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ORIGINAL SCIENTIFIC REPORT

Association of Surgical Volume and Quality Management in Thyroid Surgery: A Two-Nation Multicenter Study

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Abstract

Background High-volume caseload in thyroid surgery is associated with lower postoperative complication rates resulting to better outcomes. The aim of the present study was to investigate the correlation of the departments' annual number of thyroid surgeries on the adherence to consensus guidelines and on the implementation of measures for quality assurance.

Methods In 2016, we sent an anonymous electronic survey with questions related to the perioperative management in thyroid surgery to all directors of departments in operative medicine in Switzerland and Austria. We compared the pre- and postoperative management with the summarized recommendations of the four most frequently used consensus guidelines. Analogously, we analyzed the implementation of six measures for quality assurance related to thyroid surgery for each participating department. Using logistic regression analysis, we evaluated the correlation of number of guidelines respected and number of measures for quality assurance with the departments' annual number of surgeries performed. Furthermore, we evaluated the number of departments providing thyroid cancer surgery and their experience in neck dissection.

Results The management corresponded in 64.0% to the summarized recommendations. Adherence to the summarized recommendations and implementation of measures for quality assurance were significantly more likely with increasing numbers of surgeries performed ($p = 0.049$ and $p < 0.001$). Ninety-two departments provided thyroid cancer surgery, whereas 12/92 (13.0%) were not able to perform central and/or lateral neck dissection.

Conclusion Consensus guidelines are insufficiently implemented within thyroid surgery, and quality management is associated with surgical volume.

Dominik A. Jakob and Philipp Riss contributed equally to this work.

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Introduction

The positive effect of the implementation of evidence-based quality measures on survival and patient safety has been documented in colon cancer care [1]. Although survival rates in colon and thyroid cancer are different, the positive effects on patient safety might be generalized for the surgical treatment of all patients. Furthermore, it is well known that surgeons with a high-volume caseload have lower postoperative complication rates and better outcomes [2–5]. Besides surgical skills and experience, an underlying reason might be a better adherence of high-volume surgeons to consensus guidelines [6]. However, the definition for a high-volume surgeon in thyroid surgery varies widely, ranging from 25 to 100 procedures per year [7, 8].

In various countries, a large number of thyroid surgeries are performed in hospitals with a low annual number of surgeries, including Switzerland and Austria: In 2016, 48.6% of the hospitals provide thyroid surgery performed between 1 and 30 thyroid resections [9, 10]. To provide the same perioperative management standards in all hospitals and to maintain lower complication rates in thyroid surgery, different consensus guidelines have been written by independent professional scientific organizations worldwide [11–19]. While the role of prophylactic central compartment neck dissection is contentious [7], the guidelines provide clear recommendations on surgery for clinically or radiographically evident lymph node metastases and on prophylactic lateral compartment neck dissection [11–19].

The aim of the present study was to assess the implementation of consensus guidelines in thyroid surgery and to evaluate the correlation of the departments' annual number of thyroid surgeries on the adherence to consensus guidelines and on the implementation of measures for quality assurance.

Materials and methods

Study design

An anonymous electronic survey was provided to all departmental directors within operative medicine in Switzerland and to all members of the "working group surgical endocrinology" of the Austrian Society of Surgery in their national languages in 2016. Heads of thyroid surgery completed the surveys. Eligible participants in Switzerland were identified from the database of the Swiss Surgical Society and in Austria from the society's membership register. Response enhancement techniques included advanced notification by the working groups in endocrine surgery in Switzerland [20] and Austria [21], as well as a mailed reminder. Participants were anonymized using online survey software Qualtrics^{TM} [22].

Survey structure

The survey was subdivided into four sections. The first section addressed the characteristics of the participating departments (hospital category, number of beds available, number of thyroid surgeries in 2016, and conduct of surgery for thyroid cancer). We correlated hospital categories of Switzerland and Austria according to the SIWF (Swiss Institute for Postgraduate and Further Education in Medicine)/FMH (Swiss Medical Association) criteria in Switzerland [23] and the corresponding criteria in Austria.

