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ORIGINAL ARTICLE

Perioperative outcomes of thyroid cancer surgery in children and adults: a nationwide inpatient database study in Japan

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ABSTRACT

BACKGROUND

Little is known about perioperative outcomes after pediatric thyroidectomy. This study was performed to compare perioperative outcomes between children and adults undergoing thyroid cancer surgery using a nationwide inpatient database in Japan.

METHODS

Using the Japanese Diagnosis Procedure Combination database, we identified patients aged 0 to 40 years with thyroid cancer who underwent thyroidectomy from July 2010 to March 2020. To compare the occurrence of in-hospital morbidities including local complications (e.g., recurrent laryngeal nerve paralysis, postoperative bleeding), duration of anesthesia, postoperative length of stay, and total hospitalization costs between children (0–18 years) and adults (19–40 years), we used multivariable logistic regression analysis for the occurrence of in-hospital morbidities and linear regression for other outcomes.

RESULTS

For 16,016 eligible patients (666 children vs. 15,350 adults), no significant differences between the two groups were found in any in-hospital morbidity (5.4% vs. 5.9%; adjusted odds ratio [OR], 0.80; 95% confidence interval [CI], 0.57–1.14; P = 0.23), local complications (5.0% vs. 5.5%; OR, 0.80; 95% CI, 0.55–1.15; P = 0.22), recurrent laryngeal nerve paralysis (2.1% vs. 2.4%; OR, 0.78; 95% CI, 0.45–1.35; P = 0.37), or postoperative bleeding (1.7% vs. 1.4%; OR, 0.99; 95% CI, 0.53–1.87; P = 0.98). Children showed a longer duration of anesthesia (difference, 20 minutes; 95% CI, 13–27; P < 0.001) and higher total costs (difference, 445 US dollars; 95% CI, 239–651; P < 0.001) than adults.

CONCLUSION

This large nationwide cohort study showed no significant difference in perioperative complications between children and adults undergoing thyroid cancer surgery.

KEY WORDS

thyroid cancer, thyroidectomy, postoperative complication, recurrent laryngeal nerve paralysis, children

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INTRODUCTION

Thyroid cancer is rare in children, accounting for around 6% of all pediatric cancers from 2012 to 2016 [1]. The proportion of children is also lower than that of adults among people with thyroid cancer, with pediatric thyroid cancer representing only 2.3% of all thyroid cancer diagnoses [2]. However, pediatric differentiated thyroid cancer has increased over time in the United States and worldwide [3, 4]. In the United States, the incidence of pediatric thyroid cancer increased more rapidly from 2006 to 2013 than from 1973 to 2006 [5].

Thyroidectomy is an essential treatment of thyroid cancer; however, several severe complications specific to thyroidectomy may occur. The frequencies of such complications in adults have been reported in numerous studies. For example, recurrent laryngeal nerve (RLN) paralysis (0.2%–3.9%) can result in dysphagia and may require rehabilitation [6–13]. Postoperative bleeding (0.4%–4.4%) can result in airway constriction and laryngeal edema and often requires reoperation [6, 8–10, 14–17]. Postoperative chylothorax (1.85%) requires drainage or reoperation [18]. However, few studies have focused on perioperative outcomes of pediatric thyroidectomy [19, 20]. The risk of perioperative outcomes has not been accurately compared between children and adults.

Nevertheless, management guidelines for pediatric thyroid cancer state that children undergoing thyroidectomy have a higher risk of complications than adults because of the rarity of thyroid disease requiring surgical intervention and the popularity of locoregional lymph node metastasis in pediatric patients [21]. In a previous study using Healthcare Cost and Utilization Project–National Inpatient Sample hospital discharge information, children had worse outcomes in terms of endocrine complication than adults, but no significant differences were detected in general complication, RLN-related complications, or length of stay (LOS) between children (n = 1,199) and adults (n = 96,002) [22]. Indeed, the study showed no increase in complications with the exception of endocrine complications. However, the study included benign diseases and did not adjust for any confounders (e.g., systemic comorbidities, cancer stage, lymph node dissection, and hospital volume) [23].

