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Short-term impact of delayed surgical treatment on the prognosis of patients with T1bN1-stage PTC: a retrospective cohort study

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Abstract

Background As the incidence of papillary thyroid carcinoma (PTC) increases, optimal timing for surgical interventions remains undefined. While surgical delays are known to affect prognosis adversely in various cancers, their impact on PTC is controversial.

Methods A retrospective study was conducted on 478 T1bN1-stage PTC patients treated at West China Hospital from January 2020 to May 2022. Patients underwent thyroidectomy with lymph node dissection and were categorized into three groups based on surgical delay: ≤90 days (group A, $n=264$), >90–180 days (group B, $n=92$), and >180 days (group C, $n=122$). Additionally, patients were reclassified into two groups based on a one-year threshold: ≤365 days (group D, $n=420$) and >365 days (group E, $n=58$). Tumor metastasis rates and postoperative complications were analyzed across these groups.

Results The median surgical delay was 79 days, and the median follow-up was 1362 days. Tumor metastasis occurred in 1.67% (8 patients), while postoperative complications occurred in 5.65% (27 patients). Metastasis rates were 1.89%, 1.09%, and 1.64%, and complication rates were 5.68%, 4.35%, and 6.56% for groups A, B, and C, respectively. No statistically significant differences were observed in metastasis or complication rates among the three groups. Similarly, no significant differences were found between groups D and E in tumor metastasis ($p=1.000$) or complication rates ($p=0.555$).

Conclusion Delayed surgery was not associated with significantly increased short-term tumor metastasis or postoperative complication rates in patients with T1bN1-stage PTC.

Keywords Delayed surgery, Papillary thyroid carcinoma, T1bN1-stage, Tumor metastasis, Postoperative complications.

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Introduction

With the rising incidence of papillary thyroid carcinoma (PTC) in recent years, thyroid cancer has become the ninth most common malignancy [1, 2]. The American Thyroid Association (ATA) recommends various surgical procedures based on the stage of PTC but does not provide specific guidelines for the optimal timing of surgery [3].

Timely surgical intervention is critical for optimal outcomes in cancer treatment. Nevertheless, health-system limitations, such as resource or policy constraints, often delay surgical care for cancer patients [4, 5]. Extensive research underscores that such delays can adversely affect prognosis across various malignancies, including breast, esophageal, colorectal, and lung cancers [6, 7, 8, 9]. However, whether surgical delay influences tumor metastasis, postoperative complications, or survival in PTC remains controversial. Patients with PTC generally have a favorable prognosis, with 10-, 15-, and 20-year overall survival rates of 97%, 95%, and 90%, respectively, following standard surgical resection [10]. Because of the high survival rate of PTC patients, delayed surgery is often deemed acceptable.

Nevertheless, previous studies have reported conflicting results regarding the prognostic impact of delayed surgery in PTC. Some studies suggest that prolonged waiting time is associated with reduced overall survival [11, 12, 13, 14]. For instance, in 2023, Chaves et al. analyzed disease-specific survival (DSS) and overall survival (OS) in 8,170 patients with PTC and concluded that delayed surgery of >180 days was associated with a 61% increased risk of mortality. Additionally, patients with T2-stage PTC have an estimated disease-specific mortality rate three times higher than that of other patients [11]. In contrast, other studies have indicated that delayed surgery has no significant effect on short-term outcomes, especially among patients with intermediate- to high-risk papillary thyroid microcarcinoma (PTMC, T1a stage), where active surveillance is considered safe and effective [7, 15, 16]. In 2022, Zhou et al. retrospectively analyzed 871 patients with intermediate- to high-risk PTC and concluded that surgical timing did not significantly affect short-term outcomes [16].

However, these prior studies have mainly focused on mixed-stage cohorts or PTMC (T1a stage). Compared with T1aN0 patients, T1b-stage tumors, especially those with lymph node metastasis (N1 stage), may exhibit more aggressive biological behavior and a higher recurrence risk [17, 18, 19]. Despite these differences, current guidelines, including the 2015 ATA recommendations, provide no clear advice on surgical timing for T1bN1-stage patients, and whether surgical delay is safe in this subgroup remains unclear.

Therefore, this study specifically investigates the impact of delayed surgery on tumor metastasis rates and postoperative complications in patients with T1bN1-stage PTC. Conducted at West China Hospital, which treats tens of thousands of PTC cases annually, this study aims to address the clinical uncertainty regarding surgical timing in this particular patient population, especially when immediate surgery may not be feasible.

Subjects and methods

Research subjects

Ethical approval for this study (2024 [2051]) was obtained from the Biomedical Ethics Review Committee of West China Hospital, Sichuan University, on 01 November 2024, and registration was completed with the Chinese Clinical Trial Registry (ChiCTR2500095113). Because this retrospective cohort study used anonymized clinicopathological information, the requirement for patient informed consent was waived. We retrospectively included patients with pathological T1bN1-stage papillary thyroid carcinoma (PTC) who underwent surgical treatment at our center between January 2020 and May 2022. The inclusion criteria were as follows: (1) postoperative pathological specimens confirmed papillary thyroid carcinoma; (2) tumors met the T1bN1-stage according to TNM classification; (3) age >16 years; and (4) follow-up duration of at least 24 months. The exclusion criteria were as follows (any of the following conditions led to exclusion): (1) postoperative pathological diagnosis indicated non-PTC or concurrent other types of thyroid cancers; (2) history of thyroid or parathyroid surgery, or other neck surgeries; (3) history of external neck irradiation; (4) abnormal parathyroid hormone or serum calcium levels prior to surgery; (5) dysfunction of the liver, kidneys, or other organs; (6) pregnancy or lactation; (7) missed follow-up visits for various reasons; (8) incomplete baseline data. After inclusion, patients were divided into three groups based on the time interval between PTC diagnosis confirmed by fine-needle aspiration cytology (FNA) and thyroid surgery (delayed surgery): group A included patients who underwent surgery within 90 days after diagnosis; group B included patients who underwent surgery between 91 and 180 days after diagnosis; and group C included patients who underwent surgery more than 180 days after diagnosis. To further explore whether different definitions of surgical waiting time might have an impact on study outcomes, we further categorized surgical waiting time into two groups: patients who underwent surgery within ≤365 days of diagnosis were group D and those who underwent surgery within >365 days of diagnosis were group E. With this adjustment, the aim was to test the potential impact of different divisions of surgical time intervals on study outcomes.

