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Original Research

Superior parathyroid blood supply safety in thyroid cancer surgery: A randomized controlled trial

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ABSTRACT

Background: To evaluate the clinical value of a technique protecting blood supply to the superior parathyroid during surgery for thyroid cancer.

Materials and methods: The observation group comprised 113 patients admitted to our hospital during the period from January 1, 2016 to December 31, 2016, who were diagnosed with thyroid cancer and treated by surgery using a technique protecting blood supply to the superior parathyroid. The control group comprised 113 patients diagnosed with thyroid cancer who were treated by surgery using the conventional technique. Postoperative parathyroid function damage and blood calcium levels were assessed in both groups.

Results: The incidences of hypocalcemia and low parathyroid hormone in the observation and control groups were 10.6% and 31.9%, and 14.2% and 35.4%, respectively. The relative risk (RR) of the control group was increased (RR = 3.009 for control; RR = 2.493 for observation). Univariate logistic regression analysis showed that postoperative temporary hypoparathyroidism was associated with lymph node metastasis, use of the above protective technique, and tumor size [(odds ratio, OR = 1.936, 95%CI 1.029–3.643; P = 0.041), (OR = 0.301, 95%CI 0.156–0.579; P = 0.001) and (OR = 2.022, 95%CI 1.089–3.756; P = 0.026), respectively]. Postoperative temporary hypoparathyroidism was also associated with lymph node dissection (Bilateral vs. No, P = 0.003) and T classification (T3 vs. T1, P = 0.034). Multivariate logistic regression analysis showed that, after including significant independent variables of univariate logistic regression analysis (e.g., lymph node metastasis, lymph node resection, protective technique, tumor size, and T classification), the protective technique was a factor supporting reduced incidence of postoperative temporary hypoparathyroidism (OR = 0.325, 95% CI 0.163–0.648; P = 0.001).

Conclusion: Application of a technique protecting blood supply to the superior parathyroid during thyroid cancer surgery effectively reduced the incidence of postoperative temporary hypoparathyroidism. However, because of the imbalance in lymph node dissection between the two groups, confounding factors could not be completely eliminated, and matched pair analysis is needed to eliminate these factors.

1. Introduction

Thyroid cancer cases account for 1%–5% of all cancers, with incidence increasing with age and growing rapidly [1]. Currently, surgery is considered the first treatment of choice for thyroid cancer; meanwhile, the main surgical complications include injury of the parathyroid and recurrent laryngeal nerve. The clinical application of nerve monitoring has played a positive role in the detection and functional protection of the recurrent laryngeal nerve during surgery. However, postoperative hypoparathyroidism caused by parathyroid damage remains a challenge for thyroid surgeons [2–7]. The incidence rates of temporary and permanent hypoparathyroidism after thyroid surgery are 14–60% and 1.5–11%, respectively [8–11]. Temporary hypoparathyroidism can cause transient hypocalcemia symptoms and increase medical costs. Permanent hypoparathyroidism can result in permanent hypocalcemia symptoms, mainly manifested as hand and foot numbness, and limb convulsions, severely affecting the patients' quality of life. It has become a major factor generating medical disputes.

Halsted pointed out long ago that a finely preserved parathyroid gland can prevent permanent hypocalcemia. Considering the current advocacy for routine dissection of central lymph nodes, the inferior parathyroid gland is often difficult to retain intraoperatively during the

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dissection of level VI lymph nodes due to large position variations. The probability of damage to the inferior parathyroid gland is much higher than that of injury to the superior parathyroid gland. Therefore, caution should be used when treating parathyroid glands in clinical practice. The position of the superior parathyroid gland is relatively constant, and it can effectively retain the parathyroid gland [12,13]. Currently, domestic and foreign techniques for retaining the parathyroid gland mainly include the meticulous capsular dissection technique [14,15], *in-situ* protection technique [16–18], using carbon nanoparticles [19], and parathyroid auto-transplantation technique [20–22]. However, the incidence of postoperative hypoparathyroidism remains relatively high. According to the characteristics of blood supply to the parathyroid gland, after using a technique protecting blood supply to the superior parathyroid the incidence of postoperative hypoparathyroidism was found to be significantly reduced, with the patients' quality of life greatly improved after surgery.

