Surgery 166 (2019) 41–47

Contents lists available at ScienceDirect

Surgery

journal homepage: www.elsevier.com/locate/surg

Endocrine

Changes in total thyroidectomy versus thyroid lobectomy for papillary thyroid cancer during the past 15 years

Benjamin C. James, MD, MS[a,*], Lava Timsina, PhD[b], Ryan Graham, BS[c], Peter Angelos, MD, PhD, FACS[d], David A. Haggstrom, MD, MAS[e,f,g]

[a] Section of Endocrine Surgery, Department of Surgery, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA
[b] Indiana University School of Medicine, Department of Surgery, Indianapolis
[c] Indiana University School of Medicine, Indianapolis
[d] Section of Endocrine Surgery, Department of Surgery, University of Chicago, IL
[e] Indiana University School of Medicine, Department of Medicine, Division of General Internal Medicine and Geriatrics, Indianapolis
[f] Center for Health Information and Communication, US Department of Veterans Affairs, Veterans Health Administration, Health Services Research and Development Service, Richard L. Roudebush VA Medical Center, Indianapolis, IN
[g] Regenstrief Institute, Inc, Indianapolis, IN

ARTICLE INFO

Article history:
Accepted 8 January 2019
Available online 21 March 2019

ABSTRACT

Background: The incidence of papillary thyroid cancer has increased substantially during the past 15 years, which is likely related to an increased detection of small, nonlethal cancers. Studies have shown that patients may have a similar prognosis when undergoing less aggressive surgical intervention, such as thyroid lobectomy. The objective of this study is to determine whether surgical treatment patterns for papillary thyroid cancer have changed during the past 15 years.
Methods: We performed a retrospective cohort study evaluating changes in the incidence and proportion of total thyroidectomy versus thyroid lobectomy for histologically confirmed papillary thyroid cancers, using the National Cancer Institute Surveillance, Epidemiology, and End Results cancer registries between 2000 and 2014.
Results: During the study period, 44,537 patients underwent surgical treatment for papillary thyroid cancer, of which 77% were female and 81.3% were white. The incidence of papillary thyroid cancer more than doubled: from 6.2 (5.9–6.5) to 13.0 (12.5–13.4) per 100,000. The proportion of total thyroidectomy among all papillary cases increased from 78.16% in 2000 to 85.67% in 2014, and the proportion of thyroid lobectomy dropped from 16.62% to 11.41%. When stratified by tumor size, we observed a sustained and increasing gap in the proportions of total thyroidectomy and thyroid lobectomy.
Conclusion: The incidence of total thyroidectomy has not decreased despite recommendations encouraging consideration of lobectomy for patients with small papillary thyroid cancers. Although these findings could be attributed to the lag between scientific evidence and clinical practice, further work is warranted to explore any additional patient and provider factors that may explain this lack of change.

Introduction

Throughout the past several decades, the incidence of thyroid cancer has increased by 3% annually, and thyroid cancer is close to being the third most-common cancer type in women.[1,2] The majority of this increase has occurred in small papillary thyroid cancers (PTCs).[3–5] Although multiple factors may be contributing to a true rise in the incidence of thyroid cancer, such as exposure to flame-retardant chemicals and am increased use of diagnostic radiography, the majority of this increase has been attributed to incidentally found thyroid cancers.[1,6] This explanation is further supported by a multitude of pathologic studies demonstrating incidentally found thyroid cancers on autopsy.[7–10] Moreover, multiple studies have shown that this change in incidence has not been associated with a change in mortality.[1,5,11] This finding gains more significance when placed in the context of the significant financial and psychologic burden attributed to thyroid cancer treatment.[12–17]

* Reprint requests: Benjamin C. James, MD, MS, Chief, Section of Endocrine Surgery, Department of Surgery, Beth Israel Deaconess Medical Center, Assistant Professor of Surgery, Harvard Medical School, 185 Pilgrim Road, Palmer 605, Boston, MA 02115.
E-mail address: bjames1@bidmc.harvard.edu (B.C. James).