Surgical treatment and follow-up strategy

All included patients underwent either total thyroidectomy or lobectomy with isthmusectomy (partial thyroidectomy). Patients with negative lymph nodes on preoperative ultrasonography underwent prophylactic central neck lymph node dissection. Patients with central lymph node metastasis, diagnosed or suspected during preoperative ultrasound or perioperative evaluation, underwent therapeutic central neck dissection. Patients with biopsy-confirmed metastatic lateral cervical lymph node enlargement underwent lateral neck dissection. Specific surgical options were determined by a combination of patient preference and surgeon expertise. All surgeries were performed by thyroid surgeons with over10 years of experience at our center, each performing more than 200 thyroid surgeries annually. Pathological diagnoses were made by thyroid cytopathology pathologists. Post-total thyroidectomy radioactive iodine (RAI) remnant ablation was performed in patients at risk of recurrence [20]. After the initial treatment, all patients were regularly followed up every 3 months for thyroid function tests, serum thyroglobulin (Tg), anti-thyroglobulin antibody (TgAb), thyroid-stimulating hormone (TSH), parathyroid hormone (PTH), serum calcium, and neck ultrasonography. Follow-up data were collected during each in-person outpatient visit. If a patient missed clinic visits for over three months, telephone follow-up was performed to obtain the necessary clinical information.

Statistical analyses

Standard descriptive statistics were employed to summarize the baseline characteristics and clinical outcomes of the patients in this study. Continuous variables were expressed as medians with interquartile ranges, while categorical variables were presented as frequencies and percentages. Statistical tests were chosen based on the distribution characteristics of the data, for continuous variables across three groups, the Kruskal-Wallis H test was applied (since most indicators did not follow a normal distribution, as confirmed by the Shapiro-Wilk test for normality), and the Mann-Whitney U test was used for continuous variables between two groups. For any categorical variable where the sample size in any group is less than five, the comparison among the three groups was performed using the Fisher-Freeman-Halton extension of the Fisher exact test, while comparisons between two groups were conducted using the Fisher exact test. Other categorical variables were compared using the chi-square test. The primary outcome of interest was the tumor metastasis rate across different groups, and the chi-square test was used for between-group comparisons to further assess the effect of surgical waiting time on tumor metastasis. For variables showing significant differences between groups, we applied multiple comparison corrections (e.g., Benjamini-Hochberg adjustment) to account for multiple testing and reduce the false-positive rate. All statistical analyses were performed using the R software (version 4.4.0). A p-value of less than 0.05 was considered statistically significant. Kaplan-Meier survival curves were used to estimate tumor metastasis-free rates over time in each group, with group differences compared visually. Censored data (i.e., patients who did not experience metastasis by the end of follow-up) were marked with vertical lines.

Results

Based on the inclusion and exclusion criteria, 478 patients with T1bN1-stage PTC were included in this study. The kernel density distribution of surgical delay days and their frequency are shown in Fig. 1, with the majority of patients undergoing surgery within 200 days of diagnosis. The clinicopathological characteristics of the patients included in the study are presented in Table 1, with the following distribution across groups: group A ($n = 264$, 55.23%), group B ($n = 92$, 19.25%), and group C ($n = 122$, 25.52%). Tumor metastasis occurred in 8 patients (1.67%), and postoperative complications occurred in 27 patients (5.65%), most commonly convulsions, hoarseness, and coughing. The cohort included 329 females (68.83%) with a median age of 36 years. The overall median surgical delay was 79 days. Total thyroidectomy (TT) was performed in 338 patients (70.71%), and bilateral central compartment lymph node dissection was performed in 175 patients (36.61%). The median follow-up duration was 1362 days. Most patients had thyroid peritumoral invasion, and the incidence of temporary parathyroid dysfunction was approximately 32 times higher than that of permanent parathyroid dysfunction.

After statistical screening, all eight patients who developed tumor metastasis underwent total thyroidectomy, with a mean age of approximately 34 years. Five patients developed cervical lymph node metastasis, and three developed lung metastasis. The mean time to metastasis was 328.5 days postoperatively and the mean interval between diagnosis and surgery was approximately 145.4 days (Supplementary Table 1). Fisher-Freeman-Halton extended exact test analysis revealed no statistically significant difference in tumor metastasis rates among the three groups ($p = 1.000$), nor was there a significant difference in the incidence of surgical complications ($p = 0.801$). To further investigate potential differences in prognosis between the groups, we calculated odds ratios with 95% confidence intervals and P-values for tumor recurrence and surgical complications (Table 2). No significant differences were observed for either outcome: for tumor recurrence, ORs ranged from 0.66 to 1.76 with all 95% CIs crossing 1; for surgical complications, ORs ranged from 0.65 to 1.33, likewise with non-significant

