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Research Paper

Current Practice Patterns Regarding the Conduct of Thyroidectomy and Parathyroidectomy amongst Surgeons - A Survey Study

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Abstract

Background: Heterogeneity of surgical care exists among surgeons regarding the conduct of thyroidectomy and parathyroidectomy.

Aim: To identify the current patterns of technical conduct of operation amongst surgeons performing thyroidectomy or parathyroidectomy.

Methods: A survey was designed and beta-tested on five surgical oncologists for face validity and usability. The final version of this survey was constructed and disseminated using the professional version of the internet-based survey mechanism Survey Monkey and consisted of two eligibility questions and 22 questions regarding thyroidectomy/parathyroidectomy treatment patterns. The survey was disseminated electronically to American Association of Endocrine Surgeons (AAES) and American College of Surgeons (ACS) members. Survey results were collected, tabulated and analyzed. Responses among groups were compared using two sample T- tests. Significant responses were subsequently analyzed in generalized linear models to ascertain if significance remained with control of covariates.

Results: Of 420 initial web survey visits, 236 (56.2%) surveys were completed. The majority of respondents reported being 'fellowship trained', experienced and 'high-volume' surgeons. The most common fellowship trainings were endocrine (46%), oncology (22%), head & neck (13%), or combinations of the three fellowships (14%). Most surgeons reported that they dissect the course of the recurrent laryngeal nerve (RLN) without using neuromonitoring. Nearly a third of respondents reported routinely using the Harmonic scalpel during the conduct of the operations. Significant differences emerged regarding operative technique according to residency training type, fellowship training, surgeon volume, and practice setting, but only those associated with residency training type and annual surgeon surgical volume remained significant within generalized linear models.

Conclusion: Most surgeons who responded to this survey do not routinely use RLN neuromonitoring and most dissect the RLN during thyroidectomy. There are multiple variations in technique according to surgical training, surgeon volume, experience, and practice setting; however, only differences by residency training type and surgeon volume remained correlated significantly to surgeons' approaches to thyroidectomy and parathyroidectomy in multivariate analysis. These data may be useful for surgeons reflecting upon their individual practice, as well as for further defining current standards of practice from a medico legal perspective.

Key words: thyroidectomy, survey, neuromonitoring, laryngeal nerve.

Introduction

Thyroid and parathyroid disorders and surgical resection of these glands are very common in the United States [1]. Thyroid nodules are clinically identifiable in 2-6% of all patients, and in up to 35% of patients undergoing sonography [2]. Differentiated thyroid cancer is the most common endocrine malignancy, and it represents the fastest rising cancer in the United States, with incidence rates having doubled in the past three decades [3, 4]. In addition, approximately 2 in every10, 000 people in America develop primary hyperparathyroidism each year [5]. Hence, thyroid and parathyroid surgery is commonplace in the U.S. today [6].

Thyroidectomy and parathyroidectomy are operations conducted by surgeons of varying types and levels of training, surgical experience, and clinical practice settings. While some surgeons seek subspecialty training through a variety of fellowships, the fundamental training in the conduct of the operations is accomplished during the early parts of a surgeon's training - either General Surgery or Otolaryngology residency. From a residency training perspective, there is relatively little interaction between the two surgical training programs, and it is reasonable to hypothesize that operative technique for these procedures may differ substantially between the two surgical communities. Differences might also exist based upon advanced (subspecialty) training, experience, volume of practice, or practice setting.