https://doi.org/10.1016/j.surg.2019.01.007
0039-6060/

Before the early 2000s, the standard surgical treatment of thyroid cancer, regardless of size, was a total thyroidectomy. This approach was supported by a large retrospective study using the National Cancer Data Base of more than 50,000 patients, presenting a lower recurrence rate and increased survival in patients who underwent total thyroidectomy compared with thyroid lobectomy.[18] However, further studies failed to replicate these findings.[19–26] Additional arguments for a more aggressive surgical approach include the ability to subsequently treat with radioactive iodine and detect recurrence using thyroglobulin, both of which require total thyroidectomy to be utilized. However, the use of radioactive iodine has not been substantiated in small, nonaggressive PTCs.[27–30] Along with the considerable data showing equivalency in outcomes with less aggressive surgery, there have also been several studies showing significant quality of life effects associated with the treatment of thyroid cancer, primarily thyroidectomy and radioiodine ablation, suggesting a true detrimental effect of overtreating these less aggressive thyroid cancers.[15,16,31–33]

As a result of the growing body of literature suggesting overdiagnosis and overtreatment of nonaggressive PTCs, a substantial shift in the recommendations for the surgical treatment have occurred during the past 12 years. In 2006, the American Thyroid Association (ATA) guidelines shifted to recommending thyroid lobectomy for low-risk PTCs smaller than 1 cm.[34] In 2009, the ATA guidelines further expanded the recommendation for thyroid lobectomy to cancers smaller than or equal to 1.5 cm.[35] More recent guidelines from other organizations have recommended thyroid lobectomy as safe for the treatment of PTCs up to 4 cm in size.[36] To evaluate the effects of changing guidelines, we describe the recent practice patterns in the United States in total thyroidectomy and thyroid lobectomy for PTC based on size.

Materials and Methods

Data source

Data on thyroid cancer incidence, histology, size distribution, and surgical treatment were obtained from the Surveillance, Epidemiology, and End Results (SEER)*Stat database.[37] This program is maintained by the National Cancer Institute, which began collecting data in 1973. Of the 18 SEER registries, 9 registries (Atlanta Metropolitan, Connecticut, Detroit Metropolitan, Hawaii, Iowa, New Mexico, San Francisco-Oakland, Seattle-Puget Sound, and Utah) were chosen to represent roughly 10% of the US population and provide long-term incidence data since 1973.

Tumor definitions, characteristics, extent of surgery

Histologically confirmed thyroid cancer cases from 2000 to 2014 were included. Thyroid cancer cases, as defined by the International Classification of Diseases for Oncology, 3rd ed and WHO 2008 site recode C739, were identified. Of those thyroid cases, we restricted our sample to include only papillary thyroid cases (Histologic Type ICD-O-3: 8050, 8052, 8130, 8260, 8340-8344, 8450-8452) that were histologically confirmed and not reported from death certificate or autopsy only. All cases labelled "in situ," benign, were excluded from the analysis. Only the first matching record for each person was selected for each case. Based on the histologic criteria, we excluded 11.8% ($n = 5{,}950$) of the thyroid cases that were not PTCs.

For all included cases, the overall incidence of thyroid cancer was evaluated. In addition, we analyzed cases by tumor size grouped into < 1 cm, 1–2 cm, 2–4 cm, and 4 cm +. We also grouped the PTC by SEER Historic Stage A into localized, regional, and distant, which is derived from Collaborative Stage (CS) for 2004 + and Extent of Disease (EOD) 1973 to 2003. Surgery was grouped into two categories: total thyroidectomy and thyroid lobectomy. Total thyroidectomy included those coded as subtotal thyroidectomy, near total thyroidectomy, or total thyroidectomy or thyroidectomy, not otherwise specified. Thyroid lobectomy included those coded as thyroid lobectomy or isthmusectomy. Additional data collected included sex, race or ethnicity, age at diagnosis, and residence in the Appalachian region.

Analysis

Unadjusted counts of papillary thyroid cases and age-adjusted incidence rates per 100,000 with 95% confidence intervals were calculated using SEER*Stat 8.3.4).[38] The incidence rates were standardized to the US 2000 population. In addition, we also computed proportions of various surgery types among the total number of papillary cases. We examined the trends in incidence rates and in the proportion of the PTCs by tumor size and tumor stage. Annual percentage changes (APCs) were used to quantify the trends in incidence rates. We used the Kendall's tau correlation tests for trend analysis in Stata 14.2 (StataCorp, College Station, TX). Tau, a rank-based procedure, measures the monotonic relationship between incidence rates and year. Using the case-wise listing for the first matched cases, we used the data to report the odds ratio of having total thyroidectomy or thyroid lobectomy in bivariate and multivariable logistic regression analysis.