In Sect. 2, participants were questioned about the preoperative diagnostics (thyroid ultrasonography and scintigraphy, fine needle aspiration (FNA) in suspicious thyroid nodules, laboratory investigations [thyroid stimulating hormone (TSH), calcium, parathyroid hormone (PTH), and calcitonin], and routine preoperative laryngoscopy).

In Sect. 3, the intraoperative management (types of resections performed, conduct of central and lateral neck dissection, use and type of intraoperative neuromonitoring, surgical strategy in case of intraoperative recurrent laryngeal nerve injury, and conduct of intraoperative frozen section) was addressed. Section 4 assessed the postoperative management (laboratory investigations [calcium and PTH], routine postoperative laryngoscopy, provision of postoperative outpatient care, analysis of quality results/implementation of morbidity and mortality conferences, and quality control/documentation of complications).

Main outcomes

We compared the pre- and postoperative management with the recommendations of the four most frequently used consensus guidelines in Switzerland and Austria, originating from the American Association of Clinical Endocrinologists, American College of Endocrinology, and Associazione Medici Endocrinologi (AACE/ACE/AME) [11], the American Thyroid Association (ATA) [12], the European Society for Medical Oncology (ESMO) [13], and the German Association of Endocrine Surgeons (CAEK) [14]. We excluded the intraoperative management for various reasons: Firstly, due to irreconcilable recommendations regarding the indication for total thyroidectomy in the four consensus guidelines. Secondly, different experiences of participating departments in neck dissection lead

to a different surgical approach independent of the guidelines. Lastly, only optional recommendations exist for the application of intermittent and continuous neuromonitoring.

We identified 11 domains, which were recommended in the pre- and postoperative workup in at least one of the four consensus guidelines: thyroid ultrasonography, thyroid scintigraphy, FNA in suspicious thyroid nodules, preoperative TSH, calcium, PTH and routine serum calcitonin, preoperative laryngoscopy, postoperative calcium and PTH, and postoperative laryngoscopy. Measurements of postoperative calcium and PTH were included in the present study, as they are acknowledged in the ATA guidelines [12].

In the present study, preoperative thyroglobulin antibodies were excluded due to their limiting recommendation by the AACE/ACE/AME guidelines only. They are exclusively recommended in a small subset of patients with the suspicion of chronic lymphocytic thyroiditis and normal antithyroid peroxidase antibodies [11]. Furthermore, preoperative neck ultrasonography was excluded, as this is part of the thyroid ultrasonography for all patients with known or suspected thyroid cancer [11–14, 24]. Additionally, preoperative computed tomography and magnetic resonance imaging were excluded, as they are recommended only in the ATA guidelines as an adjunct to thyroid ultrasonography in a subset of patients with advanced disease [12].

Due to different recommendations in the four consensus guidelines, we summarized the recommendations for each domain. We evaluated adherence to the 11 summarized recommendations for each participating department. Subsequently, we performed a sum score for adherence to the 11 summarized recommendations, reaching from zero (no adherence to consensus guidelines) to 11 (adherence to all domains of the consensus guidelines).

Similarly, we analyzed the implementation of measures for quality assurance for each participating department, including application of intermittent neuromonitoring, postoperative measurement of calcium and/or PTH, postoperative laryngoscopy, provision of postoperative care by the operating department's team, analysis of the quality results/implementation of morbidity and mortality conferences, quality control/documentation of complications. We calculated a sum score for the six measures for quality assurance, ranging from zero (no implementation of measures for quality assurance) to six (implementation of all measures for quality assurance).

Furthermore, we evaluated the number of departments providing thyroid cancer surgery in relation to the experience in neck dissection.

Statistical analysis

We compared the distribution of the surgical volume of the departments included in the present study with the surgical volume of all surgical departments performing thyroid surgery in Switzerland and Austria by using Mann–Whitney *U* test [9, 10]. Data were reported as median and interquartile ranges (IQR).