Of the possible sequelae of thyroid surgery, voice changes are particularly common and may expose surgeons to medico legal risk. Injuries to the recurrent laryngeal nerve (RLN) and external branch of the superior laryngeal nerve (EBSLN) are recognized and justifiably feared complications of thyroid or parathyroid surgery, which impact the voice and related quality of life. Increasingly, however, it is understood that voice changes can occur frequently in the absence of laryngeal nerve injury. Fortunately, the majority of these post-operative changes in voice are transient, but up to 15% remain several months after thyroid surgery [7, 8]. Our group has spent considerable effort to more completely define abnormal voice outcomes after thyroid and parathyroid surgery. We have additionally sought to evaluate potential indicators of durable voice problems after surgery in the hopes of optimizing patient selection for interventions [7-11]. As part of an effort to identify potential gaps in care for which additional research would be useful, as well as further define the current standard of practice among surgeons performing these operations, we conducted a survey study of surgeons to identify screening, surveillance and referral patterns regarding the voice and abnormalities of voice in the setting of thyroidectomy or parathyroidectomy. A portion of this survey pertained to the technical conduct of thyroidectomy and/or parathyroidectomy to identify practice patterns regarding the operations among various surgical communities and surgeons with variable levels of training and experience. These data are presented herein.

Methods

The designee of the Institutional Review Board Chair at Walter Reed Army Medical Center, Washington, D.C. granted exemption for this prospective survey study. A survey was custom designed with the aim of identifying voice screening, surveillance and referral patterns after thyroid and parathyroid surgery. A portion of the survey consisted of technical questions regarding the conduct of thyroidectomy or parathyroidectomy. The survey was beta-tested on five experienced surgical oncologists for face validity and usability, and modified per their suggestions regarding terminology, wording, and general content. The final version of this survey was constructed and disseminated using the professional version of the internet-based survey mechanism Survey Monkey. It consisted of two eligibility questions and 22 questions in the body of the survey, in a combination of free -field, multiple choice, forced choice, ranking, and matrix formats.

An invitation to participate in the survey was distributed twice by the American College of Surgeons (ACS) and the American Association of Endocrine Surgeons (AAES) members via electronic newsletter and email distribution, respectively. The invitation was distributed in November and again in December 2008.

All questions were presented in a fixed order, but when feasible and appropriate, response items within survey questions were randomized. Respondents were allowed to change their responses to any questions prior to submitting as 'final' the survey, after which no further changes could be made. No reward was given for survey completion. Survey responses were collected anonymously, and respondents' IP addresses were not collected; for this reason, multiple responses could potentially be generated from any given computer.

For the purpose of the survey and data analysis, an experienced surgeon was defined as one having more than 10 years experience as an attending surgeon. High -volume surgeons were defined as those performing more than 50 procedures per year. These discriminations were chosen by author consensus as

reasonable cut offs for determining "experienced and high volume" surgeons. Practice setting was designated as "non-university" for those practicing in a community hospital, Department of Defense, or surgery center.

Descriptive statistics included means, medians, ranges and /or percentages. The factors of operative technique between two surgical communities, advanced (fellowship level) training, experience, volume of practice, or practice setting were compared by two sample T-tests. Factors identified as statistically significant were subsequently analyzed in a multivariate generalized linear model to determine if significance remained with other factors controlled. For this study, $p \leq 0.05$ was considered statistically significant.

Results

Of 420 initial website visits to the survey, there were 236 (56%) completed surveys. Two hundred two (86%) survey respondents were from the USA, and 171 (72%) reported residency training in general surgery, with the remainder trained in Otolaryngology/Head and Neck surgery (ENT) residency. Sixty-two percent of respondents reported being in practice for more than 10 years, and 53% reported completing more than 50 thyroid or parathyroid resections per year. The majority (54%) reported being fellowship trained (53% of general surgeons and 57% of ENTs). The most common fellowship training among general surgeons was endocrine (45%), oncology (22%), and head and neck (13%) surgery or combinations of the three sub-specialty surgical fellowships (14%). The most common fellowship training among ENT surgeons was head and neck surgery (81%). One hundred twenty-nine respondents (55%) reported practicing in a non-university setting. Of these, 99 worked in a community hospital, 10 within Department of Defense hospitals, 9 in same day surgery centers, and 11 reported "other" site of work.