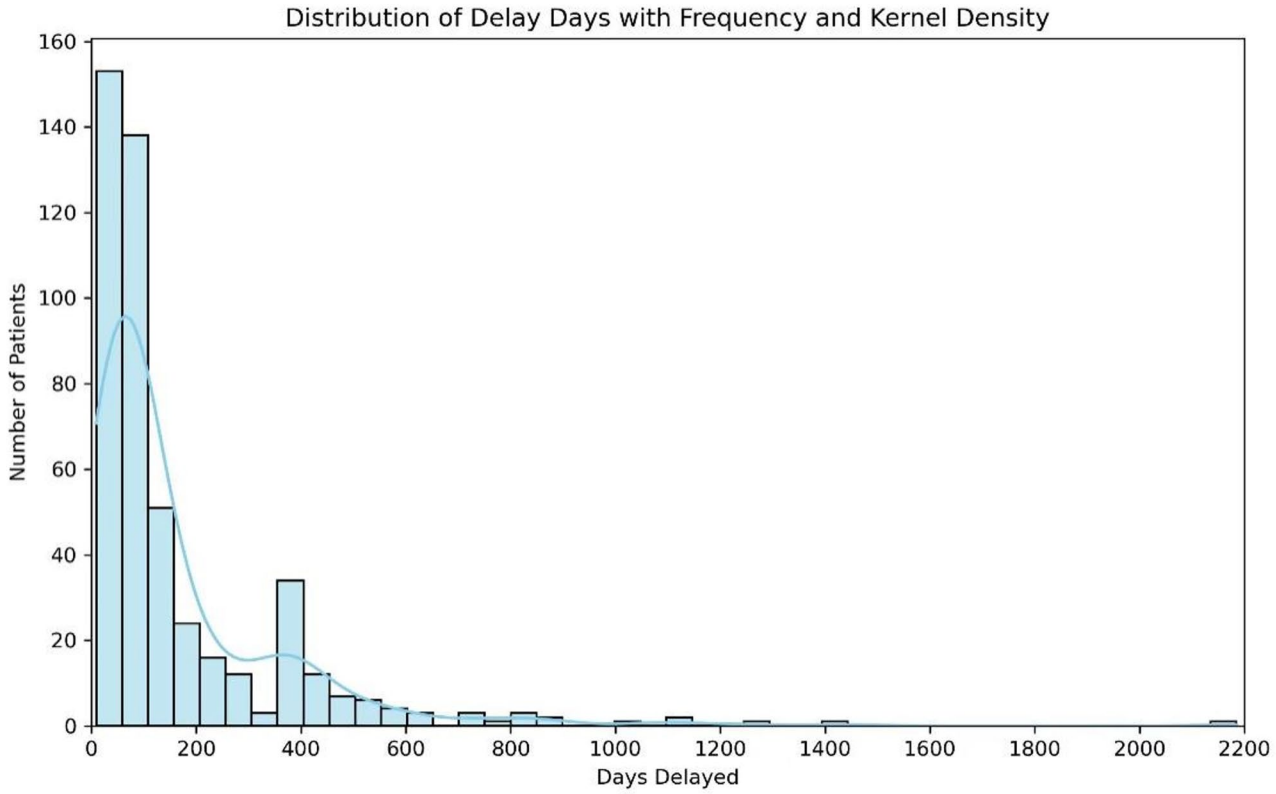

Fig. 1 Distribution of surgical delay intervals among patients with T1bN1-stage PTC

P-values across comparisons. Additionally, Kaplan-Meier survival analysis was employed to assess the impact of different surgical waiting times on the tumor metastasis-free rate. As shown in Fig. 2, the tumor metastasis-free rate in group A declined significantly during the early postoperative period, leveling off after approximately 500 days. In comparison, group C demonstrated a higher overall tumor metastasis-free rate. In contrast, the survival curves for group B showed a higher and more stable tumor metastasis-free rate.

The characteristics of the underlying data that were statistically different included Specific Delay in Days, Blood Loss, N stage, Autotransplanted PG, and Amount of Autotransplanted PGs. For indicators with significant differences, we controlled for multiple testing and reduced the false-positive rate by using the multiple comparison correction method. According to the Benjamini-Hochberg corrected analysis, the N staging was not significantly different.

Besides, we conducted a subgroup analysis of patients with N1 staging to assess the effect of delayed surgery on tumor metastasis in patients with N1a and N1b staging. The results are presented in Table 3. Among patients with N1a staging, only 2 cases developed metastasis, both of which underwent surgery within 90 days, resulting in a metastasis rate of 1.11%. For patients with N1b staging, 6 metastases occurred overall, and the metastasis rate for those with delayed surgery beyond 180 days was slightly higher at 8.33% (2 cases). Although longer surgical delay appeared to be associated with a higher metastasis rate in the N1b group, the differences were not statistically significant in either subgroup (N1a: $p = 0.988$; N1b: $p = 0.989$).

In addition, we conducted a detailed analysis of the preoperative and postoperative N staging to assess the impact of delayed surgery on lymph node metastasis in these patients. As shown in Table 4, transition from N0 to N1a was observed in 262 patients, with only 2 of these cases progressing to N1b, both of which underwent surgery within 90 days. Among patients who transitioned from N1a to N1b, metastasis progression was observed in 4 cases. By contrast, no changes were observed in patients who remained at N1b stage, indicating a high level of stable risk profile. The *p*-value from the chi-square test revealed a statistically significant correlation between preoperative and postoperative N staging.