Previous studies considered that 80% of blood supply in the parathyroid gland originates from the inferior thyroid artery. Recent findings [23] indicated that most of the blood supply to the superior parathyroid (55%) comes from the posterior branch of the superior thyroid artery, especially the high parathyroid gland. The remaining 45% originates from the anastomotic branches of superior and inferior thyroid arteries. These blood vessels are very slender and susceptible to stimuli such as pulling and separating. Some parathyroid glands do not have a single nutrient artery but are supplied by very fine terminal branches that pass through the thyroid parenchyma. Apparent ischemia occurs after detachment from the capsule of the thyroid gland. Therefore, it is particularly important to protect blood supply to the parathyroid gland. Since January 1, 2016, we have used a technique protecting blood supply to the superior parathyroid, which significantly reduces the incidence of temporary and permanent hypoparathyroidism after surgery for thyroid cancer. It was suggested that this protective technique for blood supply to the superior parathyroid has a high clinical value in protecting parathyroid function and reducing the incidence of hypoparathyroidism after surgery for thyroid cancer.

In this study, we examined 226 patients with thyroid papillary carcinoma, with the technique protecting blood supply to the superior parathyroid applied in 113 of them. The purpose of this work was to assess the clinical value of the above protective technique in preserving parathyroid function during surgery for thyroid cancer, and to further provide a theoretical basis for selecting a clinical therapeutic schedule.

2. Materials and methods

2.1. Study population

This was a prospective study with 226 thyroid cancer patients who were admitted to our hospital from January 1, 2016 to December 31, 2016. The patients were randomly divided into observation group and control group, with 113 patients in each group. The technique of parathyroid blood supply protection was used in the observation group, but not in the control group. After surgery, the plasma levels of parathyroid hormone (PTH) and blood calcium were assessed in both groups to evaluate whether protection of parathyroid blood supply enabled protection of parathyroid function during surgery for thyroid cancer. Total thyroidectomy was performed for all patients with thyroid cancer who were included in the present study. Patients underwent preoperative serum thyroid-stimulating hormone, triiodothyronine, and thyroxine assessments, as well as thyroid color ultrasound and/or neck computed tomography (CT) scans. Blood calcium and PTH levels were both assessed 1 day before and 1 day after surgery, respectively. Inclusion criteria were: (1) preoperative ultrasonography combined with fine needle biopsy showing clear and suspicious diagnosis, and preoperative PTH and serum calcium within the normal ranges; (2) diagnosis of thyroid papillary carcinoma for which surgery was clinically indicated (thyroidectomy was performed for all patients); and (3) definite diagnosis of thyroid cancer by postoperative pathology. Exclusion criteria were: (1) preoperative B ultrasonography or CT imaging suggesting widespread metastases to the neck; (2) non-differentiated thyroid malignancies and thyroid follicular carcinomas; (3) other malignancies or systemic diseases, such that the patient could not tolerate surgery; or (4) diseases that could reduce blood calcium levels, such as acute pancreatitis, chronic renal insufficiency, vitamin D deficiency, and metabolic abnormalities. Patient characteristics assessed included age, gender, tumor size, lymph node metastasis, lymph node dissection, capsule encroachment, tumor size, T classification, RAI, and calcium supplementation. T classification was divided into T1, T2, and T3 stages, in accordance with the TNM classification criteria for thyroid cancer of AJCC 7th Edition (2010). Postoperative radioactive iodine was used with an administration dose of 3.7 GBq (100 mCi). Our clinical data of lymph node dissection showed significant differences between the two groups ($P = 0.001$). The others showed no significant differences in clinical data ($P > 0.05$) (Table 1).

