less than 80 per cent of cases (8235 thyroidectomies), and constitute the 'selective laryngoscopy' group.

Multivariable analysis of risk factors for RLN palsy following thyroidectomy in the laryngoscopy group are shown in *Table 1*. Patient age, retrosternal goitre, reoperation, bilateral thyroidectomy and nodal dissection significantly increased the risk of RLN palsy, whereas the use of IONM significantly decreased the risk ($P < 0.001$). Use of energy device and gender were not associated with the risk of palsy.

In the laryngoscopy group, the RLN palsy rate was 4.9 per cent (774 of 15 881) following thyroidectomy, which is higher than the overall rate of 3.0 per cent (1250 of 42 341). The highest palsy rate of 5.6 per cent (458 of 8235) was found following thyroidectomy in the selective laryngoscopy group, and the lowest of 4.1 per

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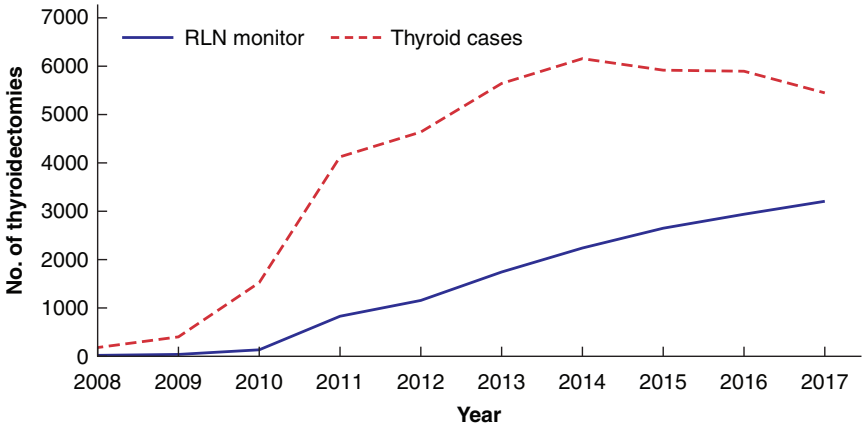

Fig. 2 Use of recurrent laryngeal nerve monitoring in thyroidectomy according to United Kingdom Registry of Endocrine and Thyroid Surgery data, 2008–2017

RLN, recurrent laryngeal nerve.

Table 1 Binary logistic multivariable analysis of risk factors for recurrent laryngeal nerve palsy after thyroidectomy in patients who had preoperative and postoperative laryngoscopy

	Odds ratio for RLN palsy
Patient age	1.01 (1.00, 1.01)
Male gender	0.91 (0.76, 1.09)
Retrosternal goitre	1.73 (1.45, 2.06)
Reoperation	1.75 (1.40, 2.19)
Total thyroidectomy	1.63 (1.39, 1.91)
Nodal dissection	1.99 (1.64, 2.42)
RLN IONM	0.63 (0.54, 0.74)
Use of energy device	0.93 (0.80, 1.09)

Values in parentheses are 95 per cent confidence intervals. RLN, recurrent laryngeal nerve; IONM, intraoperative nerve monitoring.

Table 2 Distribution of high-risk thyroidectomies* between groups

	RLN palsy rate (%)	Proportion of high-risk cases (%)
Laryngoscopy group	4.9	53.9
Routine laryngoscopy group	4.1	52.3
Selective laryngoscopy group	5.6	55.4

*Defined as total thyroidectomy, retrosternal goitre, reoperation and nodal dissection. RLN, recurrent laryngeal nerve.

cent (316 of 7646) in the routine laryngoscopy group (*Table 2*). Use of IONM significantly reduced the risk of RLN palsy in a multivariable analysis of risk factors in both the selective (OR 0.57, 95 per cent CI 0.47 to 0.69; $P < 0.001$) and routine (OR 0.72, 0.57 to 0.90; $P = 0.004$) laryngoscopy groups.