Results

Of the 50,487 thyroid cancer cases, 44,537 (88.2%) patients met criteria for inclusion with PTC (Table I). Of these, 77% were female and 81.3% were white patients. Roughly 46% of the patients were diagnosed at 40 to 59 years of age, followed by 27.6% at 20 to 39 years of age. About one-third of the tumors were smaller than 1 cm in size and 8.6% were larger than 4 cm. A total of 64% of cancers were localized and only 2.5% had distant disease. Approximately 84.3% of the patients underwent total thyroidectomy, and 12.4% had a thyroid lobectomy. During the 2000–2014 study period, there were 10.3 per 100,000 cases reported from the 9 participating cancer registries. Table I also presents the rate of PTC per 100,000 by sociodemographic and clinical characteristics.

From 2000 to 2014, the incidence of PTC more than doubled from 6.2 (5.9–6.5) to 13.0 (12.5–13.4) per 100,000. Figure 1 presents the trend of surgery among PTC cases during a period of 15 years (2000–2014). During the study period, the rate of total thyroidectomy increased from 4.9 (4.6–5.1) to 11.1 (10.7–11.5), with 5.83 annual percent change ($P < .001$). The rate of thyroid lobectomy increased from 1.0 (0.9–1.2) to 1.4 (1.3–1.6) per 100,000 with 3.36 annual percent change ($P < .001$). However, the proportion of total thyroidectomy among all papillary cases increased from 78.16% in 2000 to 85.67% in 2014, but the proportion of thyroid lobectomy dropped from 16.62% to 11.41%. Analysis of trends for proportion showed that, compared with the total, annually there appears to be a significant drop in the proportion of thyroid lobectomy ($P = .019$). When stratified by tumor size, we observed a sustained and increasing gap in the proportions of total thyroidectomy and thyroid lobectomy (Fig 2). For tumors < 4 cm in size, we found that the proportion of total thyroidectomy increased every year from 2000 to 2014, whereas the proportions of thyroid lobectomy decreased (Table II).

Table III exhibits results from bivariate and multivariable analyses of total thyroidectomy versus thyroid lobectomy. Bivariate analysis demonstrated that men were more likely to undergo total thyroidectomy than women (odds ratio {OR}: 1.09 [95% confidence interval {CI}: 1.02–1.17], $P = .014$). Similarly, we found that compared with age group 40 to 59 years, patients under 40 years of

Table I
Sample characteristics, age-adjusted incidence rates, and adjusted odds ratio (AOR) of papillary thyroid cancer (SEER 9 Registries, 2000–2014)

Characteristics	Count	Rates (95% CI)	APC	AOR (95% CI)	*P* value
Overall	44,537	10.26 (10.17–10.36)	5.39*		
Sex					
Male	10,275	4.9 (4.8–4.99)	5.51*	0.97 (0.91–1.04)	.384
Female	34,262	15.49 (15.32–15.65)	5.36*	REF	
Race					
White	36,205	10.99 (10.87–11.1)	5.43*	REF	
Black	2,692	5.6 (5.39–5.82)	6.56*	0.74 (0.67–0.83)	< .001
Other	5,105	9.51 (9.25–9.78)	4.25*	1.36 (1.22–1.50)	< .001
Age at diagnosis (years)					
0–19	827	0.71 (0.66–0.76)	5.72*	1.13 (0.91–1.41)	.257
20–39	12,290	10.54 (10.35–10.73)	4.56*	1.38 (1.27–1.49)	< .001
40–59	20,645	17.42 (17.18–17.66)	5.72*	REF	
60–79	9,753	16.9 (16.56–17.24)	5.78*	0.72 (0.67–0.78)	< .001
80 +	1,022	7.02 (6.6–7.46)	4.37*	0.56 (0.48–0.65)	< .001
Appalachia region					
Not Appalachia	43,495	10.29 (10.19–10.38)	5.42*	1.32 (1.07–1.61)	.008
Appalachia	1,042	9.61 (9.01–10.24)	4.07*	REF	
Thyroid cancer size (cm)					
< 1	15,470	3.54 (3.48–3.59)	6.67*	REF	
1–2	12,899	2.98 (2.93–3.04)	6.69*	0.36 (0.32–0.40)	< .001
2–4	10,333	2.4 (2.35–2.44)	4.25*	0.12 (0.11–0.14)	< .001
4 +	3,840	0.89 (0.86–0.92)	5.38*	0.05 (0.05–0.06)	< .001
Stage					
Localized	28,648	6.59 (6.51–6.66)	5.06*	REF	
Regional	14,402	3.33 (3.28–3.39)	6.21*	1.01 (0.94–1.07)	.988
Distant	1,144	0.27 (0.25–0.28)	3.43*	0.49 (0.43–0.56)	< .001
Surgery					
Total Thyroidectomy	37,566	8.66 (8.57–8.75)	5.83*	REF	
Lobectomy	5,540	1.27 (1.24–1.31)	3.36*	0.44 (0.40–0.48)	< .001
No surgery	702	0.16 (0.15–0.18)	5.09*	0.32 (0.27–0.38)	< .001