Despite the public health and clinical importance of the increasing incidence of pediatric thyroid cancer worldwide and the subsequent increase in the number of surgeries, little is known about perioperative outcomes of pediatric thyroidectomy. To address this knowledge gap, we compared perioperative outcomes between children and adults undergoing thyroid cancer surgery with adjustment for background characteristics using a Japanese nationwide inpatient database.

METHODS

DATABASE

This nationwide retrospective cohort study was performed using the Diagnosis Procedure Combination database. This database includes hospital administrative claims data and discharge abstracts of approximately 8,000,000 inpatients per year in more than 1,200 hospitals throughout Japan, covering approximately half of all inpatient admissions to acute-care hospitals in Japan. All 82 university hospitals are obliged to participate in the database; participation by community hospitals is voluntary [24].

The database includes the following data: unique hospital identifiers; patients' age and body mass index (BMI) at admission; sex; main diagnoses and comorbidities at admission and complications after admission recorded with text data in the Japanese language and International Classification of Diseases, Tenth Revision (ICD-10) codes; clinical Tumor, Node, Metastasis (TNM) classification of malignant tumors; interventional/surgical procedures indexed by the original Japanese codes; duration of anesthesia; LOS; discharge status; and total hospitalization cost. The total hospitalization cost is based on reference prices in the fee schedule that determine item-by-item prices for inpatient services such as operations. All discharge abstract data for each patient are recorded at discharge by the attending physicians. A previous validation study showed good sensitivity and specificity of the diagnoses and procedure records in the database [25] and high validity of cancer diagnoses [26].

STUDY PROTOCOL

We identified patients aged 0 to 40 years with thyroid cancer who underwent thyroidectomy from July 2010 to March 2020. We used the Japanese original procedure codes for these surgeries to identify patients who received them. We excluded patients whose preoperative diagnosis was not well-differentiated thyroid carcinoma —thyroidectomy is not the first mode of therapy—such as patients with poorly differentiated thyroid carcinoma, anaplastic thyroid carcinoma, and malignant lymphoma.

We compared children (0–18 years old) and adults (19–40 years old). To eliminate the possible effects of adult-onset comorbidities (e.g., diabetes, hypertension),

we defined the adult group (control group) as patients ≤40 years of age (i.e., adolescent and young adult population [27, 28]). The primary outcome was the occurrence of in-hospital morbidities. In-hospital morbidities were divided into local complications and general complications. We defined local complications as RLN paralysis (temporary or permanent), bleeding, surgical site infection, chyle leakage (including chylothorax), and esophageal injury. We defined general complications as respiratory complications, urinary tract infection, sepsis, heart failure, stroke, acute renal failure, and pulmonary embolism. The definitions of these terms are defined on the basis of the approach used in previous studies [7, 29] and are listed in **Supplemental Table E1**. The secondary outcomes were the duration of anesthesia, postoperative LOS, total hospitalization cost, and 30-day readmission at the same hospital. We defined the currency exchange rate as 110 Japanese yen per 1 US dollar.

STATISTICAL ANALYSIS

We examined patient background factors including sex, age, BMI, comorbidities (i.e., hyperthyroidism, hypothyroidism, and thyroiditis), preoperative drug use, preoperative diagnosis, clinical TNM classification, operative procedure (total thyroidectomy or hemi-/partial thyroidectomy), endoscopic thyroidectomy, extended lymph node dissection (searched in Japanese original procedure codes), intraoperative device use (energy device such as ultrasonic coagulating shears and electrothermal bipolar vessel sealing device, neuromonitoring), type of hospital, and hospital volume. BMI was categorized into three groups: <18.5 kg/m^2 (underweight), 18.5 to 24.9 kg/m^2 (normal weight), and ≥25.0 kg/m^2 (overweight and obese). Hospital volume was defined as the number of thyroidectomies for thyroid cancer performed annually at each hospital and was categorized as high volume (≥33 cases/year [median]) or low volume (<33 cases).

We used the chi-square test to compare proportions of categorical variables and the *t* test or Mann–Whitney U test to compare averages or medians of continuous variables. We constructed unadjusted and adjusted logistic regression models for in-hospital morbidities. In the adjusted models, we adjusted for sex, BMI, comorbidities, preoperative drug use, preoperative diagnosis, clinical TNM classification, operative procedure, extended lymph node dissection, intraoperative device use, type of hospital, and hospital volume based on biological plausibility and *a priori* knowledge [7, 21].