Of the 774 patients with RLN palsy 9 were recorded as having temporary and permanent palsy at follow up and were assumed therefore to have bilateral RLN palsy. 263 were operated on before October 2014 and it was possible to calculate the exact time from operation to final vocal cord check. In those who suffered a RLN palsy, the mean time to final vocal cord check was 4.1 (median 3, range 0–32) months. Overall, 64.6 per cent (506 of 783) of palsies were temporary and 35.4 per cent (277 of 783) were persistent. Persistent RLN palsy occurred in 1.7 per cent (277 of 15 881) of the laryngoscopy group, 2.4 per cent (195 of 8235) of the selective group, and 1.1 per cent (82 of 7646) of the routine group. Multivariable analysis of risk factors for persistent RLN palsy showed that use of IONM reduced the risk of persistent palsy in the laryngoscopy group (OR 0.47, 95 per cent CI 0.37 to 0.61; $P < 0.001$), both in the selective group (OR 0.48, 0.36 to 0.65; $P < 0.001$) and in the routine group (OR 0.54, 0.35 to 0.84; $P = 0.007$).

As expected, there was a difference in the proportion of high-risk thyroidectomies (defined in this study as bilateral thyroidectomy, retrosternal goitre, reoperation and nodal dissection) between groups, with the patients in the selective laryngoscopy group having the highest proportion of high-risk cases and those in the routine laryngoscopy group having the lowest proportion.

Further analysis of the routine laryngoscopy group was then undertaken to investigate any potential influence of: selective IONM use; pathology in patients undergoing bilateral thyroidectomy; and timing of the vocal cord check on the incidence of RLN palsy and bilateral palsy in operations recorded after October 2014.

There were 52 surgeons in the routine laryngoscopy group who undertook laryngoscopy in more than 80 per cent of thyroidectomies, of whom 28 also used IONM in more than 80 per cent of patients. These surgeons recorded 130 RLN palsies in 3528 thyroidectomies, giving a palsy rate of 3.7 per cent. The remaining 24 surgeons, who used IONM in less than 80 per cent of patients in addition to routine laryngoscopy, recorded 180 palsies in 4118 thyroidectomies, giving a higher RLN rate of 4.4 per cent, but the difference between these groups was not statistically significant ($P = 0.131$).

Subanalysis to investigate the influence of pathology was undertaken on bilateral thyroidectomies in the routine laryngoscopy group. Primary diagnoses were grouped into benign non-thyrotoxic, benign thyrotoxic, and malignant based on the pathology report. Certain risk factors were highly independently correlated, such as benign non-thyrotoxic and malignant pathology, and so both could not be included in the multivariable analysis.

A total of 347 RLN palsies were recorded in 5312 bilateral thyroidectomies, giving a RLN palsy rate of 6.5 per cent, or 3.3 per cent (347 of 10 624) per nerves at risk in this group. Age ($P = 0.025$), retrosternal goitre ($P = 0.020$) and reoperation ($P = 0.013$) significantly increased the risk of palsy, whereas IONM use ($P < 0.001$) and thyrotoxicosis ($P = 0.007$) were associated with a decreased risk. Thyroid cancer was not associated with RLN palsy (*Table 3*).

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Table 3 Binary logistic multivariable analysis of risk factors for recurrent laryngeal nerve palsy after total thyroidectomy in the routine laryngoscopy group including primary pathological diagnosis

	Odds ratio for RLN palsy
Patient age	1.01 (1.00, 1.02)
Retrosternal goitre	1.36 (1.05, 1.77)
Reoperation	1.84 (1.14, 2.97)
RLN IONM	0.52 (0.41, 0.65)
Thyrotoxicosis	0.66 (0.49, 0.90)
Thyroid cancer	1.16 (0.97, 1.39)

Values in parentheses are 95 per cent confidence intervals. RLN, recurrent laryngeal nerve; IONM, intraoperative nerve monitoring.