APC, annual percentage change; *REF*, reference.
* *P* value < .001 based on the significance testing for annual percent change (APC) for age-adjusted incidence of papillary thyroid cancer during the study period (2000–2014).

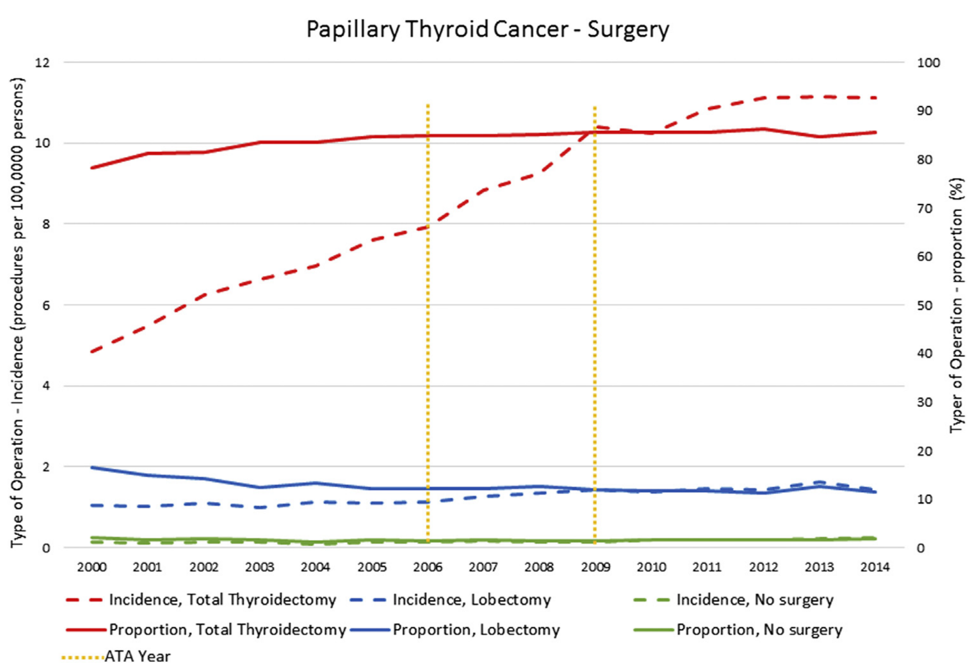

Fig 1. Incidence and proportion of total thyroidectomy versus thyroid lobectomy for papillary thyroid cancer. Each solid line represents the proportion of total thyroidectomy versus thyroid lobectomy during the study period. Each *dotted line* represents the change in incidence of total thyroidectomy versus thyroid lobectomy during the study period. *Vertical dotted lines* represent the dates of the ATA guideline changes.