We conducted a series of sensitivity analyses to examine the robustness of our findings. First, we changed the threshold of adults groups to <50 and <60 years of age and repeated the analyses. Second, to eliminate the potential effects of adult-specific systemic diseases such as hypertension and diabetes, we excluded older adults (30–40 years) from the adult group and then repeated the analyses for the outcomes. Third, we also repeated the analyses with stratification by operative procedure and hospital volume. Lastly, to examine the potential heterogeneity in the pediatric group, we subdivided these patients into three groups (0–12, 13–15, and 16–18 years) and then compared in-hospital morbidities.

All hypothesis tests had a two-sided significance level of 0.05. All statistical analyses were conducted using Stata/MP 16.0 (StataCorp, College Station, TX, USA).

RESULTS

We identified 16,041 patients aged ≤40 years who underwent thyroidectomy from July 2010 to March 2020. We excluded 25 patients who had a thyroid malignancy other than well-differentiated thyroid cancer. Of the 16,016 eligible patients, the pediatric group comprised 666 patients and the adult group comprised 15,350 patients.

Table 1 shows the demographics of all patients. Among all patients, there were more female than male patients. With the exception of unspecified thyroid carcinoma, about 90% of preoperative diagnoses were papillary carcinoma. Children more likely to have an advanced T/N classification and distant metastasis, to undergo total thyroidectomy, to use neuromonitoring, and to undergo surgery in high-volume centers than adults.

Table 2 shows the crude outcomes for in-hospital morbidities, mortality, blood transfusion, and 30-day readmission between the two groups. Between the children and adults, there were no significant differences in the proportion of in-hospital morbidity (5.4% vs. 5.9%, P = 0.56), local complications (5.0% vs. 5.5%, P = 0.55), or general complication (0.5% vs. 0.6%, P = 0.61). Among local complications, no significant difference was shown in RLN paralysis (2.1% vs. 2.4%, P = 0.64), postoperative bleeding (1.7% vs. 1.4%, P = 0.65), blood transfusion (0.3% vs. 0.2%, P = 0.70), or chyle leakage (0.2% vs. 0.5%, P = 0.64). Additionally, no significant difference was shown in in-hospital mortality, blood transfusion, or 30-day readmission. Similar results were shown in the sensitivity analysis with subdivided age categories (**Supplemental Table E2**).

Table 3 shows the crude outcomes for the duration of anesthesia, postoperative LOS, and total hospitalization

Table 1 **Baseline characteristics of children and adults undergoing thyroid cancer surgery**

	Children (0–18 y, n = 666)		Adults (19–40 y, n = 15,350)		P-value
	n	(%)	n	(%)	
Age, y	16 (14–18)		34 (29–38)		<0.001
Sex					
Male	184	(28)	3,267	(21)	<0.001
Body mass index, kg/m^2					<0.001
<18.5 (underweight)	172	(26)	1,733	(11)	
18.5–24.9 (normal weight)	419	(63)	10,032	(65)	
≥25 (overweight, obese)	73	(11)	3,490	(23)	
Missing	2	(0.3)	95	(0.6)	
Comorbidities					
Hyperthyroidism	10	(1.5)	438	(2.9)	0.038
Hypothyroidism	33	(5.0)	631	(4.1)	0.29
Thyroiditis	29	(4.4)	716	(4.7)	0.71
Multiple Endocrine Neoplasia type 2*	14	(2.1)	34	(0.2)	<0.001
Preoperative drug use					
Heparin	2	(0.3)	45	(0.3)	0.97
Steroid	2	(0.3)	74	(0.5)	0.50
Preoperative diagnosis					<0.001
Papillary carcinoma	335	(50)	8,020	(52)	
Follicular carcinoma	19	(2.9)	216	(1.4)	
Medullary carcinoma	31	(4.7)	163	(1.1)	
Unspecified thyroid carcinoma	281	(42)	6,951	(45)	
T classification					<0.001
T0	2	(0.3)	46	(0.3)	
T1	207	(31)	6,734	(44)	
T2	154	(23)	3,133	(20)	
T3	169	(25)	2,985	(19)	
T4	31	(4.7)	405	(2.6)	
TX	75	(11)	1,391	(9.1)	
Missing data	28	(4.2)	656	(4.3)	
N classification					<0.001
N0	277	(42)	7,699	(50)	
N1	279	(42)	5,399	(35)	
NX	75	(11)	1,391	(9.1)	
Missing data	35	(5.3)	861	(5.6)	
Distant metastasis	48	(7.2)	223	(1.5)	<0.001
Operative procedure					
Total thyroidectomy	351	(53)	7,252	(47)	0.006
Second partial thyroidectomy†	8	(1.2)	238	(1.6)	0.76
Endoscopic thyroidectomy	2	(0.3)	143	(0.9)	0.092
Extended lymph node dissection‡	185	(28)	4,389	(29)	0.65
Nerve reconstruction	2	(0.3)	39	(0.3)	0.82
Intraoperative device					
Energy device§	352	(53)	8,059	(53)	0.86
Neuromonitoring	200	(30)	2,927	(19)	<0.001
Teaching hospital	577	(87)	12,484	(81)	0.001
Hospital volume‖					<0.001
Low (<33)	213	(32)	6,295	(41)	
High	453	(68)	9,055	(59)	