Table 4 Binary logistic multivariable analysis of risk factors for recurrent laryngeal nerve palsy after thyroidectomy in the routine laryngoscopy group*

	Odds ratio for RLN palsy
Patient age	1.02 (1.01, 1.03)
Male gender	1.00 (0.73, 1.38)
Retrosternal goitre	1.37 (1.00, 1.89)
Reoperation	1.83 (1.22, 2.75)
Bilateral thyroidectomy	1.88 (1.41, 2.50)
Nodal dissection	2.28 (1.60, 3.25)
RLN IONM	0.63 (0.48, 0.83)
Outpatient laryngoscopy	0.50 (0.37, 0.67)

Values in parentheses are 95 per cent confidence intervals. *Includes patients treated after 8 October 2014 in whom the date to first vocal cord check was known. RLN, recurrent laryngeal nerve; IONM, intraoperative nerve monitoring.

A total of 4175 patients in the routine laryngoscopy group underwent thyroidectomy after 8 October 2014. After excluding patients with missing data in the data fields 'date of discharge' and 'date of first vocal cord check', 3912 patients remained in the analysis. The majority, 82.3 per cent (3218 of 3912) of this subgroup had an outpatient vocal cord check, at a mean of 33 (range 1–645) days after surgery. Subanalysis of these patients showed that the timing of postoperative laryngoscopy affected the incidence of RLN palsy if done in an outpatient setting (OR 0.50, 95 per cent CI 0.37 to 0.67; $P < 0.001$).

In this subgroup, 6.2 per cent (242 of 3912) had a new RLN palsy, of which 0.3 per cent (12 of 3912) were bilateral. The incidence of a new palsy was particularly high, at 9.8 per cent (68 of 694), when postoperative laryngoscopy was done as an inpatient. It was lower when postoperative laryngoscopy was done as an outpatient: 5.4 per cent (174 of 3218).

Binary multivariable analysis of risk factors for new vocal cord palsy demonstrated that age ($P < 0.001$), retrosternal goitre ($P = 0.050$), reoperation ($P = 0.004$), bilateral thyroidectomy ($P < 0.001$) and nodal dissection ($P < 0.001$) significantly increased the risk of RLN palsy in this subgroup, whereas use of IONM ($P = 0.001$) and outpatient laryngoscopy ($P < 0.001$) were associated with a significantly lower risk of palsy (*Table 4*). Multivariable analysis of risk factors for bilateral RLN palsy in this subgroup demonstrated that only reoperation (OR 12.30, 95 per cent CI 2.90 to 52.10; $P = 0.001$) and bilateral thyroidectomy (OR 6.52, 1.50 to 27.80; $P = 0.010$) were significantly associated with bilateral nerve palsy.

Discussion

The main finding of this study is that the use of IONM protected against postoperative RLN palsy in thyroid surgery with a significantly decreased risk in multivariable analysis of risk factors in patients who underwent preoperative and postoperative laryngoscopy (OR 0.63, 95 per cent CI 0.54 to 0.74; $P < 0.001$),. Most of these palsies were temporary, with persistent RLN palsy occurring in approximately one-third of patients with palsy (35.4 per cent, or 277 of 783 thyroidectomies). The risk of persistent nerve palsy was also reduced when IONM was used in thyroidectomy (OR 0.47, 0.37 to 0.61, $P < 0.001$). This study did not provide data on continuous *versus* intermittent IONM, as the high rate of missing data in these data fields in UKRETS precluded this analysis.

Bergenfelz and colleagues[17] performed a national study of registry data from the Scandinavian Quality Register for Thyroid, Parathyroid and Adrenal Surgery (SQRTPA) database of 5252 patients who had thyroidectomy. They reported similar findings to those in the present study, with a significant reduction in permanent RLN palsy with IONM utilization, as shown by the negative association between permanent vocal cord palsy and IONM use (OR 0.43, 95 per cent CI 0.19 to 0.93). In the Bergenfelz study[17], postoperative laryngoscopy was performed in 1757 patients, which represented 33.5 per cent of the study population, compared with 15 881 patients in the present study, albeit with a similar proportion of thyroidectomy cases that involved laryngoscopy at 37.5 per cent (15 881 of 42 341).