We analyzed lymph node-related features, including the number of positive lymph nodes, number of lymph nodes dissected, lymph node metastasis rate, and the average size of lymph node metastasis (Supplementary Table 2). No statistically significant differences were found among the three groups in terms of the number of positive lymph nodes, number of lymph nodes dissected, or lymph node metastasis rate, based on Mann–Whitney

Table 1 Patient characteristics by surgical timing in T1bN1-Stage PTC (≤ 90 days, 91–180 days, > 180 days)

	Overall	Time to surgery(days)			*P*-value
		≤ 90(Group A)	91–180(Group B)	> 180(Group C)	
Number of Patients	478	264	92	122	/
Tumor Recurrence/Metastasis					
Yes	8 (1.67%)	5 (1.89%)	1 (1.09%)	2 (1.64%)	1.000
No	470 (98.33%)	259 (98.11%)	91 (98.91%)	120 (98.36%)	
Postoperative Complications					
Yes	27 (5.65%)	15 (5.68%)	4 (4.35%)	8 (6.56%)	0.801
No	451 (94.35%)	249 (94.32%)	88 (95.65%)	114 (93.44%)	
Gender					
Male	149 (31.17%)	80 (30.30%)	24 (26.09%)	45 (36.89%)	0.217
Female	329 (68.83%)	184 (69.70%)	68 (73.91%)	77 (63.11%)	
Age	36.00 (30.00–45.00)	36.00 (29.75-45.00)	36.00 (32.00–44.00)	37.50 (31.00–46.00)	0.332
BMI	23.23 (21.23–25.42)	23.13 (21.08–25.31)	22.80 (21.15–24.67)	23.61 (21.66–26.02)	0.167
Specific Delay in Days	79.00 (48.00-183.50)	50.50 (32.00-63.25)	120.00 (106.00-148.50)	365.00 (273.25–472.50)	<0.01*
Extent of Surgical Resection					
Less than TT	140 (29.29%)	76 (28.79%)	28 (30.43%)	36 (29.51%)	0.954
TT	338 (70.71%)	188 (71.21%)	64 (69.57%)	86 (70.49%)	
Preoperative N stage					
N0	264 (71.55%)	141 (53.41%)	50 (54.35%)	73 (59.84%)	0.094
N1a	61 (71.55%)	28 (10.61%)	12 (13.04%)	21 (17.21%)	
N1b	153 (71.55%)	95 (35.98%)	30 (32.61%)	28 (22.95%)	
N stage					
N1a	342 (71.55%)	180 (68.18%)	64 (69.57%)	98 (80.33%)	0.044*
N1b	136 (28.45%)	84 (31.82%)	28 (30.43%)	24 (19.67%)	
Extent of Lymph Node Dissection					
UCND	167 (34.94%)	82 (31.06%)	33 (35.87%)	52 (42.62%)	0.168
UCND + ULND	4 (0.84%)	2 (0.76%)	2 (2.17%)	0(0.00%)	
BCND	175 (36.61%)	98 (37.12%)	31 (33.7%)	46 (37.7%)	
BCND + ULND	118 (24.69%)	72 (27.27%)	23 (25.0%)	23 (18.85%)	
BCND + BLND	14 (2.93%)	10 (3.79%)	3 (3.26%)	1 (0.82%)	
Blood Loss	20.00 (10.00–30.00)	20.00 (10.00-42.50)	20.0 (10.0–50.0)	15.00(10.00–30.00)	0.026*
Positive Lymph Nodes	4.00 (2.00–7.00)	4.00 (2.00–7.00)	4.00 (2.00–9.00)	3.00 (1.00-6.75)	0.144
Lymph Node Dissected	12.00 (7.00-28.75)	12.00 (7.00-32.25)	12.00 (6.00–29.00)	11.00 (6.00-21.25)	0.185
Lymph Node Metastasis Rate	0.29 (0.18–0.50)	0.30 (0.17–0.50)	0.32 (0.21–0.50)	0.28 (0.17–0.50)	0.575
Size of Positive Lymph Nodes (mm)	0.60 (0.40–0.95)	0.65 (0.45-1.0)	0.60 (0.40–0.96)	0.55 (0.40–0.85)	0.054
Autotransplanted PGs					
Yes	368 (76.99%)	213 (80.68%)	74 (80.43%)	81 (66.39%)	<0.01*
No	110 (23.01%)	51 (19.32%)	18 (19.57%)	41 (33.61%)	
Amount of Autotransplanted PGs					
0	111 (23.22%)	51 (19.32%)	18 (19.57%)	42 (34.43%)	0.017*
1	261 (54.60%)	159 (60.23%)	49 (53.26%)	53 (43.44%)	
2	101 (21.13%)	51 (19.32%)	24 (26.09%)	26 (21.31%)	
3	5 (1.05%)	3 (1.14%)	1 (1.09%)	1 (0.82%)	
Hospitalization Time (Days)	7.00 (6.00–8.00)	7.0 (6.0–8.0)	7.0 (6.0–8.0)	6.50 (6.00–8.00)	0.373
Follow-up Time (days)	1362.00 (1123.75–1532.00)	1431.00 (1141.00-1527.00)	1255.00 (1086.25-1518.75)	1369.50 (1150.50-1559.75)	0.292
Capsular Invasion					
Yes	398 (83.26%)	220 (83.33%)	73 (79.35%)	105 (86.07%)	0.427
No	80 (16.74%)	44 (16.67%)	19 (20.65%)	17 (13.93%)	
Iodine-131 treatment					
Yes	249 (52.09%)	148 (56.06%)	45 (48.91%)	56 (45.9%)	0.141
No	229 (47.91%)	116 (43.94%)	47 (51.09%)	66 (54.1%)	