We used completely randomized grouping and random number residue grouping to establish the groups of patients in this study. In total, 232 experimental units were numbered according to the time of admission, ranging from 1 to 232. Using a computer random number generation expert (version 1.5) to obtain three-digit random numbers; beginning from any number in the random number generation, one random number for each experimental unit is obtained in the same direction. The random number is divided by the remainder of the array number "2," and the remainder of the whole division is used as the array number. A remainder of 1 resulted in allocation to the observation group, while a remainder of 2 resulted in allocation to the control

Table 1
Clinical and pathological features in the observation and control groups.

Parameters	All	Control group	Observation group	P-value
N	226	113	113	
Age(years)				0.506
≤45	116 (51.3)	55 (48.7)	61 (54.0)	
> 45	110 (48.7)	58 (51.3)	52 (46.0)	
Gender				0.682
Male	27 (11.9)	12 (10.6)	15 (13.3)	
Female	199 (88.1)	101 (89.4)	98 (86.7)	
Lymph node metastasis				0.192
Negative	158 (69.9)	74 (65.5)	84 (74.3)	
Positive	68 (30.1)	39 (34.5)	29 (25.7)	
lymph node dissection				0.001
No	49 (21.7)	13 (11.5)	36 (31.9)	
unilateral	126 (55.8)	69 (61.1)	57 (50.4)	
Bilateral	51 (22.6)	31 (27.4)	20 (17.7)	
tumor capsule invasion				0.783
No	212 (93.8)	105 (92.9)	107 (94.7)	
Yes	14 (6.2)	8 (7.1)	6 (5.3)	
Parathyroid autotransplantation				0.614
No	209 (92.5)	103 (91.2)	106 (93.8)	
Yes	17 (7.5)	10 (8.8)	7 (6.2)	
Postoperative hypocalcemia				< 0.001
No	178 (78.8)	77 (68.1)	101 (89.4)	
Yes	48 (21.2)	36 (31.9)	12 (10.6)	
Temporary hypoparathyroidism				< 0.001
No	170 (75.2)	73 (64.6)	97 (85.8)	
Yes	56 (24.8)	40 (35.4)	16 (14.2)	
Permanent hypoparathyroidism				0.064
No	215 (95.1)	104 (92.0)	111 (98.2)	
Yes	11 (4.9)	9 (8.0)	2 (1.8)	
Tumor size				0.779
≤1 cm	149 (65.9)	76 (67.3)	73 (64.6)	
> 1 cm	77 (34.1)	37 (32.7)	40 (35.4)	
T classification				0.966
T1	146 (64.6)	73 (64.6)	73 (64.6)	
T2	61 (27.0)	30 (26.5)	31 (27.4)	
T3	19 (8.4)	10 (8.8)	9 (8.0)	
RAI				0.594
No	119 (52.7)	57 (50.4)	62 (54.9)	
Yes	107 (47.3)	56 (49.6)	51 (45.1)	