The summary of survey responses is given in Table 1. Only 65 (28%) respondents reported that they mostly or always use a RLN neuromonitor during operation, while over half (51%) reported rarely using one. Most surgeons (65%) reported always dissecting out the RLN nerve in the course of the procedure. The majority (74%) of surgeons avoid the use of electrocautery in the tracheoesophageal (TE) groove, but only 26% of respondents routinely use bipolar electrocautery in this location. The majority of surgeons rarely divide strap muscles (namely the sternothyroid muscle at its insertion on the thyroid cartilage in order to gain exposure to the superior pole) during thyroidectomy. Responses regarding searching for the external branch of the superior laryngeal nerve and the use of the harmonic scalpel during surgery were more evenly distributed.

There were considerable technical differences in responses between thyroid/parathyroid surgery according to residency training (i.e. ENTs and general surgeons (Table 2). Regarding the use of RLN neuromonitoring, 55% of ENTs reported usage "almost always" whereas 61% of general surgeons reported "rarely" using neuromonitoring. The mean and standard deviation (SD) were 3.0 (half-time) ± 1.3 for the ENT group and 1.7 (less than sometime) ± 1.2 for the general surgeons ($p < 0.0005$). ENTs also reported that they more often (59% almost always) use bipolar electrocautery during dissection in the TE groove (mean 3.2 ± 1.0) than general surgeons, of whom 60% responded "rare or never" usage (mean 1.7 ± 1.1, $p<0.0005$). The use of RLN neuromonitoring, dissection of the course of the RLN and use of bipolar electrocautery remained significantly different between ENT and general surgeons in a generalized linear model (Table 7).

There were no significant difference between fellowship and non-fellowship trained surgeons regarding reported use of RLN neuromonitoring (Table 3), as nearly half the time neither does so. Fellowship trained surgeons more often dissect out the RLN during operation $p<=0.009$) and more often search for the EBSLN during operation ($p=0.03$) than non-fellowship trained surgeons. Of interest, however, none of these findings on univariate analysis persisted within a generalized linear model when other factors were controlled.

There were statistically significant differences in responses between surgeons of higher and lower volume (Table 4). High volume surgeons reported more often dissecting out the RLN ($p=0.001$) and also reported more frequently using the harmonic scalpel ($p=0.013$), both of which remained significant in a generalized linear model (Table 7).

The survey responses, stratified by surgical experience and practice setting are given in Tables 5 and 6. There were no significant findings stratified by experience level. University surgeons reported more often dissecting the RLN ($p=0.001$) and searching for the EBSLN than non-university colleagues ($p=0.008$; Table 6). However, neither remained significant within generalized linear model (table 7).

The results of the analysis employing generalized linear models of cohort characteristic according to technique response are summarized in Table 7. Only responses related to residency training type and surgeon's annual volume of procedures remained significant with control of other factors.

Table 1. Summary of responses: n, (% of responses).

	Always	Halftime	Sometimes	Rarely	Unsure
Use RLN neuromonitor	65 (28)	14 (6)	34 (14)	120 (51)	3 (1)
Use electrocautery near TE groove	21 (9)	6 (3)	35 (15)	174 (74)	0
Bipolar cautery use near TE groove	62 (26)	20 (9)	44 (19)	109 (46)	1 (0)
Harmonic scalpel use on vessels	74 (31)	30 (13)	41 (17)	89 (38)	2 (1)
Dissect out RLN	153 (65)	30 (13)	30 (13)	22 (9)	1 (0)
Search for EBSLN	66 (28)	30 (13)	70 (30)	68 (29)	2 (1)
Divide strap muscles	13 (6)	7 (3)	57 (24)	157 (67)	2 (1)

RLN: recurrent laryngeal nerve
TE: tracheoesophageal groove
EBSLN: external branch superior laryngeal nerve
Strap muscles: sternothyroid and/or sternohyoid muscles

Table 2: Technical differences in thyroid/parathyroid surgery by residency, n (% of respondents).