Table 1 (continued)

	Overall	Time to surgery(days)			*P*-value
		≤ 90(Group A)	91–180(Group B)	> 180(Group C)	
Temporary Hypoparathyroidism					
Yes	193 (40.38%)	105 (39.77%)	33 (35.87%)	55 (45.08%)	0.379
No	285 (59.62%)	159 (60.23%)	59 (64.13%)	67 (54.92%)	
Permanent Hypoparathyroidism					
Yes	6 (1.26%)	4 (1.52%)	2 (2.17%)	0(0.00%)	0.229
No	472 (98.74%)	260 (98.48%)	90 (97.83%)	122 (100%)	

BMI: Body Mass Index; TT: Total Thyroidectomy; UCND: Unilateral Central Neck Dissection; BCND: Bilateral Central Neck Dissection; ULND: Unilateral Lateral Neck Dissection; BLND: Bilateral Lateral Neck Dissection; PGs: Parathyroid Glands

Table 2 Intergroup comparison of tumor recurrence or metastasis rates

Comparison	Recurrence rate OR (95% CI), *P*-value	Surgery complications OR (95% CI), *P*-value
≤ 90 vs. 91-180days	1.76 (0.20–15.24), $P=0.250$	1.33 (0.43–4.10), $P=0.233$
≤ 90 vs. > 180days	1.16 (0.22–6.06), $P=0.500$	0.86 (0.35–2.08), $P=0.583$
91–180 vs. > 180days	0.66 (0.06–7.38), $P=1.000$	0.65 (0.19–2.22), $P=0.375$

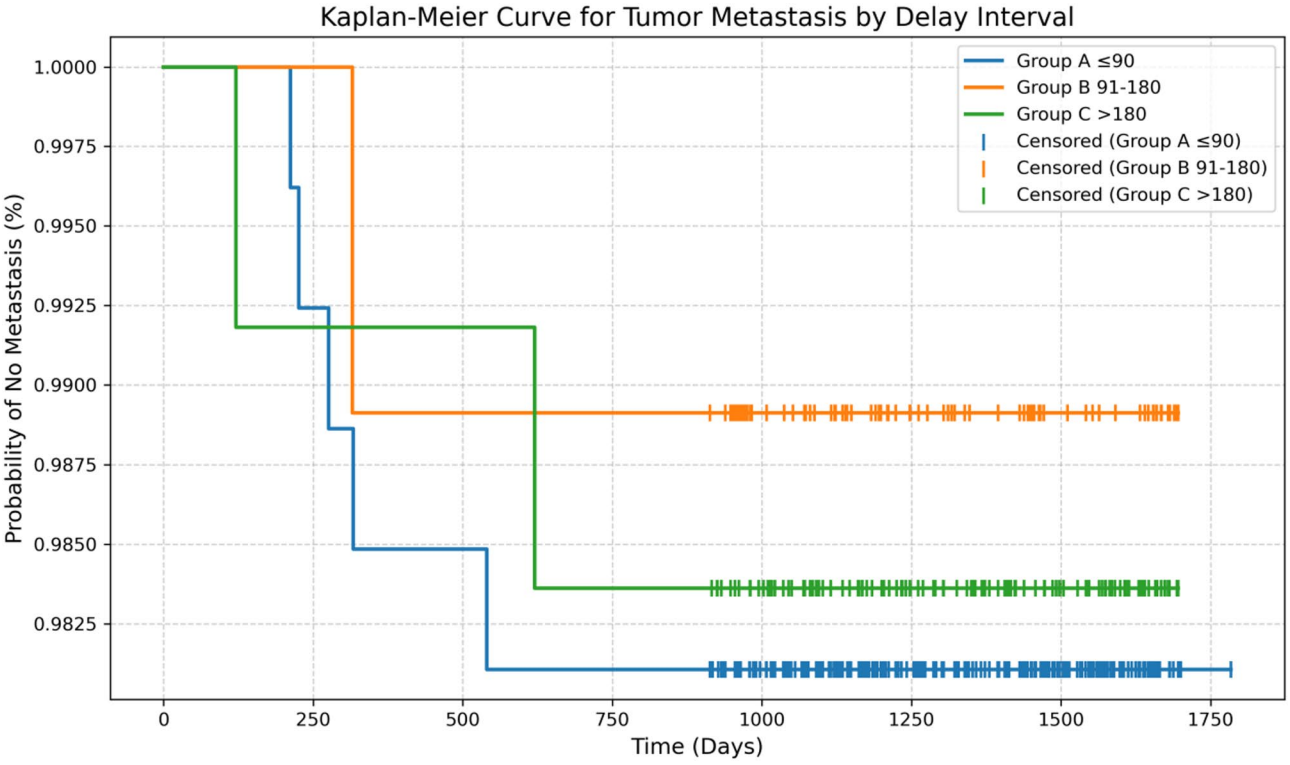

Fig. 2 Kaplan-Meier estimates of tumor metastasis -free survival by surgical waiting times for T1bN1-stage PTC patients

Table 3 Subgroup analysis of surgical delay impact on tumor metastasis in N1a and N1b stage patients with PTC

	Overall	Time to surgery(days)			*P*-value
		≤ 90	91–180	> 180	
N1a Tumor Metastasis					
Yes	2 (0.59%)	2 (1.11%)	0 (0.00%)	0 (0.00%)	0.988
No	340 (99.41%)	178 (98.89%)	64 (100.00%)	98 (100.00%)	
N1b Tumor Metastasis					
Yes	6 (4.41%)	3 (3.57%)	1 (3.57%)	2 (8.33%)	0.989
No	130 (95.59%)	81 (96.43%)	27 (96.43%)	22 (91.67%)	

Table 4 Preoperative to postoperative N stage transition tabulation

Preoperative *N* stage	Postoperative N1a	Postoperative N1b	*P*-value
N0	262	2	<0.01*
N1a	57	4	
N1b	23	130	

U tests. However, the average size of metastatic lymph nodes was significantly larger in group C than in group A.