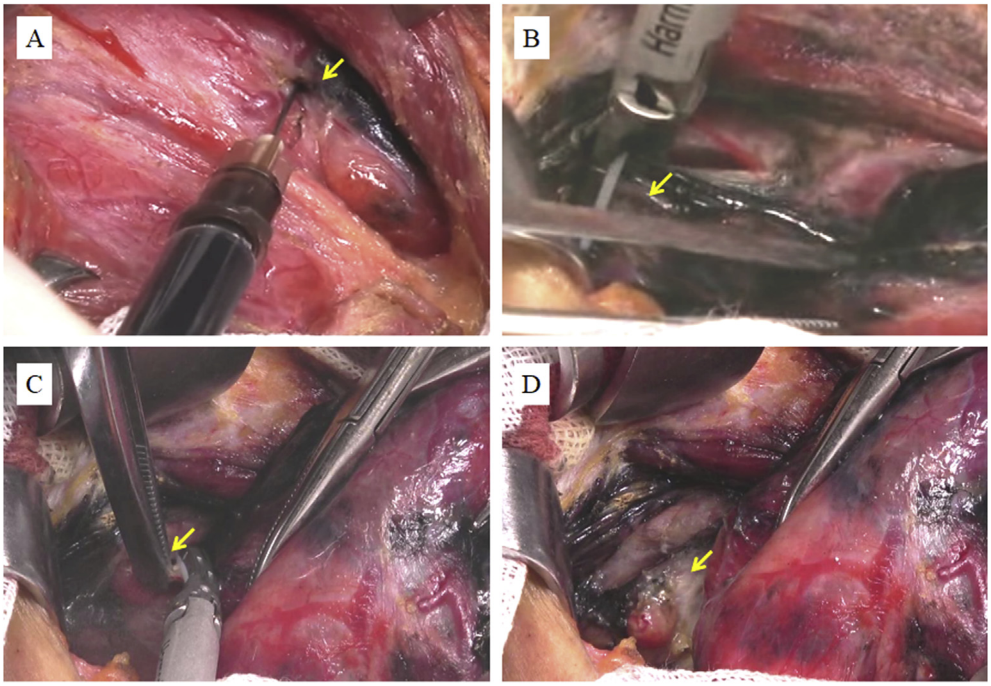

Fig. 1. A: The nano-carbon negative imaging of parathyroid(red arrow) (yellow arrow) **B**: Cutting off main trunk of superior thyroid artery (yellow arrow), charring due to the application of nano-carbon **C**: Exposing the gap between the thyroid and parathyroid glands (yellow arrow) **D**:Protect the parathyroid gland and its blood vessels in situ (yellow arrow). (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

group. Initially, the observation group included 125 patients, whereas the control group contained 109 patients. Seven patients were randomly transferred from the observation group to the control group, using the following approach: their random numbers were copied, and the remainder of the random number divided by 125 was used as the serial number of the observation group units. Seven patients from the observation group were transferred to the control group, such that there were 116 patients in both the observation and control groups. Three patients in the observation group and three patients in the control group were excluded because of pathological confirmation that they did not exhibit thyroid cancer. Finally, there were 113 patients in both the observation group and control groups.

This study has been reported in accordance with the Consolidated Standards of Reporting Trials (CONSORT) Guidelines.

2.2. Treatments

In the control group, the technique protecting blood supply to the superior parathyroid was not used. During surgery, nano-carbon negative imaging of the parathyroid was performed (Fig. 1A). The superior thyroid gland was exposed, and the main trunk of the superior thyroid artery was severed (Fig. 1B). The surgical capsule was opened on the outside of the thyroid, with the back of the thyroid gland protruding upwards. Following careful identification of the parathyroid gland and its vascular pedicle, the free capsule of the parathyroid gland was gently clamped, exposing the gap between the thyroid and parathyroid glands (Fig. 1C). Along the gap, the parathyroid gland was dissociated from its vascular pedicle, and the gland and blood vessels were gently separated from the thyroid gland's surface to protect the parathyroid gland and its blood vessels in situ (Fig. 1D). Ligation and abscission of the inferior thyroid artery trunk was avoided to preserve arterial blood supply and venous return in the parathyroid gland. During central lymph node dissection, the vascular pedicle—connected to the inferior parathyroid gland—was finely dissected, skeletonized, and protected from destruction. If inferior parathyroid glands were mistakenly cut, auto-transplantation was performed after pathological confirmation.

In addition to the above treatment for control patients, the observation group underwent application of a technique to protect blood supply to the superior parathyroid. The protective technique was as follows.