Data are presented as median (interquartile range) or n (%) of patients.
* 11 (1.7%) patients in children and 32 patients (0.2%) in adults were preoperatively diagnosed with medullary thyroid cancer.
† Defined as a second partial thyroidectomy at the same hospital.
‡ Defined as dissection of more than the central lymph nodes.
‡ Defined as ultrasonic coagulating shears or an electrothermal bipolar vessel sealing device.
‖ Based on the median of thyroid cancer surgery (including those in patients aged ≥40 y) per year.

Table 2 Comparisons of in-hospital morbidities, mortality, blood transfusion, and 30-day readmission between children and adults undergoing thyroid cancer surgery

Outcomes	Children (0–18 y, n = 666)		Adults (19–40 y, n = 15,350)		P-value
	n	(%)	n	(%)	
In-hospital morbidity	36	(5.4)	913	(5.9)	0.56
Local complications	33	(5.0)	844	(5.5)	0.55
RLN paralysis	14	(2.1)	366	(2.4)	0.64
Postoperative bleeding	11	(1.7)	221	(1.4)	0.65
Surgical site infection	8	(1.2)	207	(1.3)	0.75
Chyle leakage	1	(0.2)	71	(0.5)	0.24
Esophageal injury	0	(0.0)	1	(0.0)	0.84
General complications	3	(0.5)	93	(0.6)	0.61
Respiratory	2	(0.3)	59	(0.4)	0.73
Urinary tract infection	0	(0.0)	16	(0.1)	0.41
Sepsis	0	(0.0)	2	(0.0)	0.77
Heart failure	1	(0.2)	11	(0.1)	0.47
Stroke	0	(0.0)	2	(0.0)	0.77
Acute renal failure	0	(0.0)	2	(0.0)	0.77
Pulmonary embolism	0	(0.0)	1	(0.0)	0.84
In-hospital mortality	0	(0.0)	5	(0.0)	0.64
Blood transfusion	2	(0.3)	35	(0.2)	0.70
30-day readmission	10	(1.5)	141	(0.9)	0.13

Data are presented as n (%) of patients.
Abbreviation: RLN, recurrent laryngeal nerve.

Table 3 Comparisons of duration of anesthesia, postoperative length of stay, and total hospitalization cost between children and adults undergoing thyroid cancer surgery

Outcomes	Children (0–18 y, n = 666)		Adults (19–40 y, n = 15,350)		P-value
	Median	(IQR)	Median	(IQR)	
Duration of anesthesia, min	198.5	(151–303)	189	(141–259)	<0.001
Postoperative length of stay, days	5	(4–7)	5	(4–7)	<0.001
Total hospitalization cost, US dollars	6,345	(5,426–7,938)	6,274	(5,541–7,308)	0.063

Abbreviation: IQR, interquartile range.

cost between the two groups. Compared with adults, children had a significantly longer duration of anesthesia (median [interquartile range], 198.5 [151–303] vs. 189 [141–259] min, P < 0.001) and longer total postoperative LOS (5 [4–7] vs. 5 [4–7] days, P < 0.001).