age in the bivariate analysis were more likely to undergo total thyroidectomy for any size cancer, whereas patients older than 59 years of age were more likely to receive thyroid lobectomy. This relationship remains the same for older age groups in the multivariable model. We observed no racial differences in surgical approach. Cases from the non-Appalachian region were less likely to receive total thyroidectomy (OR: 0.54 [95% CI: 0.43–0.68], $P <$ .001). When compared with large tumor size (4 + cm), those with a

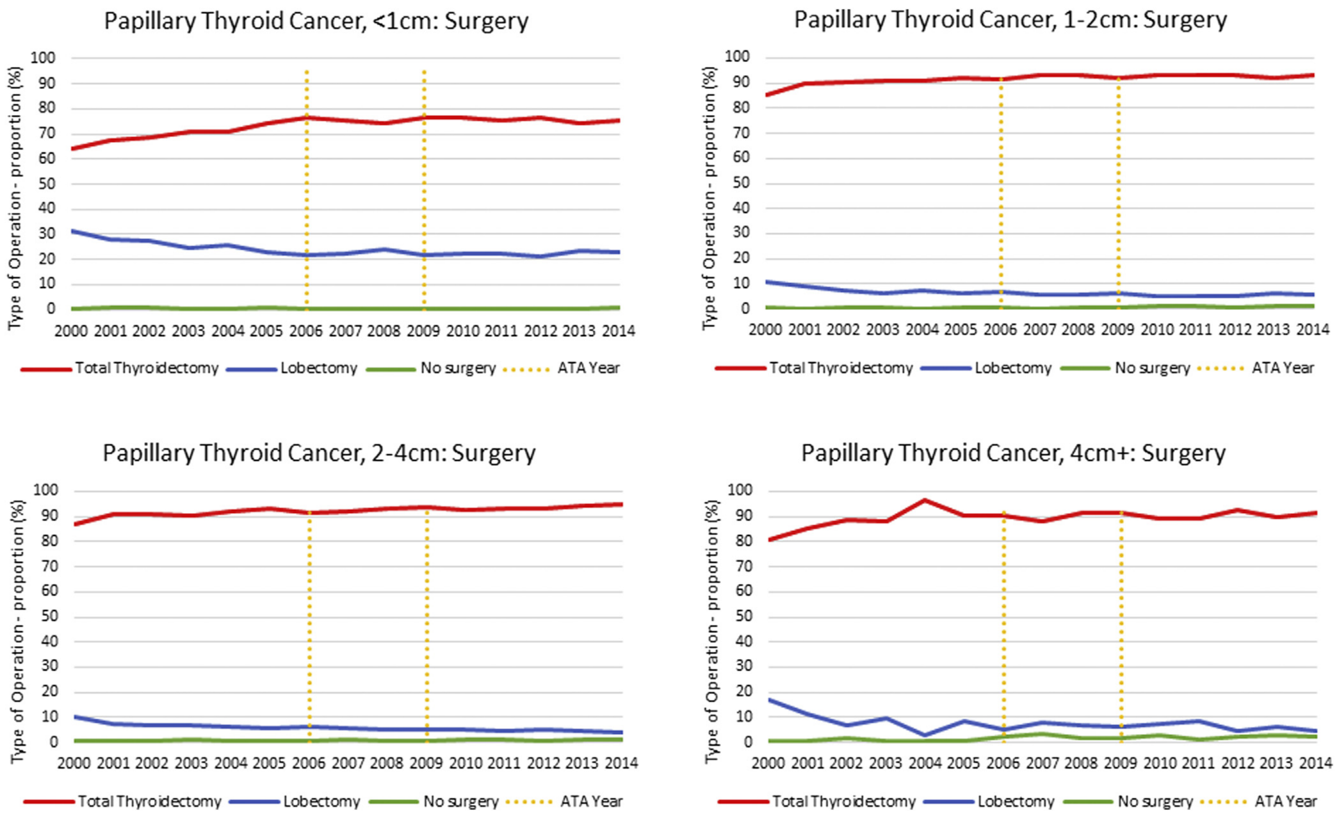

Fig 2. Incidence and proportion of total thyroidectomy versus thyroid lobectomy for papillary thyroid cancer by size (< 1 cm, 1–2 cm, 2–4 cm, and > 4 cm). Each *solid line* represents the proportion of total thyroidectomy versus thyroid lobectomy during the study period. Each *dotted line* represents the change in incidence of total thyroidectomy versus thyroid lobectomy during the study period. *Vertical dotted lines* represent the dates of the ATA guideline changes.