1. The anterior branch of the superior thyroid artery was cut (Fig. 2A). After confirming the separation of parathyroid glands in situ, the three types of terminal blood vessels entering and exiting the thyroid were cut off in close proximity to the thyroid's intrinsic capsule. The distal end of the posterior branch of the superior thyroid artery entering the thyroid gland was cut, then closely ligatured, adjacent to the thyroid gland (Fig. 2B).
2. The superior parathyroid gland and associated nutritional blood supply were maintained. If no tumor invasion was observed, parathyroid glands were sharply dissected together with the surrounding blood vessels and connective tissue from the true capsule of the thyroid gland, and the peripheral vascular pedicle was protected (Fig. 2C).
3. When dissecting central lymph nodes, the superior parathyroid artery, which branched from the inferior thyroid artery, was exposed and protected as much as possible (Fig. 2D).

During the operation, normal parathyroid tissue in the resected specimens was carefully identified. If there was any suspicion of misresection of the parathyroid gland, a small portion of the tissue was removed by routine excision; then, intraoperative pathology was conducted to confirm pathological changes. Using a scalpel, the remaining parathyroid tissue was then cut into thin slices of 1 mm in diameter if confirmed. The tissue was implanted into a pre-made pocket in the contralateral sternocleidomastoid muscle of the patient, and then the pockets were sutured. A parathyroid gland was mistakenly cut in 17 patients with autologous parathyroid transplantation.

Adequate calcium supplementation was administered after surgery, and was adjusted according to blood calcium levels. All operations in both groups were performed by the same experienced thyroid surgeon.

2.3. Observation indexes

All patients underwent venous blood collection before surgery. Blood calcium and PTH levels were measured by the direct chemiluminescence method. Blood calcium, phosphorus, and PTH levels were

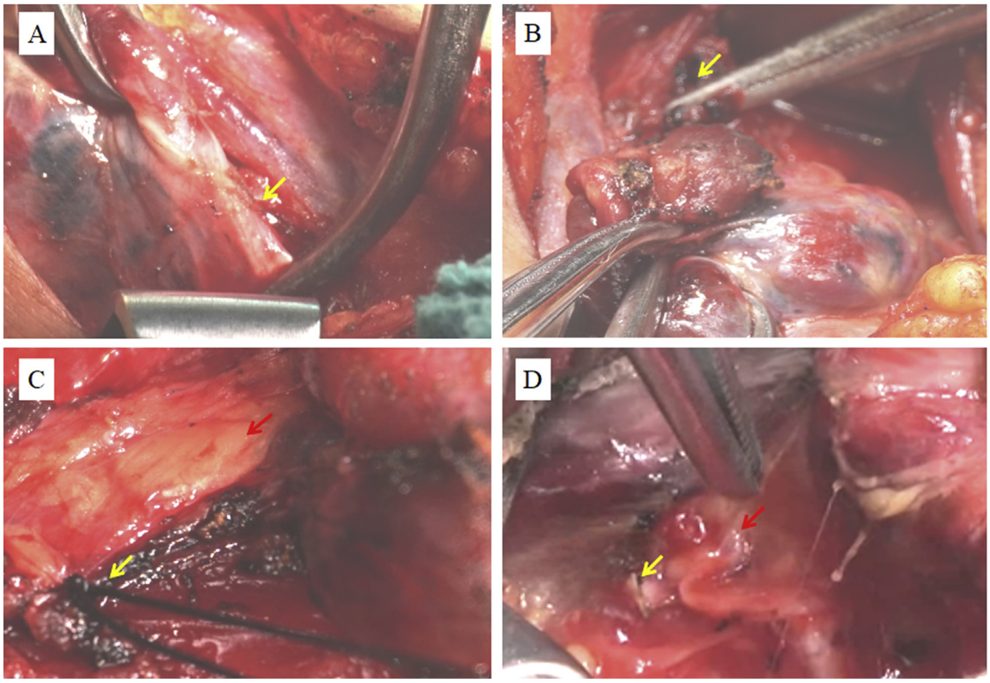

Fig. 2. A: Cutting the anterior branch of the superior thyroid artery(yellow arrow) **B**:After confirming the separation of parathyroid glands in situ, The distal end of the posterior branch of the superior thyroid artery entering the thyroid gland was cut (yellow arrow) **C**:Keeping the superior parathyroid gland and associated nutritional blood supply (red arrow) **D**: The superior parathyroid artery branched from the inferior thyroid artery was exposed and protected as much as possible (red arrow). (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