	Always/Mostly	Half-time	Some-times	Rarely	Unsure	P (t-test)
Use RLN neuromonitor						
ENT	36(55)	5(8)	9(14)	15(23)	0(0)	<.0005
General Surgery	29(17)	9(5)	25(15)	105(61)	3(2)	
Use electrocautery near TE groove						
ENT	3(5)	0(0)	6(9)	56(86)	-	.004
General Surgery	18(11)	6(4)	29(17)	118(69)		
Use bipolar near TE groove						
ENT	38(59)	10(15)	11(17)	6(9)	0(0)	<.0005
General Surgery	24(14)	10(6)	33(19)	103(60)	1(1)	
Use harmonic scalpel on vessels						
ENT	21(32)	11(17)	12(19)	20(31)	1(2)	.322
General Surgery	53(31)	19(11)	29(17)	69(40)	1(1)	
Dissect RLN						
ENT	46(71)	12(19)	5(8)	2(3)	0(0)	.012
General Surgery	107(63)	18(11)	25(15)	20(12)	1(1)	
Search for EBSLN						
ENT	13(20)	12(19)	27(42)	13(20)	0(0)	.882
General Surgery	53(31)	18(11)	43(25)	55(32)	2(1)	
Divide Strap muscles						
ENT	4(6)	4(6)	15(23)	42(65)	0(0)	.420
General Surgery	9(5)	3(2)	42(25)	115(67)	2(1)	

P-values are from t-test where categories were coded as 4-Always, 3-Half-time, 2-Sometime and 1-Rarely and treated as ordinal data. "Unsure" data were not included in the analysis.

Table 3: Technical differences in thyroid/parathyroid surgery by fellowship training; N, (% of respondents).

	Always/Mostly	Half-time	Some-times	Rarely	Unsure	P(t-test)
Use RLN neuromonitor						
No Fellowship	28(26)	3(3)	12(11)	63(58)	3(3)	.131
Fellowship	37(29)	11(9)	22(17)	57(45)	0(0)	
Use electrocautery near TE groove						

No Fellowship	6(6)	3(3)	15(14)	85(78)	-	.086
Fellowship	15(12)	3(2)	20(16)	89(70)		
Bipolar near TE groove						
No Fellowship	22(20)	9(8)	17(16)	60(55)	1(1)	.016
Fellowship	40(32)	11(9)	27(21)	49(39)	0(0)	
Harmonic on vessels						
No Fellowship	32(29)	9(8)	18(17)	49(45)	1(1)	.08
Fellowship	42(33)	21(17)	23(18)	40(32)	1(1)	
Dissect RLN						
No Fellowship	64(59)	13(12)	16(15)	16(15)	0(0)	.009
Fellowship	89(70)	17(13)	14(11)	6(5)	1(1)	
Look for EBSLN						
No Fellowship	27(25)	12(11)	27(25)	42(39)	1(1)	.031
Fellowship	39(31)	18(14)	43(34)	26(21)	1(1)	
Divide Strap muscles						
No Fellowship	4(4)	2(2)	25(23)	77(71)	1(1)	
Fellowship	9(7)	5(4)	32(25)	80(63)	1(1)	.105

P-values are t-test where categories were coded as 4-Always, 3-Half-time, 2-Sometime and 1-Rarely and treated as ordinal data. "Unsure" data were not included in the analysis.

Table 4: Technical differences in thyroid/parathyroid surgery by surgeon volume N; (% of respondents).

	Always/Mostly	Half-time	Some-times	Rarely	Unsure	P(t-test)
Use RLN neuromonitor						
Low Volume	34(30)	3(3)	10(9)	62(55)	3(3)	.823
High Volume	31(25)	11(9)	24(19)	58(47)	0(0)	
Use electrocautery near TE groove						
Low Volume	9(8)	2(2)	11(10)	90(80)	-	.146
High Volume	12(10)	4(3)	24(19)	84(68)		
Use bipolar near TE groove						
Low Volume	28(25)	8(7)	21(19)	54(48)	1(1)	.500
High Volume	34(27)	12(10)	23(19)	55(44)	0(0)	
Use harmonic scalpel on vessels						
Low Volume	28(25)	11(10)	23(21)	49(44)	1(1)	.013
High Volume	46(37)	19(15)	18(15)	40(32)	1(1)	
Dissect RLN						
Low Volume	62(55)	15(13)	17(15)	18(16)	0(0)	.001
High Volume	91(73)	15(12)	13(11)	4(3)	1(1)	
Look for EBSLN						
Low Volume	26(23)	13(12)	33(30)	40(36)	0(0)	.026
High Volume	40(32)	17(14)	37(30)	28(23)	2(2)	
Divide Strap muscles						
Low Volume	4(4)	4(4)	27(24)	76(68)	1(1)	.400
High Volume	9(7)	3(2)	30(24)	81(65)	1(1)	