Fig. 1 shows the unadjusted and adjusted associations of age with in-hospital morbidities. There was no significant difference between the children and adults in the risk of in-hospital morbidity (adjusted odds ratio [OR], 0.80; 95% confidence interval [CI], 0.57–1.14; P = 0.23), local complications (adjusted OR, 0.80; 95% CI, 0.55–1.15; P = 0.22), RLN paralysis (adjusted OR, 0.78; 95% CI, 0.45–1.35; P = 0.37), or postoperative bleeding (adjusted OR, 0.99; 95% CI, 0.53–1.87; P = 0.98). Because

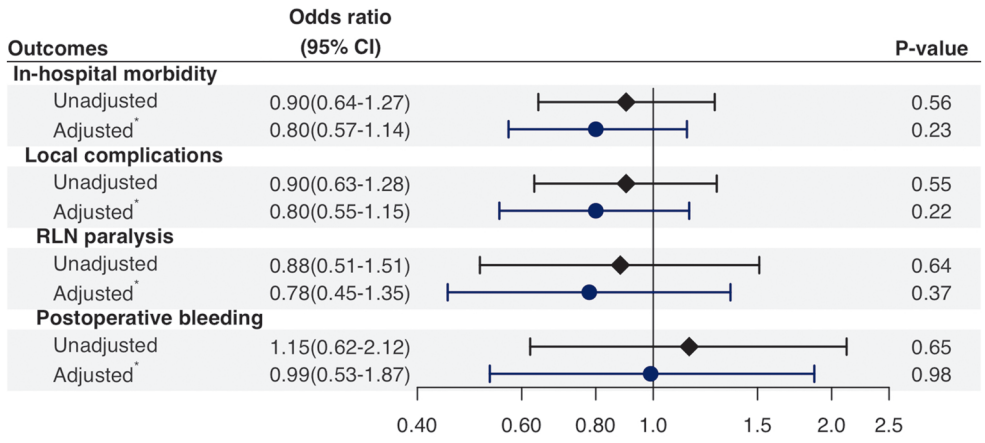

Fig. 1 **Unadjusted and adjusted associations of age with in-hospital morbidity in thyroid cancer surgery**

The risk of in-hospital morbidity was compared between children (age of 0–18 y) and adults (age of 19–40 y).
* Adjusted for sex, body mass index, comorbidities, preoperative drug use, preoperative diagnosis, clinical TNM classification, operative procedure, extended lymph node dissection, intraoperative device use, type of hospital, and hospital volume.
Abbreviations: CI, confidence interval; RLN, recurrent laryngeal nerve.

Table 4 **Unadjusted and adjusted associations of age category with duration of anesthesia, postoperative length of stay, and total hospitalization cost**

Outcomes	Unadjusted model		Adjusted model	
	Coefficient (95% CI)*	P-value	Coefficient (95% CI)*	P-value
Duration of anesthesia, min	34 (25–43)	<0.001	20 (13–27)	<0.001
Postoperative length of stay, days	0.4 (−0.004–0.9)	0.052	0.1 (−0.3–0.6)	0.50
Total hospitalization cost, US dollars	752 (521–982)	<0.001	445 (239–651)	<0.001

Abbreviation: CI, confidence interval.
* Coefficients are with reference to the adult group.

of the small number of outcomes, we did not perform multivariable logistic regression analyses for other complications.

Table 4 shows the unadjusted and adjusted associations of age with the duration of anesthesia, postoperative LOS, and total hospitalization cost. Children had a longer duration of anesthesia (difference, 20 minutes; 95% CI, 13–27; P < 0.001) and higher total hospitalization costs (difference, 445 dollars; 95% CI, 239–651; P < 0.001) than adults. There was no significant difference in postoperative LOS.

Multiple sensitivity analyses supported the robustness of our findings. In the analysis that the thresholds of adults groups are <50 and <60 years of age, there were no significant differences in in-hospital morbidity and local complications between the two groups (**Supplemental Table E3**).