assessed 1 day after surgery. Patients were closely monitored for clinical manifestations, such as finger numbness and limb convulsions. Normal blood calcium and PTH levels were 2.15–2.55 mmol/L and 15–65 pg/mL, respectively. Temporary hypoparathyroidism was diagnosed if PTH was < 15 pg/mL. Blood calcium levels < 2.15 mmol/L were regarded as transient hypocalcemia. Permanent hypoparathyroidism was defined on the basis of the requirement for oral calcium and vitamin D supplementation at 6 months after surgery [24].

2.4. Follow-up

Patients with temporary hypoparathyroidism were followed up for 6 months postoperatively. PTH and blood calcium levels were examined during outpatient visits. The last follow-up occurred on June 1, 2017; no patients were lost to follow-up.

2.5. Statistical analysis

One-way chi-squared tests or Fisher's exact tests were used to assess whether the clinicopathological features of the observation and control groups were comparable. Associations of temporary hypoparathyroidism with clinical characteristics were determined. Univariate logistic regression analysis was used to assess whether use of the protective technique, tumor capsule invasion, accidental resection of the parathyroid gland, double neck dissection, and other clinicopathological features in the observation and control groups were factors affecting postoperative hypoparathyroidism. For more than two categories of classification variables, dumb variables were used for univariate logistic regression. Software was used for automatic implementationof data analysis. Significant independent variables in univariate logistic analysis were included in multivariate logistic regression analysis. The entry method was used in multivariate logistic regression analysis; selection variables were not used and weights were not applied. Two-sided comparisons with $P < 0.05$ were considered to be statistically significant.

3. Results

3.1. Intraoperative assessments

The incidence of postoperative hypocalcemia was 10.6% in the observation group, whereas it was 31.9% in the control group. The relative risk (RR) was increased by 3.009-fold (RR = 3.009) in the control group. The incidence of postoperative low PTH was 14.2% in the observation group, whereas it was 35.4% in the control group. The RR was increased by 2.493-fold (RR = 2.493) in the control group. The operative time of the control group was 84.22 ± 10.36 min, whereas that of the observation group was 91.25 ± 12.25 min; this difference was significant (t = 4.654, P = 0.001).

The average number of parathyroid glands observed and preserved in situ in each patient in the control group was 2.95 ± 1.07, whereas that in each patient in the observation group was 2.89 ± 1.19; this difference was not significant (t = 0.459, P = 0.647). All improperly resected parathyroid glands were autotransplanted. In the control group, there were 14 autotransplanted parathyroid glands, and the rate of improper parathyroid gland resection was 4.03% (14/347); in the observation group, there were 10 autotransplanted parathyroid glands and the rate of improper parathyroid gland resection was 2.98% (10/336). There was no significant difference in the rate of improper parathyroid gland resection between the two groups (Chi-squared = 0.56, P = 0.45).

3.2. Clinical and pathological features in observation and control groups

There were 56 patients with postoperative temporary hypoparathyroidism and 48 patients with postoperative hypocalcemia. There were 11 patients with permanent hypoparathyroidism; all experienced temporary hypothyroidism after operation. The incidences of postoperative hypocalcemia and postoperative temporary hypoparathyroidism were significantly lower in the observation group than in the control group ($P < 0.001$; $P < 0.001$). (Table 1).

3.3. Univariate logistic regression analysis

Postoperative temporary hypoparathyroidism was associated with

Table 2
Univariate and multivariate logistic regression for postoperative temporary hypoparathyroidism in 226 patients diagnosed with thyroid cancer.