Table II
Annual percent change in proportion of surgeries among all papillary thyroid cancer cases by tumor size from 2000 to 2014

Surgery	Tumor size (cm)	Proportion (2000)	Proportion (2014)	% change per year (2000–2014)	*P* value
Total thyroidectomy	<1	64.363	75.192	1.12	.0015
	1–2	85.548	93.065	0.60	.0002
	2–4	87.037	94.631	0.60	.0001
	4 +	80.882	91.444	0.88	.0228
Thyroid bobectomy	<1	31.102	22.781	−2.20	.0056
	1–2	10.956	5.645	−4.63	.0030
	2–4	9.954	4.139	−6.08	< .0001
	4 +	16.912	4.813	−8.59	.0377

small-sized tumor (<1 cm) were less likely to receive total thyroidectomy. However, tumors that were 1 to 2 cm (OR: 1.17 [95% CI: 1.02–1.35], $P = .03$) or 2 to 4 cm (OR: 1.32 [95% CI: 1.14–1.53], $P < .001$) were more likely to receive total thyroidectomy than those with a tumor size greater than 4 cm. Increased stage of tumor was significantly associated with higher likelihood of getting total thyroidectomy ($P < .001$).

In the multivariable analysis, after adjusting for the effect of age, sex, race, and Appalachian region, we found that compared with large (4+ cm) tumors, smaller (−4 cm) tumors were more likely to undergo total thyroidectomy ($P < .001$). Compared with localized stage, regional and distal stages of papillary cancer were significantly more likely to have total thyroidectomy than thyroid lobectomy ($P < .001$).

Discussion

These findings confirm that throughout the past 15 years in the United States, the incidence of PTC has increased substantially.[1,3] Because patient mortality has remained stable, there is concern that this rise may be attributed to overdiagnosis because of increased medical screening, and subsequent care may carry the risks of overtreatment of pseudodisease.[39,40] Both in 2006 and 2009, the ATA guidelines on the treatment of PTC shifted recommendations in the treatment of low-risk, small (1–1.5 cm) thyroid cancers to consider thyroid lobectomy and isthmusectomy as definitive surgical treatment. This shift was further endorsed for tumors up to 4 cm by the American Association of Clinical Endocrinologists in 2015.[36] During our study period, the proportion of total thyroidectomy among all papillary cases increased to 85.7%, and the proportion of thyroid lobectomy dropped to 11.4%. Because the study period encompasses two iterations of changes in the guidelines published by the ATA along with the development of molecular markers supporting less aggressive surgical treatment, we believe the lack of change in surgical management overall reflects delayed adoption and uptake of less-invasive approaches to low-risk disease.

Table III
Bivariate and multivariable logistic regressions of having total thyroidectomy versus thyroid lobectomy (SEER 9 Registries, 2000–2014)

Characteristics	OR (95% CI)	*P* value	AOR (95% CI)	*P* value
Sex				
Male	1.09 (1.02–1.17)	.014	0.86 (0.80–0.93)	< .001
Female	REF		REF	
Race				
White	REF		REF	
Black	0.92 (0.82–1.04)	.188	1.01 (0.89–1.15)	.853
Other	1.02 (0.93–1.11)	.677	0.84 (0.76–0.92)	< .001
Age at diagnosis (years)				
0–19	1.69 (1.30–2.18)	<.001	0.97 (0.73–1.30)	.862
20–39	1.26 (1.17–1.35)	< .001	1.00 (0.93–1.08)	.934
40–59	REF		REF	
60–79	0.79 (0.73–0.84)	< .001	0.81 (0.75–0.87)	< .001
80 +	0.68 (0.57–0.81)	< .001	0.49 (0.40–0.60)	< .001
Appalachia region				
Not Appalachia	0.54 (0.43–0.68)	< .001	0.50 (0.39–0.64)	<.001
Appalachia	REF		REF	
Thyroid cancer size (cm)				
< 1	0.25 (0.22–0.28)	< .001	0.37 (0.33–0.43)	< .001
1–2	1.17 (1.02–1.35)	.03	1.40 (1.21–1.63)	< .001
2–4	1.32 (1.14–1.53)	< .001	1.43 (1.23–1.67)	< .001
4 +	REF		REF	
Stage				
Localized	REF		REF	
Regional	5.96 (5.43–6.55)	< .001	4.19 (3.79–4.63)	< .001
Distant	8.72 (5.85–12.98)	< .001	6.46 (4.25–9.82)	< .001

OR, odds ratio from bivariate logistic regressions; *AOR*, adjusted odds ratio from multivariable logistic regression; *REF*, reference.