Furthermore, we adjusted the classification of surgical waiting time to further validate our findings (Table 5), categorizing patients into groups D ($n = 420$, 87.87%) and E ($n = 58$, 12.13%). Fisher's exact test revealed no statistically significant difference between the two groups in terms of tumor metastasis rate ($p = 1.000$) and incidence of surgical complications ($p = 0.555$). Regarding specific clinical and pathological characteristics, most indicators, including the number of lymph node metastases and number of lymph nodes cleared, did not show significant differences. However, the "Positive Lymph Nodes" and "Lymph Node Dissected" exhibited statistically significant differences between groups D and E ($p = 0.011$ and $p = 0.030$, respectively). Additionally, there were no significant differences between the two groups in terms of the rate of autologous parathyroid transplantation, number of transplants performed, or duration of surgery, hospitalization, and follow-up. These findings suggest that long-term clinical management and treatment strategies are essentially similar in patients with surgical waiting times ≤ 365 days versus those with waiting times >365 days.

Discussion

With the development of evidence-based medicine and the accumulation of clinical experience, ATA-recommended treatment guidelines are constantly updated to provide more scientific guidance to patients with thyroid cancer. For example, the 2009 ATA guidelines set the minimum diameter threshold for nodules requiring FNA at 0.5 cm, and the 2015 version increased this value to 1 cm [3]. Active surveillance has become an optional treatment regimen for T1a-stage papillary thyroid cancer. Many studies have shown that delayed surgery for T1a-stage papillary thyroid cancer does not increase the risk of death [21, 22, 23]. In 2016, Anderson et al. showed no significant difference in DSS and OS between patients with T1b-stage and T1a-stage PTC [24]. For patients with T1b-stage, the ATA guidelines recommend lobectomy and isthmus resection, and total thyroidectomy is also feasible for some patients with high-risk factors. Although ATA provides feasible treatment options for each stage of PTC, it does not specify the timing of surgery, and this issue has been the subject of much clinical controversy. Due to the specificity of the study's focus, ethical dilemmas, and considerations of health impacts on patients, it is difficult for investigators to conduct prospective randomized controlled trials to answer this question.

At the end of 2019, the issue of delayed surgery for PTC patients was amplified by the global COVID-19 pandemic, as cancer surgery is considered a scheduled procedure rather than an emergency and more healthcare resources are being allocated to save critically ill COVID-19 patients [25]. Several studies have demonstrated, from multiple perspectives, that delayed surgery significantly impacts the prognosis of patients with PTC [26, 27, 28, 29]. For example, in 2021, Fligor et al. analyzed data from 103,812 thyroid cancer patients in the National Cancer Database (NCDB) [12]. They found that a surgical delay of 91–180 days resulted in a 30% increased risk of death, a delay of more than 180 days resulted in a 94% increased risk, and the 5-year overall survival rate decreased from 95.7 to 87.9% with increasing surgical delay. In addition, a multicenter cross-sectional study in 2023 showed that delayed surgical treatment during the COVID-19 pandemic may lead to a significant increase in the rate of lymph node metastasis and risk of tumor recurrence in thyroid cancers [13]. Meanwhile, other investigators have suggested that delayed surgery under active surveillance is acceptable, especially for PTMC, and that close follow-up is a viable alternative to immediate surgery [30, 31, 32]. In 2023, Turaga et al. analyzed data from 4.4 million cancer patients in the NCDB and concluded that, for most malignancies, surgical delays of up to four weeks beyond standard waiting times did not significantly impact patient survival [33]. Similarly, several studies have shown that patients with low-risk PTC can be closely monitored and that delayed surgery is not associated with an increased incidence of structural tumor recurrence or local metastases [34, 35]. Although these studies offer valuable insights, most were limited to PTMC populations or lacked detailed staging information, and none specifically focused on patients with T1bN1-stage PTC. Therefore, we investigated the effect of delayed surgery on the rate of tumor recurrence or metastasis and postoperative complications in patients with T1bN1-stage PTC.

Patients with T1bN1-stage PTC who underwent surgical treatment at our center during the COVID-19 pandemic were included in this study. Disease-specific survival (DSS) and overall survival (OS) were not analyzed due to the short duration of this retrospective study, with a median follow-up of 1362 days and no patient experiencing mortality. Our findings suggest that delayed surgery did not significantly affect short-term clinical outcomes in patients with T1bN1-stage PTC.