P-values are from t-test where categories were coded as 4-Always, 3-Half-time, 2-Sometime and 1-Rarely and treated as ordinal data. "Unsure" data were not included in the analysis.

Table 5: Technical differences in thyroid/parathyroid surgery by years of experience (n, % of responses).

	Always/Mostly	Half-time	Some-times	Rarely	Unsure	P(t-test)
Use RLN neuromonitor						
10 or less	21(29)	4(6)	9(13)	38(53)	-	.330
11 or more	28(24)	4(3)	16(13)	69(58)		
Use electrocautery near TE groove						
10 or less	6(8)	3(4)	8(11)	55(76)	-	.431
11 or more	12(10)	2(2)	26(22)	79(66)		
Use bipolar near TE groove						
10 or less	23(32)	5(7)	11(15)	33(46)	-	.435
11 or more	29(24)	11(9)	22(19)	57(48)		
Use harmonic scalpel on vessels						
10 or less	22(31)	7(10)	10(14)	32(44)	-	.678
11 or more	33(28)	20(17)	20(17)	45(38)		
Dissect RLN						
10 or less	44(61)	11(15)	10(14)	7(10)	-	.862
11 or more	76(64)	14(12)	16(13)	12(10)		
Look for EBSLN						
10 or less	22(31)	12(17)	19(26)	18(25)	1(1)	.235
11 or more	31(26)	16(13)	31(26)	40(34)	1(1)	
Divide Strap muscles						
10 or less	9(13)	3(4)	11(15)	49(68)	0(0)	.164
11 or more	3(3)	2(2)	36(30)	76(64)	2(2)	

P-values are t-test where categories were coded as 4-Always, 3-Half-time, 2-Sometime and 1-Rarely and treated as ordinal data. "Unsure" data were not included in the analysis.

Table 6: Technical differences in thyroid/parathyroid surgery by practice setting, n (% of respondents).

	Always/Mostly	Half-time	Some-times	Rarely	Unsure	P(t-test)
Use RLN neuromonitor						
Non-University	37(29)	3(2)	13(10)	74(57)	2(2)	.308
University	28(26)	11(10)	21(20)	46(43)	1(1)	
Use electrocautery near TE groove						
Non-University	14(11)	4(3)	14(11)	97(75)	-	.581
University	7(7)	2(2)	21(20)	77(72)		
Use bipolar near TE groove						
Non-University	31(24)	10(8)	24(19)	63(49)	1(1)	.297
University	31(29)	10(9)	20(19)	46(43)	0(0)	
Use harmonic scalpel on vessels						
Non-University	43(33)	11(9)	20(16)	54(42)	1(1)	.561
University	31(29)	19(18)	21(20)	35(33)	1(1)	
Dissect RLN						
Non-University	76(59)	14(11)	20(16)	19(15)	0(0)	.001
University	77(72)	16(15)	10(9)	3(3)	1(1)	
Look for EBSLN						
Non-University	31(24)	15(12)	34(26)	49(38)	0(0)	.008
University	35(33)	15(14)	36(34)	19(18)	2(2)	
Divide Strap muscles						

Non-University	5(4)	2(2)	28(22)	93(72)	1(1)	.035
University	8(8)	5(5)	29(27)	64(60)	1(1)	

P-values are from t-test where categories were coded as 4-Always, 3-Half-time, 2-Sometime and 1-Rarely and treated as ordinal data. "Unsure" data were not included in the analysis.