In the present study, the laryngoscopy group was further subdivided into routine and selective groups, depending on whether laryngoscopy was used before and after surgery by surgeons in more or less than 80 per cent of cases. Although the reasons why laryngoscopy was used selectively by those surgeons is unknown, the likelihood is that it was used more frequently for high-risk patients, or those with intraoperative or postoperative suspicion of RLN palsy, thereby potentially biasing the outcome in the selective laryngoscopy group. This is reflected in the higher proportion of high-risk patients (55.4 per cent) and higher RLN palsy rate of 5.6 per cent seen in the selective laryngoscopy group. Patients who had undergone previous neck surgery were included in the present study, and this may partly explain the high RLN palsy rate, particularly in the selective group, but also the overall rate in the laryngoscopy group of 4.9 per cent (774 of 15 881).

The routine laryngoscopy group was of more interest as it demonstrated the likely benefit of IONM in routine thyroidectomy practice. In this group, the benefit of selective IONM use was examined by analysing RLN palsy rates for surgeons using IONM in more or less than 80 per cent of thyroidectomies. This subanalysis demonstrated that a non-significantly higher proportion of RLN palsies occurred when surgeons used IONM in less than 80 per cent of cases, further supporting the use of IONM.

Cirocchi and co-workers[18], in their 2019 Cochrane systematic review of five trials including 1558 patients, found no firm evidence for an advantage of IONM compared with visual nerve identification for either permanent (risk ratio (RR) 0.77, 95 per cent CI 0.33 to 1.77; $P = 0.54$) or transient (RR 0.62, 0.35 to 1.08; $P = 0.09$) RLN palsy, although they admitted that the included studies contained some systematic errors and imprecise outcomes. This systematic review[18] also excluded trials containing participants who had previous neck surgery where visual identification alone is expected to be challenging owing to obliteration of the usual anatomical planes and fibrosis from previous surgery.

Pisanu *et al.*[19] in 2014 and Lombardi and colleagues[14] in 2016 performed systematic reviews and meta-analyses showing no significant benefit for IONM use over direct visualization in reducing the risk of permanent RLN palsy. These studies included non-randomized trials as well as RCTs, with wide variation in the

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definition of permanent RLN palsy, spectrum of pathologies, and proportion of recurrent or first-time surgeries, which may have confounded the interpretation of the results[14]. In another meta-analysis in 2013 by Sanabria and co-workers[20], a statistically significant decrease in the risk of temporary RLN injury was found, but, again, the included RCTs were of low methodological quality with high risk of bias.

Other systematic reviews and meta-analysis have shown no benefit for IONM use; however, most of these studies showed heterogeneous results because of varied methodological qualities[15]. Moreover, the low incidence of RLN palsy (3–8 per cent in most of the studies) requires a sample size of at least 2000 patients per arm to demonstrate a decrease of 50 per cent in the RLN palsy rate[15], and most studies do not achieve this. Hence methodological flaws, underpowering and bias have hampered the analysis of IONM in thyroidectomy.

Unexpectedly, this study showed that surgery for thyrotoxicosis was associated with a decreased risk of RLN palsy and that surgery for thyroid malignancy was not associated with risk of recurrent laryngeal nerve palsy. In 2004, Dralle *et al.*[5] reported an increased risk of permanent RLN palsy in primary surgery for thyroid malignancy (OR 2.04, 95 per cent CI 1.41 to 2.96; $P<0.001$) in a prospective analysis of 29 998 nerves at risk, including 1036 patients with thyroid malignancy. Chan and colleagues[6] in 2006 also reported thyroidectomy for malignancy to be a risk factor for RLN palsy (OR 1.93, 0.99 to 3.76; $P=0.05$), although the number of patients with thyroid malignancy in this study was low. Previous analysis of UKRETS data from 2010 to 2016 also showed no association between RLN palsy and hyperthyroidism, although nodal dissection was associated with a significantly increased risk. Age, retrosternal goitre, reoperation and bilateral thyroidectomy have consistently been found to be risk factors for RLN palsy, and IONM to be protective, in both UKRETS data analyses[21].