Table 5 Patient characteristics by surgical delay in T1bN1-Stage PTC (≤ 365 days, > 365 days)

	Overall	Time to surgery(days)		*P*-value
		≤ 365(Group D)	> 365(Group E)	
Number of Patients	478	420	58	/
Tumor Recurrence/Metastasis				
Yes	8 (1.67%)	7 (1.67%)	1 (1.72%)	1.000
No	470 (98.33%)	413 (98.33%)	57 (98.28%)	
Postoperative Complications				
Yes	27 (5.65%)	23 (5.48%)	4 (6.9%)	0.555
No	451 (94.35%)	397 (94.52%)	54 (93.1%)	
Gender				
Male	149 (31.17%)	127 (30.24%)	22 (37.93%)	0.301
Female	329 (68.83%)	293 (69.76%)	36 (62.07%)	
Age	36.00(30.00–45.00)	36.00(30.00–45.00)	39.00(31.00-49.75)	0.112
BMI	23.23(21.23–25.42)	23.23(21.23–25.58)	23.47(21.09–24.49)	0.771
Specific Delay in Days	79.00(48.00-183.50)	68.00(43.00-122.00)	491.00(414.25–704.00)	<0.01*
Extent of Surgical Resection				
Less than TT	140 (29.29%)	123 (29.29%)	17 (29.31%)	1.000
TT	338 (70.71%)	297 (70.71%)	41 (70.69%)	
N stage				
N1a	342 (71.55%)	295 (70.24%)	47 (81.03%)	0.120
N1b	136 (28.45%)	125 (29.76%)	11 (18.97%)	
Extent of Lymph Node Dissection				
UCND	167 (34.94%)	143 (34.05%)	24 (41.38%)	0.748
UCND + ULND	4 (0.84%)	4 (0.95%)	0(0.00%)	
BCND	175 (36.61%)	153 (36.43%)	22 (37.93%)	
BCND + ULND	118 (24.69%)	106 (25.24%)	12 (20.69%)	
BCND + BLND	14 (2.93%)	14 (3.33%)	0(0.00%)	
Blood Loss	20.00(10.00–30.00)	20.00(10.00–30.00)	15.00(10.00–30.00)	0.209
Positive Lymph Nodes	4.00(2.00–7.00)	4.00(2.00–7.00)	3.00(1.00–6.00)	0.011*
Lymph Node Dissected	12.00(7.00-28.75)	12.00(7.00-30.25)	10.00(5.00-17.75)	0.030*
Lymph Node Metastasis Rate	0.29(0.18–0.50)	0.30(0.18–0.50)	0.28(0.20–0.50)	0.821
Size of Positive Lymph Nodes (mm)	0.60(0.40–0.95)	0.60(0.40–0.95)	0.55(0.40–0.85)	0.051
Autotransplanted PG				
Yes	368 (76.99%)	325 (77.38%)	43 (74.14%)	0.701
No	110 (23.01%)	95 (22.62%)	15 (25.86%)	
Amount of Autotransplanted PGs				
0	111 (23.22%)	96 (22.86%)	15 (25.86%)	0.953
1	261 (54.60%)	230 (54.76%)	31 (53.45%)	
2	101 (21.13%)	89 (21.19%)	12 (20.69%)	
3	5 (1.05%)	5 (1.19%)	0(0.00%)	
Hospitalization Time (Days)	7.00(6.00–8.00)	7.00(6.00–8.00)	7.00(5.00–8.00)	0.199
Follow-up Time (days)	1362.00 (1123.75–1532.00)	1346.50 (1119.00-1528.25)	1410.50 (1227.00-1559.50)	0.218
Capsular Invasion				
Yes	398 (83.26%)	350 (83.33%)	48 (82.76%)	1.000
No	80 (16.74%)	70 (16.67%)	10 (17.24%)	
Iodine-131 treatment				
Yes	249 (52.09%)	223 (53.1%)	26 (44.83%)	0.298
No	229 (47.91%)	197 (46.9%)	32 (55.17%)	
Temporary Hypoparathyroidism				
Yes	193 (40.38%)	168 (40.0%)	25 (43.1%)	0.757
No	285 (59.62%)	252 (60.0%)	33 (56.9%)	

Table 5 (continued)

	Overall	Time to surgery(days)		*P*-value
		≤ 365(Group D)	> 365(Group E)	
Permanent Hypoparathyroidism				
Yes	6 (1.26%)	6 (1.43%)	0(0.00%)	1.000
No	472 (98.74%)	414 (98.57%)	58 (100.0%)	

BMI: Body Mass Index; TT: Total Thyroidectomy; UCND: Unilateral Central Neck Dissection; BCND: Bilateral Central Neck Dissection; ULND: Unilateral Lateral Neck Dissection; BLND: Bilateral Lateral Neck Dissection; PGs: Parathyroid Glands

Despite the disruptions caused by the pandemic, more than 50% of the patients underwent surgery within 90 days of diagnosis. We initially divided the surgical delay into three time segments and found no significant differences in tumor metastasis or surgical complication rates among the three groups. Previous studies have also examined the effects of delayed surgery in patients with PTC, with time categorized into similar segments [11, 12]. It could be argued that categorizing the time period differently might yield varying results. To address this, we categorized this possibility and categorized the patients into two groups based on a 365-day cutoff: one group with a delay of more than 365 days (metastasis rate of 1.67%) and another group with a delay of 365 days or less (metastasis rate of 1.72%). These results were consistent with our previous findings, showing no significant association between delayed surgery and tumor metastasis rates ($p = 1.000$) or postoperative complications ($p = 0.555$). While segmenting the surgical delay differently may influence the statistical outcomes, this did not alter the conclusions of the study.

In the patients who developed tumor metastasis in this study, the sites were the cervical lymph nodes and lungs, which is consistent with the most common sites of distant metastasis of differentiated thyroid cancer reported by Chen et al. [36]. Regarding postoperative complications, a total of 27 patients had complications, except for one patient with airway obstruction (degree III laryngeal obstruction) who underwent laryngeal support surgery. The remaining patients' complications were clinically mild, and there was no significant difference in the incidence of temporary parathyroidism or permanent parathyroidism between the different groups.