In the analysis excluding patients aged 30 to 40 years from the adult group (**Table 5**), there were also no significant differences in in-hospital morbidity or local complications between the two groups. The stratified analysis by operative procedures (total thyroidectomy or hemi-/partial thyroidectomy) and hospital volume (low- or high-volume hospital) also showed consistent results with the main analyses (**Supplemental Tables E4** and **E5**).

DISCUSSION

In the current study, we compared perioperative outcomes between children and adults undergoing thyroid cancer surgery using a nationwide inpatient database with adjustment for patients' demographics, operative characteristics, and hospital volume. The data showed that children were more likely than adults to have

Table 5 Unadjusted and adjusted associations of age with outcomes in sensitivity analyses for limited adult group (age of 19–29 y)

Outcome (n = 15,022)	Unadjusted model		Adjusted model*	
	Point estimate (95% CI)†	P-value	Point estimate (95% CI)†	P-value
	Odds ratio		Odds ratio	
In-hospital morbidity	0.96 (0.67–1.37)	0.81	0.88 (0.60–1.28)	0.49
Local complications	0.96 (0.66–1.39)	0.81	0.87 (0.59–1.30)	0.50
RLN paralysis	0.83 (0.47–1.46)	0.52	0.75 (0.41–1.36)	0.34
Postoperative bleeding	1.49 (0.77–2.90)	0.24	1.29 (0.63–2.61)	0.49
	Coefficient		Coefficient	
Duration of anesthesia, min	29 (19–39)	<0.001	16 (8–24)	<0.001
Postoperative length of stay, days	0.5 (0.08–1.02)	0.023	0.3 (−0.2–0.7)	0.25
Total hospitalization costs, US dollars	727 (449–1,006)	<0.001	475 (217–732)	<0.001

Abbreviations: CI, confidence interval; RLN, recurrent laryngeal nerve.
* Adjusted for sex, body mass index, comorbidities, preoperative drug use, preoperative diagnosis, clinical TNM classification, operative procedure, extended lymph node dissection, intraoperative device use, type of hospital, and hospital volume.
† Odds ratios and coefficients are with reference to the limited adult group.

advanced cancer and to undergo total thyroidectomy. Children also had a longer duration of anesthesia and higher total hospitalization cost. However, no significant differences were detected in the occurrence of in-hospital morbidities (both local and general complications). These findings were consistent with the sensitivity analyses. To our knowledge, this is the first study to compare perioperative outcomes between children and adults undergoing thyroid cancer surgery with adjustment for potential confounders.

Previous studies showed that children were likely to have a more advanced stage of cancer with distant metastasis than adults [30–34]. This tendency was similar to our findings and may be explained by the small thyroid volume in children, allowing a tumor to extend beyond the thyroid capsule and invade adjacent tissues and neck lymph nodes [35]. Research has also shown that genetic factors may contribute [36], although no definitive conclusions have been reached. Although children were likely to have a more advanced stage of cancer than adults, the current study also revealed no differences in in-hospital morbidities in the analysis without adjustment for cancer stage. Additionally, many studies have shown that children with thyroid carcinoma have favorable long-term outcomes [31, 34, 37–40].

A large study using the Kids' Inpatient Database in the United States showed that the proportions of RLN paralysis and postoperative bleeding were 1.7% and 0.9%, respectively, in pediatric thyroidectomy for cancer and benign diseases including goiter [19]. These results are comparable with those in the current study. Regarding local complications, a previous study showed no significant differences in perioperative morbidities between children and adults, which is also compatible with the current study [22]. However, the previous study included benign diseases and did not adjust for potential confounders such as cancer stage, comorbidities, and hospital volume. The present large-scale database study is the first to compare perioperative outcomes between children and adults undergoing thyroid cancer surgery with adjustment for various potential confounders. Although pediatric surgery is generally considered to require a more meticulous procedure than adult surgery, the median age of patients in the pediatric group was 16 years, and their body habitus was not markedly different from that of patients in the adult group. The surgical field of pediatric thyroidectomy is not as narrow as that of adult thyroidectomy, even though the neck lymph nodes and thymus of children are reportedly more prominent [41–43]; consequently, the rarity of pediatric thyroidectomy would not have affected in-hospital morbidity. These results were also robust in the stratified analysis by operative procedures (total or hemi-/partial thyroidectomy) and hospital volume.