Results demonstrate that the overall proportion of total thyroidectomies performed for patients with PTC has not decreased. Even among patients with tumors <1 cm in diameter, for whom the guidelines are most clearly applicable, the proportion of total thyroidectomy has remained static or increased since 2006. Although there are medical reasons to consider total thyroidectomy (patients who are already receiving synthroid for hypothyroidism or have bilateral thyroid nodules), it is unlikely that the proportion of patients with those characteristics would have changed during the study period. It is also possible that patients may anticipate long-term surveillance in the remaining lobe to be burdensome. Finally, another potential explanation for the increase in the proportion of thyroidectomies is that a greater number of surgeries are being done in community practices relative to academic practices, the latter of which may be more supportive of less-aggressive surgical approaches.

Over time, there have been numerous studies showing that patients have an excellent prognosis with low-risk PTC. The unchanging, high proportion of patients receiving total thyroidectomy raises concerns about the harms of overtreatment, especially because thyroid lobectomy has been found to be equally effective when compared with total thyroidectomy.[19,20,22] Compared with thyroid lobectomy, total thyroidectomy poses an increased risk for hypoparathyroidism, vocal cord paralysis, respiratory complications, hematoma, and tracheostomy.[12,25,41] Thyroid lobectomy substantially decreases the rate of biochemical hypothyroidism and the need for lifelong thyroid replacement medication. Financially, thyroid lobectomy also comes with a significantly lower average pricetag ($19,365 vs $15,602, $P < .0001$).[12] Thyroid lobectomy has also been shown to be more cost-effective in the long term, after only 3 years, among 1- to 4-cm PTCs.[13]

In addition to the surgical complications and potential financial toxicity associated with the treatment of thyroid cancer, an emerging body of evidence suggests that the diagnosis and treatment of thyroid cancer is associated with a negative impact upon quality of life and financial health.[13–15,17] One study shows that thyroid cancer may have similar or worse quality-of-life outcomes compared with both breast and colorectal cancer.[16] Future study should be performed to determine whether thyroid lobectomy may be associated with improved quality of life or reduced financial burdens. Notably, PTC is generally clinically silent, and the survival rate for patients with uncomplicated PTC who are not treated in the first year of diagnosis has been reported as 97% at 20 years.[42]

The lack of change in practice may be related to both patient and provider factors. The fear of a cancer diagnosis may impact patient preferences for a more aggressive surgical approach, and provider resistance may exist regarding delivering—or even discussing—more conservative approaches. Comparison can be made with other types of cancer treatment guidelines to contextualize the slow rate of change observed in clinical practice. In 2010, the National Comprehensive Cancer Network released guidelines recommending active surveillance for very low—risk prostate cancer.[43] Among a low-risk group of 40,839 prostate cancer patients diagnosed from 2010 to 2013, active surveillance was slowly but increasingly utilized, rising from 12% up to 27% of patients by 2013.[44] A larger study, which was less conservative in its selection of low-risk patients, found that from 2004 to 2013 the rate of expectant management for low-risk prostate cancer increased from 27% to 60%.[45] Although both of these studies show an increasing adoption of active surveillance, change has been slow and a large proportion of patients were still receiving surgical therapies for low-risk tumors in spite of changing National Comprehensive Cancer Network guidelines. As is needed in thyroid cancer, research has started to explore provider and patient explanations for this slow adoption, including clinician experience and opinion and patient preferences.[46,47] An optimal approach to managing these choices is shared decision-making, wherein medical decision-making incorporates the preferences of informed patients.