Using a logistic regression analysis, we evaluated the correlation of the sum scores (number of guidelines respected and number of measures for quality assurance) within the departments' annual number of surgeries performed. Similarly, we evaluated the correlation of the ability to perform central and lateral neck dissection for departments providing thyroid cancer surgery with the departments' annual number of surgeries performed.

We assessed the correlation between the sum scores of adherence to consensus guidelines recommendations and implementation of measures for quality assurance with spearman correlation analysis.

Mann–Whitney *U* test was used to compare the adherence to the summarized guidelines recommendations and the implementation of measures for quality assurance in departments providing carcinoma surgery with experience versus no experience in central and/or lateral neck dissection.

We expressed categorical outcomes as frequencies and percentages. For data analysis, we used SPSS version 25.0 (IBM, Armonk, NY). All statistical tests were two-sided with a significance level of 0.05.

Results

We distributed 239 questionnaires and received a full reply from 104 (43.5%) surgical departments (Fig. 1). Characteristics of the participating departments are shown in Table 1. The surgical volume of the participating departments was significantly higher compared to the surgical volume of all surgical departments performing thyroid surgery in Switzerland [9] and Austria [10] (75 [IQR 35–150] vs. 36 [IQR 10–81]; $p < 0.001$).

Details relating to the pre-, intra-, and postoperative management in Switzerland and Austria are shown in Supplementary Table 1–3.

Adherence to guideline recommendations versus patient volume

The most pertinent consensus guidelines with their recommendations for the 11 evaluated pre- and postoperative diagnostic instruments are shown in Table 2. The four consensus guidelines covered between 3/11 (27.3%) and

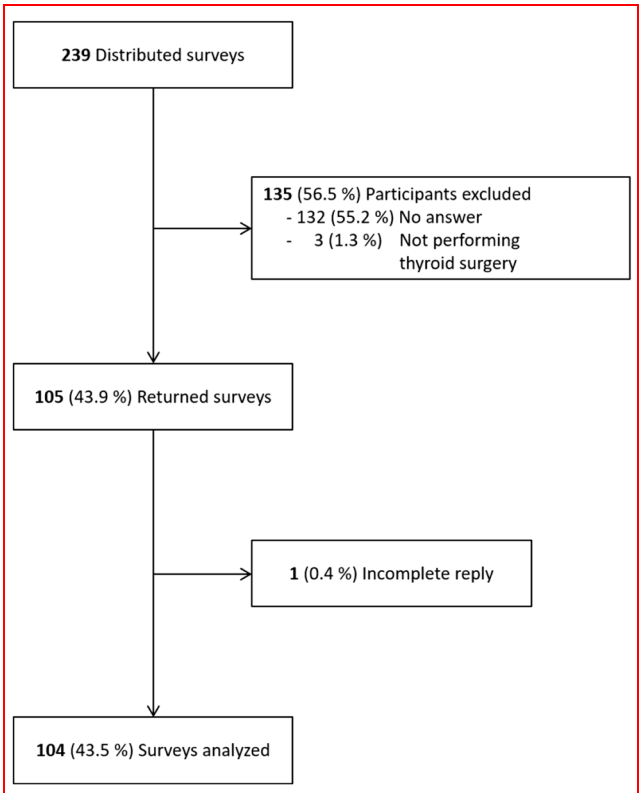

Fig. 1 Flowchart of participating departments

8/11 (72.7%) diagnostic instruments with a recommendation.

The adherence to the summarized recommendations by the participating departments for each pre- and postoperative diagnostic instrument is shown in Table 2. Overall, the management corresponded in 64.0% to the summarized recommendations. Adherence to the summarized recommendations was significantly more likely with increasing numbers of surgeries performed ($p = 0.049$; Fig. 2).