To our knowledge, no studies have compared the duration of surgery between children and adults. The

database we used in this study lacked data on the skin-to-skin surgical time. However, we were able to obtain data on the duration of anesthesia as an alternative. The present study showed a significantly longer duration of anesthesia in the children than adult groups. Although a long operation and anesthesia are generally considered to be associated with increased compilations and LOS, the present study showed no significant difference in in-hospital morbidity or LOS between the children and adults [44]. The 20-minute difference in the duration of anesthesia seems plausible because it takes more time to induce anesthesia and prepare for operations in children. Although the difference was statistically significant in this study, it may be clinically unimportant.

Our study also showed that the total hospitalization cost was US $445 higher in the children than adults. This may be because the basic hospitalization fee for children is reimbursed by the universal health coverage system in Japan, which reimburses higher charges for hospitalization of children in a pediatric ward than that of adults in a general ward. The difference in the basic hospitalization cost per day between children and adults is US $180 to $280. It is understandable and unavoidable that management of children requires more effort than management of adults, and the achievement of favorable outcomes with this $445 higher cost would thus be acceptable.

LIMITATIONS

The present study has several potential limitations. First, we were unable to assess the occurrences of postoperative hypocalcemia and hypoparathyroidism, major complications specific to thyroidectomy. In Japan, calcium and/or vitamin D supplements are commonly administered prophylactically to prevent symptomatic hypocalcemia [45, 46]. Because the database used in this study does not contain symptoms or laboratory data, we were not able to distinguish between treatments and prophylaxis for these complications. A previous study showed that children had a significantly higher proportion of endocrine-specific complications than adults (9.1% vs. 6.3%, $P < 0.01$) after thyroidectomy. [22] However, this comparison did not involve adjustment for potential confounders, and further research is therefore needed. Second, we were not able to assess long-term outcomes because of a lack of data. However, several studies have shown that children tend to have a more favorable prognosis and lower mortality than adults with thyroid cancer [31, 34, 37–40]. Third, we were not able to follow up patients across different hospitals in this database. Thus, we may have underestimated the occurrence of post discharge outcomes (e.g., 30-day readmission). Fourth, the Diagnosis Procedure Combination database does not provide detailed surgical information such as the blood loss and operative time. We therefore assessed the blood transfusion and duration of anesthesia instead of the blood loss and operative time, respectively. Finally, the database lacked data on surgeons' individual surgical skill levels to determine how they affected the perioperative outcomes. Instead, we used the hospital volume and type of hospital (teaching or nonteaching hospital) as potential confounders.

CONCLUSION

We compared perioperative outcomes between children and adults undergoing thyroid cancer surgery using a nationwide inpatient data in Japan. No significant difference was detected in the occurrence of in-hospital morbidities or LOS. These findings suggest that the surgical safety of thyroidectomy for pediatric patients is equivalent to that for adults. These observations should minimize parental and children's preoperative anxiety by providing evidence-based preoperative information [47, 48].

DISCLOSURES

The authors have no conflicts of interest directly relevant to the content of this article.

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DATA AVAILABILITY STATEMENT

The datasets analyzed during the current study are not publicly available due to contracts with the hospitals providing data to the database.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Michimasa Fujiogi: Conceptualization, Methodology, Data curation, Formal analysis, Writing – original draft, Writing – review & editing; Takaaki Konishi: Conceptualization, Methodology, Data curation, Formal analysis, Writing – review & editing; Nobuaki Michihata; Conceptualization, Methodology, Writing – review & editing; Yohei Hashimoto: Resources; Hiroki Matsui: Software, Resources; Kiyohide Fushimi; Investigation, Resources; Tetsuya Ishimaru: Writing – review & editing; Hideo Yasunaga: Conceptualization, Formal analysis,

Supervision, Writing – review & editing, Project administration; Jun Fujishiro: Conceptualization, Supervision, Writing – review & editing, Project administration

ETHICS/CONSENT

The requirement for informed consent in the present study was waived because of the anonymity of the patient database. This study was approved by the Institutional Review Board at The University of Tokyo.

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