Table 7: P values of results of generalized linear models between cohort characteristic and technique response.

	RLN neuro-monitor (n=234)	Electro-cautery near TE groove (n=236)	Bipolar near TE groove (n=235)	Harmonic scalpel on vessels (n=234)	Dissect RLN (n=235)	Look for EBSLN (n=234)	Divide Strap Muscles (n=234)
Residency (ENT v. general surgery	**<.0005**	.058	**<.0005**	.31	**.040**	.91	.37
Fellowship training (Y/N)	.411	.092	.726	.895	.483	.497	.404
Setting (university v. other	.353	.112	.356	.937	.708	.265	.215
Volume (≥51vs. <50 Cases per year)	.438	.610	.373	**.047**	**.035**	.161	.980

Discussion

Thyroidectomy and parathyroidectomy are operations commonly performed in the United States today. These operations are performed by surgeons of varying types and extent of training, varying years of experience and practice volume, and in different practice settings. Although the technique required for safe removal of the thyroid gland or parathyroid gland(s) is considered relatively standard, our experiences suggested that there are significant differences among surgeons in some of the details of how these technical steps are accomplished, and the operating tools used to accomplish them. In this study, which was the first to our knowledge to quantify differences in how thyroidectomy or parathyroidectomy is conducted among different surgeon groups and surgeons of varying levels of training and experience, we have confirmed that substantial variability in the conduct of these operations exists. It is our hope that this report may inform endocrine surgeons of diverse backgrounds of the current practice patterns regarding these operations, an understanding which may have potential beneficial impact upon individual surgeons' practices. It is also our hope that these data may serve to further define practice patterns from a medico legal perspective, particularly with regards to the use (or not) of RLN neuromonitoring.

Only 28% of our respondents reported using the RLN neuromonitor "most of the time" or "always" and 51% reported rarely using one, which is likely a reflection of the proportion of general surgeons who responded to the survey- as the most striking differences in usage appeared between the ENT and general surgeons. Fifty-five percent of ENTs reported "almost always/mostly" using laryngeal neuromonitoring, while 61% of general surgeons reported "rarely" using it. A prior survey study of 555 ENTs reported that only 29% used RLN neuromonitoring on all thyroidectomy cases, [12] which is somewhat lower than the percentages of ENTs reporting similar RLN usage rates in our study. While rates of usage of RLN neuromonitoring between ENTs and general surgeons are different, to our knowledge, no compelling or contemporary data have been published that demonstrate a difference in RLN injury rates by specialty training.

Numerous studies have been published regarding the potential benefits and limitations of RLN neuromonitoring [13-18]. The largest non-randomized study of RLN neuromonitoring in thyroid surgery did not show a statistically significant difference in the incidence of RLN injury as a function of neuromonitoring [14]. Similarly the only randomized controlled study published to date failed to demonstrate a decreased rate of permanent RLN injury in patients undergoing thyroidectomy with RLN neuromonitoring [16]. There are numerous implications of the decision to use or not to use RLN neuromonitoring, which may not necessarily pertain to RLN injury itself. For instance, surgeons may perceive medico-legal pressures to use a neuromonitor (as a defense if nerve injury is sustained), and some patients may choose a surgeon in part on RLN neuromonitor usage. Some experts maintain that RLN neuromonitoring represents the current standard of practice for thyroid or parathyroid procedures [12] Assuming a standard of practice is one that would be adopted by reasonable surgeons under similar circumstances, our survey results would suggest that the routine use of RLN neu-

romonitoring among surgeons is not collectively viewed as the standard of care. Other factors such as training and cost may also influence use or lack of use of RLN neuromonitoring.