Implementation of quality assurance measures versus patient volume

While 2/104 (1.9%) departments did not use a single measure for quality assurance, 18/104 (17.3%) had implemented all analyzed measures for quality assurance. The implementation of measures for quality assurance was significantly more likely with increasing numbers of surgeries performed ($p < 0.001$; Fig. 3).

The implementation of measures for quality assurance did not correlate with the adherence to the summarized consensus guidelines recommendations ($r = 0.071$; $p = 0.473$).

Experience in neck dissection in departments providing thyroid cancer surgery

Ninety-two of 104 (88.5%) departments provided thyroid cancer surgery. However, 12/92 (13.0%) departments were not able to perform central and/or lateral neck dissection.

Departments with higher numbers of surgeries were significantly more often able to perform lateral neck dissection ($p = 0.038$). No statistical significance was found for central neck dissection ($p = 0.089$; Figs. 4 and 5).

The implementation of measures for quality assurance was significantly lower in departments providing carcinoma surgery with no experience compared to departments with experience in central and/or lateral neck dissection (3.0 [IQR 2.0–4.0] vs. 4.5 [IQR 3.0–5.0]; $p < 0.021$). No

Table 1 Characteristics of the participating departments

Characteristic	Overall ($n = 104$)		University hospital ($n = 9$)		Large referral center ($n = 28$)		Regional or specialized hospital ($n = 52$)		Private practice ($n = 15$)	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
No. of thyroid surgeries in 2016										
Quartile 1 (< 35)	24	23.1	0	0.0	3	10.7	18	34.6	3	20.0
Quartile 2 (35–74)	25	24.0	1	11.1	5	17.9	16	30.8	3	20.0
Quartile 3 (75–149)	26	25.0	2	22.2	7	25.0	10	19.2	7	46.7
Quartile 4 (> 149)	29	27.9	6	66.7	13	46.4	8	15.4	2	13.3
No. of surgeons performing thyroid surgery										
1–2	47	45.2	2	22.2	7	25.0	31	59.6	7	46.7
≥ 3	55	52.9	7	77.8	20	71.4	20	38.5	8	53.3
Surgery for thyroid cancer										
Yes	92	88.5	9	100.0	26	92.9	43	82.7	14	93.3
No	12	11.5	0	0.0	2	7.1	9	17.3	1	6.7

Some percentages do not add to 100 because of missing data

Table 2 Pre- and postoperative diagnostics performed compared to the recommendations in the most pertinent consensus guidelines

Characteristic	AACE/ACE/AME (2016)	ATA (2015)	ESMO (2012)	CAEK (2013)	Summarized recommendation	Departments with management according to summarized recommendation
Thyroid sonography	Recommended	Recommended	Recommended	Recommended	Recommended	102 (98.1%)
Thyroid scintigraphy	Recommended*: low TSH, suspicion of ectopic thyroid tissue/retrosternal goiter, iodine-deficient regions	Recommended*: low TSH	N/A	Recommended*: useful for low TSH	Recommended*: low TSH	10 (9.6%)
FNA in suspicious thyroid nodules	Recommended	Recommended	Recommended	Recommended	Recommended	63 (60.6%)
Preoperative laboratory investigations						
TSH	Recommended	Recommended	N/A	N/A	Recommended	99 (95.2%)
Calcium	Recommended*: suspicion of parathyroid adenoma on US	N/A	N/A	Recommended	Recommended/*	100 (96.2%)
PTH	Recommended*: suspicion of parathyroid adenoma on US	N/A	N/A	N/A	Recommended*: suspicion of parathyroid adenoma on US	68 (65.4%)
Routine serum calcitonin	Recommended*: US or cytologic findings suggestive of MTC, family history or clinical suspicion of MTC or MEN 2	NR	Recommended	Recommended	Recommended	42 (40.4%)
Preoperative laryngoscopy	Recommended	Recommended*: abnormal voice, reoperations, extrathyroidal cancer/extensive central lymph node metastases	N/A	Recommended	Recommended	83 (79.8%)
Postoperative laboratory investigations						
Calcium	N/A	Recommended	N/A	N/A	Recommended	93 (89.4%)
PTH	N/A	Recommended	N/A	N/A	Recommended	39 (37.5%)
Postoperative laryngoscopy	N/A	Recommended*: abnormal voice	N/A	N/A	Recommended*: abnormal voice	33 (31.7%)