A total of 262 patients exhibited a transition from preoperative N0 to postoperative N1a status, with a highly significant p-value (chi-square test, $p < 0.01$), a finding that warrants careful consideration. This result underscores the limitations of preoperative imaging modalities, such as ultrasound and computed tomography (CT), in detecting regional lymph node micrometastases, a point that has been well established in the literature [37, 38, 39, 40]. These micrometastasis are often smaller than the resolution threshold of imaging techniques and can only be revealed through meticulous evaluation provided by postoperative pathological examination. Therefore, the statistical association between preoperative and postoperative N stage is likely to reflect methodological differences rather than genuine biological progression during the preoperative waiting period. Notably, although the recurrence/metastasis rate in group C (> 180 days) appeared slightly lower than in groups A and B, this difference was not statistically significant ($P = 1.000$). This paradoxical trend may be influenced by selection bias or residual confounding. For instance, some patients in group C may have presented with less aggressive tumor behavior or lower disease burden at diagnosis, leading clinicians to defer surgery. Additionally, surgical scheduling may have been affected by physician discretion, patient preference, or comorbid conditions, all of which could confound the observed outcomes. Given the retrospective nature of our study, unmeasured confounders could not be fully excluded despite controlling for multiple known variables. Importantly, unlike other studies, our cohort consisted of patients who underwent at least unilateral central compartment lymph node dissection, providing robust evidence for investigating the impact of surgical delay on lymph node metastasis. While preoperative imaging has inherent limitations in detecting micrometastasis, our analysis of lymph nodes further supports the conclusion that delayed surgery does not significantly increase the likelihood of lymph node metastasis. Notably, although the mean lymph node diameter in group C was smaller than that in group A, intergroup difference did not reach statistical significance. There were no statistically significant differences in the number of positive lymph nodes, total number of lymph nodes dissected, mean size of lymph node metastases, or rate of lymph node metastasis among the three patient groups. These findings are consistent with those of previous studies. For instance, Wang et al. demonstrated that delayed surgery did not significantly affect the rate of central lymph node metastasis, multifocal cancer, or bilateral multifocal cancer in low-risk papillary thyroid cancer (PTC) patients [34]. This supports our results, further validating that the effect of surgical delay on short-term clinical outcomes in patients with T1bN1-stage PTC is limited. Our study provides new insights that could contribute to the optimization of management strategies for patients experiencing delays in surgery.

For patients with T1bN1-stage PTC, previous surgical recommendations have typically emphasized immediate surgical treatment, pressuring patients to make decisions quickly and causing considerable mental stress [41, 42]. In contrast, the findings of this study suggest that delayed surgery does not appear to adversely affect short-term outcomes in this group of patients. This gives them more time to decide and delays potential postoperative complications and the initiation of thyroxine intake. This additional time may help reduce decision-related anxiety, allow patients to better prepare for surgery, and facilitate optimal scheduling of healthcare resources, especially in times of system strain or public health crises.

Several limitations of this study must be acknowledged. First, the relatively short follow-up period may not fully capture the long-term risks of metastasis and mortality. Future research with extended follow-up durations is needed to validate our findings. Second, this study was non-randomized, and the timing of surgery was influenced by factors such as patient preferences, epidemiological control measures, and disease progression. Furthermore, as a retrospective study, it is subject to potential confounding factors related to delayed surgery and prognosis, including the number of lymph node metastases and the administration of iodine-131 therapy. Additionally, this study may be subject to referral or selection bias, as patients who underwent delayed surgery may differ systematically from those who received earlier intervention in ways that were not fully captured by the available data. Furthermore, since all patients were treated at a single high-volume center in China, caution should be exercised when generalizing these findings to other healthcare settings or populations.

This retrospective study found that delayed surgery in patients with T1bN1-stage PTC did not significantly increase the short-term rate of tumor recurrence, metastasis, or postoperative complications. While delayed surgery may be a reasonable option in selected patients, further studies with longer follow-up are needed to assess the long-term impact on survival and quality of life.

Conclusion

Delayed surgery may be considered a reasonable and safe option for patients with T1bN1-stage PTC, without increasing short-term oncologic or surgical risks. These findings may inform individualized decision-making in clinical practice and provide a basis for further prospective investigations.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12885-025-14371-x.

Supplementary Material 1

Author contributions

A.S: Conceptualization, Methodology, Project Administration, Supervision, Writing– Review & Editing. H. G: Conceptualization, Data Curation, Formal Analysis, Investigation, Writing– Original Draft, Writing– Review & Editing. T. J: Data Curation, Investigation, Writing– Original Draft, Writing– Review & Editing. Y.Y: Data Curation. Y.J: Data Curation. Z.W: Formal Analysis, Writing– Review & Editing. All authors contributed to and approved the final version of the manuscript.

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Data availability

Data supporting this study are available from the corresponding author upon reasonable request. However, access to the data generated or analyzed during this study is restricted due to the need to protect patient confidentiality and the use of licensed data. The corresponding author will provide a detailed explanation of these restrictions and clarify the conditions under which access to specific datasets may be granted. Data sharing is not applicable to this article, as no new datasets were generated or analyzed during the course of the study. Some or all datasets generated and/or analyzed in this study are not publicly available but may be obtained from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

This retrospective cohort study was conducted in accordance with the Declaration of Helsinki and received approval from the the Biomedical Ethics Review Committee of West China Hospital, Sichuan University (2024 [2051]), and registration was completed with the Chinese Clinical Trial Registry (ChiCTR2500095113). Given the retrospective nature of the study and the use of anonymized data, the ethics committee waived the requirement for informed consent. Patient data were de-identified prior to analysis to ensure confidentiality and protect privacy. The study was conducted in compliance with local legislation and relevant guidelines.

Competing interests

The authors declare no competing interests.

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