Parameters	Univariate analysis		Mulivariate analysis	
	OR (95% CI)	P	OR (95% CI)	P
Age(years)				
> 45 vs ≤ 45	1.18 (0.645,2.16)	0.591		
Gender				
Female vs Male	0.755 (0.311,1.834)	0.535		
Lymph node metastasis				
Positive vs Negative	1.936 (1.029,3.643)	0.041	1.405 (0.687, 2.872)	0.352
lymph node dissection		0.01		0.148
unilateral vs No	2.240 (0.868, 5.776)	0.095	1.569 (0.560, 4.393)	0.391
Bilateral vs No	4.624 (1.663, 12.855)	0.003	2.843 (0.901, 8.972)	0.075
tumor capsule invasion				
Yes vs No	2.43 (0.805,7.337)	0.115		
Parathyroid autotransplantation				
Yes vs No	2.286 (0.826,6.323)	0.111		
Technique protecting blood supply to the superior parathyroid				
Yes vs No	0.301 (0.156,0.579)	0.001	0.325 (0.163, 0.648)	0.001
Tumor size				
> 1 cm vs ≤ 1 cm	2.022 (1.089,3.756)	0.026	3.070 (0.331, 28.498)	0.324
T classification		0.048		0.565
T2 vs T1	1.825 (0.927, 3.593)	0.082	0.629 (0.062, 6.401)	0.696
T3 vs T1	2.934 (1.082, 7.955)	0.034	1.228 (0.158, 9.555)	0.844

OR:odds ratio; A vs B stands for the latter B for reference.

lymph node metastasis, use of the above protective technique, and tumor size [(odds ratio, OR = 1.936, 95%CI 1.029–3.643; P = 0.041), (OR = 0.301, 95%CI 0.156–0.579; P = 0.001), and (OR = 2.022, 95%CI 1.089–3.756; P = 0.026), respectively] (Table 2). Postoperative temporary hypoparathyroidism was also associated with lymph node dissection (Bilateral dissection vs. No dissection, P = 0.003) and T classification (T3 vs. T1, P = 0.034) (Table 2).

3.4. Multivariate logistic regression analysis

We included significant independent variables from univariate logistic regression analysis (e.g., lymph node metastasis, lymph node resection, protective technique, tumor size, and T classification) in the multivariate logistic regression analysis. Notably, multivariate analysis showed that the protective technique was associated with reduced incidence of postoperative temporary hypoparathyroidism (OR = 0.325, 95%CI 0.163–0.648; P = 0.001) (Table 2).

4. Discussion

The source of blood supply for the parathyroid gland is relatively complex. Previously, it was erroneously believed that blood supplied to the parathyroid gland was primarily derived from the inferior thyroid artery [25]. The present study showed that blood supplied to the superior parathyroid gland primarily originated from the posterior branch of the superior thyroid artery, the ascending branch of the inferior thyroid artery, and the anastomotic branches between these arteries; moreover, blood supplied to the inferior parathyroid gland primarily originated from the small branch of the inferior thyroid artery or the branch of the lowest thyroid artery [23]. In addition, blood supplied to the parathyroid gland partly originates from the thyroid pseudocapsule and vascular pedicles between the thyroid pseudocapsule [23]. In thyroid surgery, a consensus approach is that parathyroid glands should not be mistakenly cut; however, protection of parathyroid blood supply has not received sufficient attention, especially with regard to the superior parathyroid gland. Therefore, blood supply to the superior parathyroid must be protected during thyroid surgery.

This study showed that the application of parathyroid blood supply protection can effectively reduce the risks of postoperative hypoparathyroidism and hypocalcemia. The protective technique effectively reduced the incidence of postoperative low calcium, as well as the rate of temporary hypoparathyroidism. Our experiment showed bias in both groups, in that they were not balanced in terms of lymph node dissection. Univariate logistic regression analysis and multivariate logistic regression analysis both showed that the protective technique effectively reduced the rate of temporary hypoparathyroidism, but confounding factors could not be completely eliminated. We will conduct further matched pair analysis to eliminate bias and confusion in future studies.