AACE/ACE/AME American Association of Clinical Endocrinologists, American College of Endocrinology, and Associazione Medici Endocrinologi; *ATA* American Thyroid Association; *ESMO* European Society for Medical Oncology; *CAEK* German Association of Endocrine Surgeons; *FNA* fine needle aspiration; *MEN 2* multiple endocrine neoplasia type 2; *MTC* medullary thyroid cancer; *NR* not recommended; *N/A* not available; *recommended**, recommended with limitation; *TSH* thyroid stimulating hormone; *PTH* parathyroid hormone; *US* ultrasound

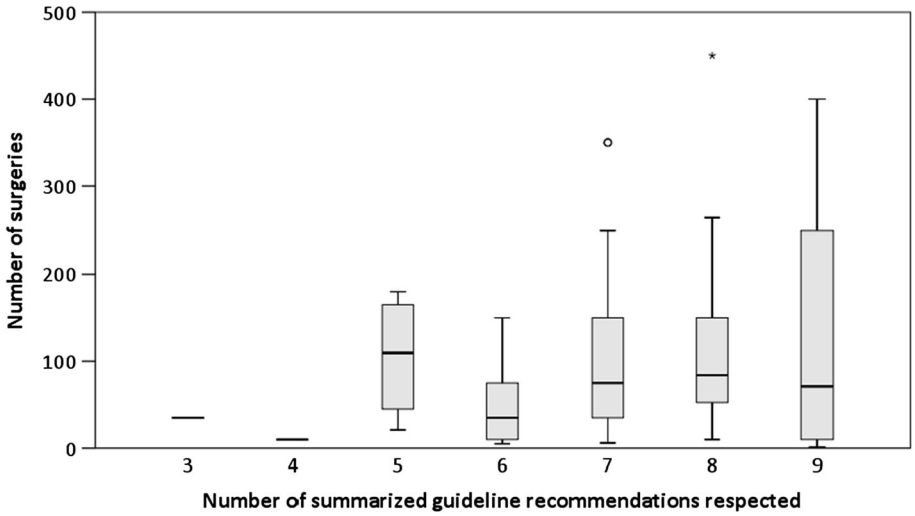

Fig. 2 Adherence to consensus guidelines according to the number of surgeries performed. Box plots of the annual number of surgeries performed, separated according to the summarized number of consensus guidelines respected. We calculated the latter by comparing the current perioperative management in thyroid surgery for 11 different items with the summarized recommendation of the most frequently used consensus guidelines (ATA, AACE/ACE/AME, ESMO, CAEK). The central bar represents the median, the box represents the interquartile range, and the bars represent the data range. The dot represents three mild outlier departments; the asterisk shows one extreme value; another extreme value of a department performing 900 surgeries per year and respecting seven guidelines in total is not shown