Nearly two thirds of surgeons in this survey routinely dissect the RLN during thyroidectomy or parathyroidectomy. Upon univariate analysis, University-based, ENT, fellowship trained, and high volume surgeons reported more often dissecting the RLN during the course of these operations than non-university surgeons, general surgeons, those without fellowship training, and those with lower volumes. In the multivariate model, ENT training and high volume of procedures remained significant. While many surgeons accept that nerve identification (through either simply observing it in the course the dissection for thyroidectomy or parathyroidectomy or actively searching for it via additional dissection) provides a higher measure of safety to the operation [19,20] versus non-identification of the nerve, many experienced thyroid surgeons would attest that if the operation is conducted properly the nerve is almost always encountered regardless of whether one actively searches for it or not. The contested issue of whether nerve safety is enhanced by dissection of its course remains debated among endocrine surgeons, and published data are conflicting on this point. A large single- institution series demonstrated lower rates of RLN injury with increasing exposure of the RLN [19] whereas a randomized trial demonstrated no difference [21]. In addition, others have actually reported even increased rates of RLN injury with increased efforts to trace its course during operation [22]. Understanding that the majority of nerve injuries accrue not by failure to identify the RLN, but rather as a result of traction, cautery-related injury, dissection of the central compartment, or incorporation of the nerve by ligatures [17] (all being issues of surgical technique rather than RLN identification), the widespread practice of routine dissection of the course of the nerves seems to us to be somewhat counter-intuitive. It is also possible that responses to this portion of the survey may also represent referral patterns- as more complex thyroid or parathyroid operations may require (for one reason or another) some element of RLN dissection. As well, the length of the course of RLN dissection was not clarified in this study, so some surgeons may have reported routine dissection as a response to simply dissecting near the nerve in the area of the Ligament of Berry rather than its entire course in the central neck (see below).

The recurrent laryngeal nerves characteristically lie in the tracheoesophageal groove as they ascend toward their insertions into the cricothyroid joint. The parathyroid glands are nearby the nerve as are the lateral (Tubercle of Zuckerkandl) extensions of the thyroid gland. As such, some dissection within the tracheoesophageal groove in proximity to the RLN is typically required in the course of total thyroidectomy or parathyroidectomy, and the nerve may be injured during the course of dissection. Nearly 75% of the respondents reported rarely using monopolar electrocautery within the TE groove, which would seem to be in accordance with prudent surgical judgment, given the possibility of electrical injury to the nerve in this area. About a quarter of our respondents reported routine use of bipolar electrocautery in this region. There was a striking difference in the rates of bipolar usage among general surgeons versus ENT surgeons, with the majority of general surgeons rarely or never using bipolar electrocautery during thyroidectomy, a difference that remained significant within the multivariate model. Again, this likely reflects a difference in training philosophy between the surgical traditions.

Most surgeons appear not to routinely search for the EBSLN. However, fellowship trained and university surgeons reported more routinely searching for the EBSLN than their comparison group - although this finding did not remain significant in the multivariate model. The EBSLN courses from superior-lateral to inferior-medial on its course to the cricothyroid muscle near the superior pole of the thyroid gland [23]. The nerve crosses the superior pole vasculature at various levels and is thus prone to injury during the mobilization of the superior thyroid pole and control of its vascular pedicle, particularly in cases where the nerve crosses below the level of the apex of the superior pole [23]. Though small in diameter, experienced surgeons are usually able to identify the EBSLN [24-26]. However, the utility of routine identification of the nerve in preventing EBSLN injury is controversial. In a randomized trial, Cernea et al reported lower rates of injury to the EBSLN when it was directly observed [25]. In contrast, Bellantone et al identified no significant increase in rates of abnormal laryngoscopic or acoustic outcomes between two groups randomly assigned to have the EBSLN identified or not during thyroidectomy, as long as the superior pole vasculature was ligated low on the superior pole (adjacent to the capsule) of the gland [26].