Studies have shown differences in the clinical management of thyroid cancer when comparing patients by race.[48] One group reported that, although appropriate utilization of surgery for differentiated thyroid cancer has improved over time for all races, the proportion of improvement has been lower for blacks compared with whites.[49] The data from our study suggests no significant differences in surgical management for PTC among African Americans. As practice patterns continue to evolve, ongoing attention to disparities among vulnerable groups is important. A greater likelihood of thyroid lobectomy, relative to total thyroidectomy, was observed among male and older thyroid cancer patients in addition to individuals from Appalachian regions. The basis for sex differences is uncertain but is perhaps grounded in preferences for more "aggressive" medical decisions among male patients.[50] Overall, thyroid cancer is 2.9 times more common among women than men but tends have a worse prognosis among men.[51] Consistent with the literature, less aggressive treatment approaches tend to be pursued among elderly cancer patients.[52] Age differences could represent either age bias or a greater comorbidity burden among older populations, a difference worth further exploration. Among Appalachian populations, the lower likelihood of thyroid lobectomy fits a pattern of rural populations being less likely to receive recommended services or high-quality treatment.[53] This population may have more limited treatment options attributable to access barriers, including greater travel distances, lower socioeconomic status, and higher uninsurance rates. Greater travel distances may lead to more aggressive surgical choices because of the difficulty of returning for follow-up.

Study limitations include the lack of detail about clinical indications for surgery in the cancer registry, including the diagnostic evaluation beforehand. Furthermore, information about the clinical decision-making process, such as provider recommendations and patient preferences, are not routinely available. Therefore, although we cannot more fully understand the surgical choice among any single patient, the lack of change in practice patterns across this nationally representative PTC population suggests very low adoption of approaches associated with lower surgical risk and morbidity. In addition, because of the nature of SEER data, which ascertains initial surgical management, it is not possible to determine incidence or proportion of patients who went on to receive a completion thyroidectomy. This type of surgery is performed when a thyroid lobectomy returns with a histologic diagnosis of cancer and the surgical team decides to return to the operating room and remove the contralateral thyroid lobe. Therefore, it is possible that some patients who underwent a thyroid lobectomy in our cohort progressed to completion thyroidectomy. If true, one could argue that the proportion of total thyroidectomy here is an underestimation of the true proportion over time. Finally, the ATA currently recommends total thyroidectomy for patients with cancers <1 cm who had been treated with head and neck radiation, presented with nodal metastasis, or had familial thyroid carcinoma.[36] Although unlikely to explain the observed differences between the receipt of thyroid lobectomy and total thyroidectomy, future work may help disentangle these outstanding issues.

The findings of this study highlight the need to better understand the reasons for the lack of adoption of guideline changes. In addition to the known lag of practice change after new guidelines are produced, it is possible that physicians and patients may not be comfortable with having a surgery less aggressive than a total thyroidectomy performed for any size PTC. However, the data are lacking on the long-term quality-of-life outcomes when patients are treated with a thyroid lobectomy versus total thyroidectomy. In addition, there may be reduced financial burden on patients associated with choosing one approach rather than another. These questions should be addressed in future studies and may provide additional data to inform the choice of surgery for smaller PTCs.

Future research should also continue to monitor rates of thyroidectomy among tumor types and populations, including those seen by both high-volume and low-volume surgeons of varied training backgrounds (ie, endocrine, head and neck, and general surgeons), to determine what factors influence practice in relation to clinical guidelines. Future study of the slow adoption of national guidelines for thyroid surgery can benefit from similarities and differences in what has been learned among populations with other low-risk cancers.[45] Although it is perhaps not unexpected that practice change lags clinical guidelines, it is nonetheless important to note that the professional responsibility to deliver care consistent with the most recent evidence—and guidelines—available is an urgent and more-than-reasonable patient expectation of physicians caring for patients diagnosed with thyroid cancer.

In conclusion, the incidence of total thyroidectomy has not decreased despite evidence of equivalency with thyroid lobectomy and recommendations from the ATA encouraging thyroid lobectomy for PTC patients with smaller tumors. Further research is warranted to explore reasons for the lack of change in clinical surgical practice. As clinical behavior commonly lags behind new professional recommendations, ongoing population-based studies are also needed to monitor for future changes in practice.

Conflicts of interest

All authors have no actual or potential conflicts of interest to disclose.

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