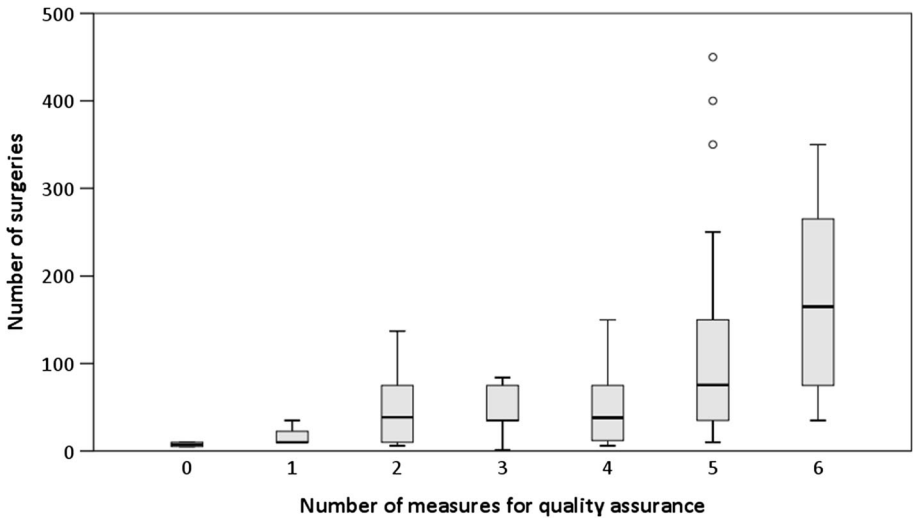

Fig. 3 Quality assurance according to number of surgeries performed. Box plots of the annual number of surgeries performed, separated according to the number of measures of quality assurance used (application of intermittent neuromonitoring, postoperative measurement of calcium and/or parathyroid hormone, postoperative laryngoscopy, provision of postoperative care by the operating department's team, analysis of the quality results/implementation of morbidity and mortality conferences, quality control/documentation of complications). The central bar represents the median, the box represents the interquartile range, and the bars represent the data range. The dots represent mild outlier departments; an extreme value of a department performing 900 surgeries per year and using six measures for quality assurance is not shown

significant difference was found for the adherence to the summarized guideline recommendations (7.0 [IQR 6.25–7.75] vs. 7.0 [IQR 6.0–8.0]; $p < 0.828$).

Discussion

The departments' management in thyroid surgery corresponded in only two-thirds with the recommendations in consensus guidelines. Higher adherence to

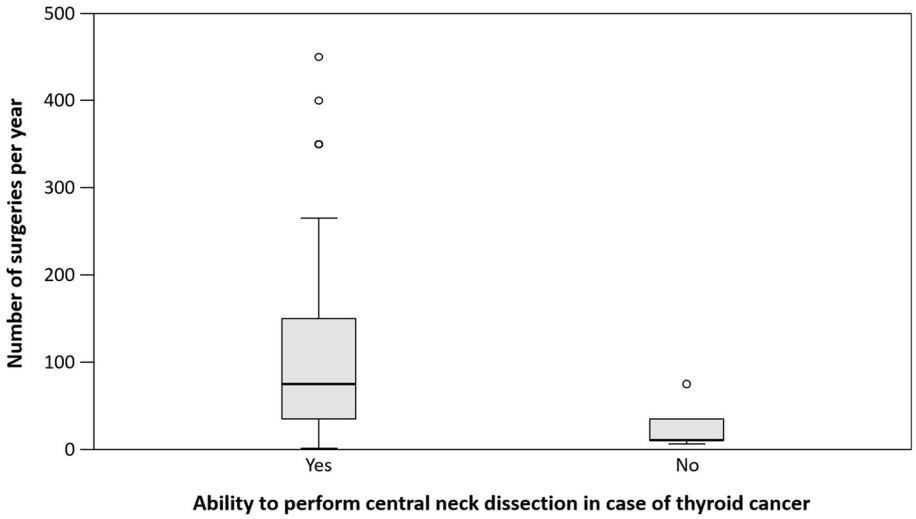

Fig. 4 Ability to perform central neck dissection in case of thyroid cancer according to number of surgeries performed. Box plots of the annual number of surgeries performed, separated according to the ability to perform central neck dissection in case of thyroid cancer for 92 departments providing thyroid cancer surgery. The central bar represents the median, the box represents the interquartile range, and the bars represent the data range. The dots represent mild outlier departments (the dot in bold represents three departments); one extreme value of an outlier department performing 900 surgeries per year with the ability to perform central neck dissection in case of thyroid cancer is not shown

recommendations in consensus guidelines and higher implementation of measures for quality assurance were both independently and significantly associated with higher numbers of surgeries performed. Furthermore, the results of the present study suggest a lack of experience in neck dissection in 13% of the departments providing thyroid cancer surgery.