Nearly a third of the respondents in this study routinely use the harmonic scalpel during thyroidectomy or parathyroidectomy. High volume surgeons seem to favor its usage most with over 50% of high volume surgeons reporting usage in at least half of cases. Harmonic scalpel utilization has been demonstrated in both individual trials [27] and meta-analysis

of randomized trials to consistently result in reduced operative time, and perhaps less operative site pain and hypocalcemia [28,29]. Proponents of the "sutureless thyroidectomy" using the harmonic scalpel argue that the additional cost of the device is offset by reduced operative time. The LigaSure device (Covidien, Dublin, Ireland) has also been demonstrated to reduce operative time during thyroidectomy compared to conventional hemostatic techniques, but rates of surgical complications using the this device appear not to be reduced compared to conventional techniques [30]. The present survey did not include questions regarding Ligasure use.

The division of the strap musculature (particularly the sternothyroid muscle near its insertion into the thyroid cartilage) can facilitate exposure during thyroidectomy, particularly of the superior pole vasculature, and this technical maneuver does not appear to have substantial impact on voice outcomes [31]. However, the vast majority of respondents in our study report that strap muscle division is rarely employed during thyroidectomy. Surgeons with 10 or fewer years of practice reported more often routine sectioning (13%) of the strap muscles as compared to the more experienced group, but this finding did not remain significant in the multivariate model. However, 30% of more experienced surgeons reported that they sometimes section the strap muscles. This finding may be reflective of clinical experience and volume, as well the referral of more complex cases. Meaning, while most surgeons may not favor the routine division of the strap muscles, experienced surgeons may have accrued sufficient clinical exposures (and experience with difficult cases) wherein they have found this technical maneuver to be occasionally useful.

There are limitations to the study that should be mentioned. The primary aim of this survey study was to determine screening, surveillance and referral patterns among surgeons who conduct thyroidectomy and parathyroidectomy. As such, the technical questions were brief in nature to keep the survey short. As such, this study does not represent a comprehensive survey of all potentially interesting technical differences in the conduct of these operations among surgeons. Also, we submitted this survey to the AAES, and ACS, which may not be reflective of the entire population of surgeons performing these operations. Distribution of the survey between these two societies differed (AAES e-mail distribution versus posting a survey link in ACS New scope). Lastly, some respondents raised occasional issue with some of the survey terminology in the comments box made available at the end of the survey.

In conclusion, we report the results of a survey of surgeons performing thyroidectomy and parathyroidectomy. Of survey respondents, 62% were classified as experienced (over 10 years experience), 53% were high volume (over 50 procedures annually), and 54% were fellowship trained. Most surgeons (65%) responding in this survey routinely dissect the RLN and do not routinely use RLN neuromonitoring- to the contrary, 51% report never using one or rare usage . There are several important differences in how these operations are performed based upon training, experience, practice volume and setting, with differences in technique by residency training type and surgeon volume remain significant with control of other variables. It is our hope that endocrine surgeons may find these data useful in reflecting upon their own practice and that these data may be also be useful from a medico legal perspective as illuminating of current standards of practice regarding these operations.

Abbreviations

AAES: American Association of Endocrine Surgeons; ACS: American College of Surgeons; EBSLN: External Branch of Superior Laryngeal Nerve; ENT: Ear Nose and Throat Surgery, (Otolaryngologists); RLN: Recurrent Laryngeal Nerve; TE groove: Tracheoesophageal groove.

Author contributions

Conception and design: Henry, Helou, Solomon, Chang, Stojadinovic. **Acquisition of data:** Helou, Libutti. **Analysis and interpretation of data**: Henry, Helou, Solomon, Stojadinovic. **Drafting of manuscript:** Henry. **Critical revision**: Helou, Solomon, Libutti, Stojadinovic. **Statistical expertise:** Chang. **Supervision**: Stojadinovic, Solomon.

We certify that all individuals who qualify as authors have been listed; each has participated in one or more of the following areas: conception and design of this work, the acquisition and/or analysis of data, the writing, and/or critical revision of the document, and supervision of this cooperative research effort. All contributing authors approve of the submission of this version of the manuscript and assert that the document represents valid work. If information derived from another source was used in this manuscript, we obtained all necessary approvals to use it and made appropriate acknowledgements in the document. All contributing authors take public responsibility for this work.

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Competing Interests

The authors have declared that no competing interest exists.

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