In this study, protection of parathyroid blood supply was employed during thyroid cancer surgery, effectively protecting the blood supply of the superior parathyroid gland, and exhibiting a protective effect on parathyroid function. Our data confirm that the protection of parathyroid blood supply can significantly reduce the incidences of hypocalcemia and hypoparathyroidism after surgery. In future studies, we will further expand the sample size to assess the ability of this new technique to protect against the onset of permanent hypoparathyroidism.

The current study was not without limitations. The sample size was relatively small and included only patients from a single hospital. Some confounding factors were not considered because data were not collected or retrieved. We will further optimize our experimental design and expand the sample size to try to reduce the experimental deviation, and identify the key factors of parathyroid protection technology, and eliminate potential confusion factors.

5. Conclusion

In conclusion, the application of a technique protecting blood supply to the superior parathyroid for patients undergoing thyroid cancer surgery can reduce the incidence of postoperative temporary hypoparathyroidism. However, because of the imbalance in lymph node dissection between the two groups, confounding factors could not be entirely eliminated. Therefore, matched pair analysis is needed to eliminate bias and confusion.

Ethical approval

All patients agreed to publish personal data and signed the informed consent form. Research have been performed in accordance with the Declaration of Helsinki and have been approved by the ethics committee of Jining first people's hospital(No.2015-018).

Sources of funding

This work was supported by the Science and Technology Development Plan of Jining No.1 People's Hospital. After the project is set up, the project capital is 10,000 yuan, and the funds are put into effect and put in place in a timely manner.

Author contribution

De-Di Kong carried out the presiding over the subject and application of surgery and technology, participated in the sequence alignment and drafted the manuscript. Wei Wang carried out the application of surgery and technology, participated in its design and coordination and helped to draft the manuscript. Mei-Hong Wang carried out the case collection and statistical data, participated in the sequence alignment. All authors read and approved the final manuscript.

Conflicts of interest

The authors declare that they have no competing interests. All authors read and approved the final manuscript.

Research registration number

RCT registration number:ChiCTR1800016965. http://www.chictr.org.cn/searchproj.aspx.

Guarantor

De-Di Kong, Mei-Hong Wang.

Data statement

This study showed that the application of parathyroid blood supply protection can effectively reduce the risks of postoperative hypoparathyroidism and hypocalcemia (relative risk was increased by 2.493 times in the control group, RR = 2.493; relative risk was increased by 3.009 time in the control groups, RR = 3.009). The protective technique effectively reduced the incidence of postoperative low calcium as well as temporary hypoparathyroidism rates ($P < 0.001$; $P < 0.001$, respectively).Our experiment showed bias in both groups that they were not balanced for lymph node dissection. In univariate logistic regression analysis and multivariate logistic regression analysis, the protective technology effectively reduces the incidence of temporary hypoparathyroidism rates (OR = 0.301; OR = 0.325, respectively), but confusion cannot be completely eliminated. We will further conduct matched pair analysis to eliminate bias and confusion.

In this study, the technique of protection of parathyroid blood supply was employed in thyroid cancer operation, ensuring the accuracy and effectiveness of the protection of the parathyroid blood supply, effectively protecting the blood supply of the superior parathyroid gland, and containing a protective effect on the parathyroid function. Our data have confirmed that the use of protection technique of parathyroid blood supply has reduced the incidence of hypocalcemia and hypoparathyroid hormone after surgery, with statistically significant difference. It has been proved that the technique of protection of parathyroid blood supply can reduce the incidence of temporary after operation. We will further expand the sample size to assess the association of the protective technique for parathyroid blood supply with permanent hypoparathyroidism.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Consent for publication

Written informed consent was obtained from the patient for the publication of accompanying figures.

Provenance and peer review

Not commissioned, externally peer-reviewed.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijsu.2019.02.019.

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