Comparison with the literature

Individual surgeon's volume rather than the hospital's volume is associated with complication rates and length of stay for thyroidectomy [2]. Adam et al. identified a surgeon volume threshold (> 25 total thyroidectomies per year) that is associated with improved patient outcomes [8]. However, other studies revealed the hospital's volume as an indicator for optimized patient care [25, 26]. Evidence-based quality standards might explain positive effects on various patient-relevant outcomes. In the present study, we analyzed the quality management in thyroid surgery based on two system processes (adherence to consensus guidelines and implementation of measures for quality assurance), which are more specific for a department than for a single surgeon. We therefore focused on the association with the department's volume.

Guidelines are not consistently applied into practice. The consistency of the department's management with the recommendations in consensus guidelines in only two-thirds in the present study is in accordance with the findings in other medical fields [27]. A possible explanation for this may refer to the high number of different consensus guidelines for thyroid surgery worldwide [11–19]: A vast number of guidelines may lead to uncertainty about implementation due to interacting contextual challenges [28]. Recommendations in the four consensus guidelines analyzed in the present study varied from "recommended" to "not recommended" for a single parameter. Low adherence to guidelines leads to preventable harm, suboptimal patient outcomes or experiences, or unnecessary consumption of resources [29]. Our findings suggest a specific deficit of quality management in low-volume departments due to their significantly lower adherence to consensus guidelines.

Based on the finding of a positive effect of the application of evidence-based quality measures on patient safety [1], our data further suggest an impairment of quality management in low-volume departments due to a low implementation of measures for quality assurance. The latter enables early identification and treatment of complications to improve the outcome. This would include the analysis of medical incidences in order to improve understanding of causative factors and to assess alternative treatment processes [30, 31].

Only 17.3% of the participating departments fully complied with all quality measures. Considering the reporting bias with higher volume centers being more likely to complete the survey, the overall prevalence of departments implementing all measures for quality assurance might be even lower. A possible explanation for the low compliance in Switzerland and Austria is that three of

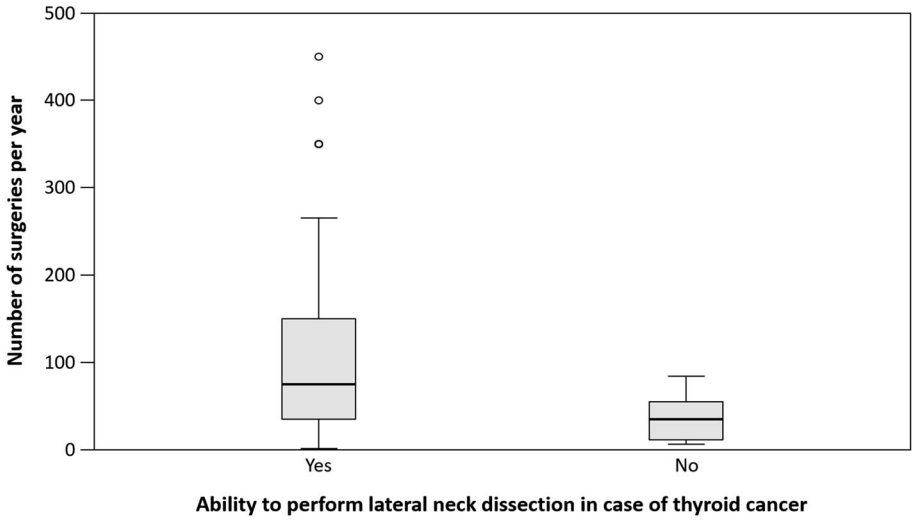

Fig. 5 Ability to perform lateral neck dissection in case of thyroid cancer according to number of surgeries performed. Box plots of the annual number of surgeries performed, separated according to the ability to perform lateral neck dissection in case of thyroid cancer for 92 departments offering thyroid cancer surgery. The central bar represents the median, the box represents the interquartile range, and the bars represent the data range. The dots represent mild outlier departments (the dot in bold represents three departments); one extreme value of an outlier department performing 900 surgeries per year with the ability to perform lateral neck dissection in case of thyroid cancer is not shown