A major limitation of this study was missing data; even though these patients were excluded, entry selection bias from surgeons may persist, with some adverse outcomes not being entered. In this regard it is worth noting that the UKRETS data have not yet been validated against other national UK data sets such as Hospital Episode Statistics.

In addition, the data fields in UKRETS changed during the time period of the study, so the influence of the timing of the first postoperative laryngoscopy on the incidence of RLN palsy could be investigated only for data added after 2014. This is an important confounding factor, as RLN palsy rates at laryngoscopy done before discharge are generally higher than those done as an outpatient. Bergenfelz *et al.*[17] reported that approximately 40 per cent of patients diagnosed with vocal cord palsy before hospital discharge had normal vocal cord function documented at the first follow-up visit, in agreement with the present study which showed an OR of 0.50 for RLN palsy when laryngoscopy was first done as an outpatient.

Approximately two-thirds of RLN palsies after thyroid surgery resolved, although the incidence of persistent palsy was also reduced signifincantly with IONM in thyroidectomy (OR 0.47, 95 per cent CI 0.37 to 0.61; $P<0.001$). It is also evident that the rate of RLN palsy is likely to be underestimated unless laryngoscopy is undertaken, as the rate overall across the whole data set was 3.0 per cent, compared with 4.9 per cent in the laryngoscopy group.

The incidence of RLN palsy was particularly high when laryngoscopy was first undertaken as an inpatient: 9.8 per cent (68 of 695), falling to 5.4 per cent (174 of 3218) when first done as an outpatient. The reasons why postoperative laryngoscopy was done as an inpatient were not known. It may have been routine practice for some surgeons, or done in patients with postoperative voice change, or suspicion of RLN palsy due to loss of signal and/or to elucidate the possible mechanism of RLN injury during IONM, all of which could have potentially biased the results of the study. Likewise, the lower incidence of RLN palsy seen when laryngoscopy was undertaken as an outpatient may reflect a lower incidence of postoperative voice problems in this group, and the time to outpatient laryngoscopy may allow resolution of neuropraxia, thereby lowering the incidence of RLN palsy found at outpatient laryngoscopy.

It was also more difficult to analyse for bilateral RLN palsy as the laterality was available only for data entered from 2014 onwards. In the 3912 patients for whom the information on laterality was known, there were only 12 occurrences of this event. The lack of any significant benefit of IONM in reducing the incidence of bilateral nerve palsy could therefore be due to a type II error in the present study (too few events). Further analysis of UKRETS data could be undertaken in the future as more cases accrue to investigate this further.

The 2017 international consensus on nerve monitoring (ICON) statement on the use of IONM in thyroid surgery agreed to its routine use in open thyroidectomy to avoid traction injury of the RLN, as more than seven series had shown IONM to be highly accurate at identifying postoperative RLN palsy with negative predictive values ranging between 90 and 100 per cent[22,23]. Results of the present study support this expert opinion, although a benefit in reducing the incidence of bilateral RLN palsy could not be demonstrated for the reasons outlined above.

In addition to the main purpose of reducing the rates RLN injury and palsy, IONM also provides real-time functional information that assists surgeons in the clinical decision-making process, such as staged thyroidectomy and optimal RLN management in thyroid cancer surgery[7,23].

In the present study, the benefit of IONM appeared to be maintained in both routine and selective practice. Despite the disadvantages of registry data, quality registries are ideal for monitoring the impact of new technologies when small differences between groups are expected. This may be needed to demonstrate a benefit for IONM, as such registries provide the large numbers of patients that are needed to show this, owing to the low incidence of postoperative RLN palsy in thyroid surgery. Based on UKRETS data analysis, the use of RLN monitoring is associated with a decreased risk of overall and persistent RLN injury in thyroidectomy. These results support the routine use of RLN monitoring in thyroid surgery.

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