the six quality assurance measures (aftercare by the specialist department team, analysis of quality results/implementation of morbidity and mortality conferences, quality control/documentation of complications) are not part of the recommendations in the most frequently used consensus guidelines. Nevertheless, they are part of accurate perioperative patient care. Furthermore, the involvement of several disciplines in the perioperative management of patients with thyroid surgery (especially surgery, endocrinology, and head and neck surgery) might lead to an outsourcing of aftercare.

Overall, 13% of departments provide thyroid cancer surgery without experience in central and/or lateral compartment neck dissection. Low-volume departments were significantly less able to perform a lateral compartment neck dissection. Furthermore, the implementation of measures for quality assurance was significantly lower in departments providing carcinoma surgery with no experience compared to departments with experience in central and/or lateral neck dissection.

Although a prophylactic neck dissection of the lateral compartment is not recommended and the role of prophylactic central compartment neck dissection remains contentious [7], clinically or radiographically suspicious lymph nodes always must be resected on behalf of a therapeutic central or lateral neck dissection [11–14]. Thyroid cancer surgery therefore should only be provided by departments with experience in central or lateral neck dissection.

Implication

Our results have implications for clinicians, especially in low-volume departments, and guideline committees. The present work illustrates the necessity for the clinicians to reflect their own adherence to consensus guidelines and implementation of measures for quality assurance. Endocrine surgeons should be aware of the indication of therapeutic neck dissection according to consensus guidelines with the corresponding practical and technical skills.

The present study supports previous data that guideline committees should provide guidelines accompanied by implementation support to improve their distribution and use [28].

Strengths and limitations

This is the first study to evaluate the association of surgical volume and quality management in thyroid surgery. Strengths and limitations can be identified. One strength is the nationwide distribution of the survey in two different countries and all respective national languages.

The response rate was comparable to other surveys among surgeons [32]. However, a low response rate can lead to a non-responder bias and has the potential of creating a non-representative sample. This can question the validity of the survey [33]. Surgical departments with a higher surgical volume were more likely to participate in the present study. We would expect an even higher

association of quality management with the surgical volume, if the hospitals with lower surgical volume had participated equally.

A limitation of the present study is that the questionnaires were only answered by the responsible persons for thyroid surgery of each participating department. One reply may therefore represent the practice of a group of different surgeons. Variations in perioperative management among the latter might lead to a reporting bias. Furthermore, we cannot exclude that the perioperative management reported by the participants is according to the consensus guidelines, but not according to clinical practice. The perioperative management was compared to the summary of the four most frequently used consensus guidelines, as surgeons in Switzerland and Austria usually do not only use a single guideline.

The postoperative complication rates, such as recurrent laryngeal nerve injury, postoperative hypoparathyroidism, and hemorrhage, are not recorded by the present survey. This would allow to further measure quality in thyroid surgery. However, data were not collected systematically by the participating departments and therefore are difficult to evaluate. The present study demonstrates that only half of the departments perform a quality control with documentation of complication rates.

Conclusions

The present two-nation multicenter study shows that consensus guidelines are insufficiently implemented in thyroid surgery, and that quality management is associated with the surgical volume.

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Author contributions PR and RMK designed the study. PR and RMK obtained clinical data. DAJ, CK, MAW, and RMK analyzed data. DAJ and RMK wrote the first draft of the manuscript. All authors contributed to the interpretation of the data and writing of the manuscript and approved the final version of the manuscript. RMK supervised all aspects of study design, data acquisition, analyses, and manuscript writing.

Compliance with ethical standards

Conflict of interest All authors declare no potential conflict of interest.

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