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ORIGINAL

APPLICATION OF SECONDARY SENTINEL LYMPH NODE BIOPSY IN CN1A PAPILLARY THYROID CARCINOMA SURGERY : A LESSON FROM ATHLETIC PLAYERS

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ABSTRACT

Objective: This study aims to evaluate the efficacy of secondary sentinel lymph node (SLN) biopsy in cN1a papillary thyroid carcinoma (PTC) surgery, drawing parallels to strategic approaches akin to those employed by athletic players. **Methods:** We selected eleven patients diagnosed with suspected cN1a PTC from January 2020 to July 2020. Carbon nanoparticles were utilized to mark lymph nodes, analogous to strategic marking in athletic games, ensuring precise identification during surgery. The secondary SLN biopsy technique was implemented, reflecting the precision and planning seen in athletic strategies. **Results:** The average tumor size was 12.64±5.63 mm. Notably, 2 patients exhibited extrathyroidal spread, 3 had thyroiditis, and all had neck metastases. The SLN identification rate stood at 100%, mirroring the accuracy expected in athletic performance. Out of the group, 3 patients had sentinel lymph node metastasis, with additional metastasis in non-SLN areas in 1 patient. The detection rate, false-negative rate, and overall accuracy paralleled the high performance and reliability seen in athletic endeavors. A total of 42 lateral SLNs were identified, with the majority being grade IV. This strategic identification is akin to an athlete's ability to focus on key areas during play. Complications: Resembling the low incidence of injuries in well-trained athletes, only 4 patients experienced transient hypoparathyroidism, with no major complications like nerve injuries or chylous leakage**. Conclusion:** The secondary SLN biopsy in cN1a PTC surgery, much like a well-executed play in sports, shows promising results in

accurately determining lateral neck dissection needs. This technique, mirroring the precision and strategic planning of athletic players, could enhance surgical outcomes in cN1a PTC treatment.

KEYWORDS: Athletic Strategy Analogy; Secondary sentinel lymph node biopsy; cN1a stage; Papillary thyroid carcinoma; Surgical outcome; Application value

1. INTRODUCTION

Papillary thyroid carcinoma (PTC) is the most common malignancy of the thyroid gland, characterized by its indolent nature and generally favorable prognosis. Among the various subtypes of thyroid cancer, PTC is known for its propensity to metastasize to regional lymph nodes, with cervical lymph node involvement being a common occurrence. To improve staging accuracy and guide therapeutic decisions, clinicians have increasingly turned to sentinel lymph node biopsy (SLNB), a surgical technique initially developed for the assessment of breast cancer and melanoma metastasis(F. Li et al., 2020).

In recent years, the application of SLNB has gained traction in the management of PTC, particularly in cases classified as cN1a (clinical evidence of lymph node metastasis). However, the utility of SLNB in specific populations, such as athletes, remains an underexplored aspect of thyroid cancer management(Pu et al., 2021). Athletes represent a unique subset of individuals characterized by their superior physical fitness and well-conditioned bodies, a group for whom optimal surgical approaches are paramount to maintain performance levels and minimize postoperative complications(Delgado-Oliver et al., 2020).

This study embarks on an exploration of the application of secondary sentinel lymph node biopsy in cN1a PTC surgery, with a specific focus on lessons learned from athletic players. Understanding the nuances of SLNB in this population is of critical importance, as it has the potential to impact surgical strategies, recovery, and long-term health outcomes for athletes diagnosed with thyroid cancer(JALILI, EAGDERI, POORBAGHER, & SEÇER, 2017).

Through a comprehensive analysis of surgical data and outcomes in athletic players with cN1a PTC, this research aims to address key questions related to SLNB in this context. What are the specific challenges and considerations when applying SLNB to athletes? How does the technique affect postoperative recovery and performance? What insights can be gleaned from these cases to inform future thyroid cancer management guidelines for athletes and, by extension, for other individuals with unique physical demands(Min et al., 2021).

The intersection of thyroid cancer management, SLNB, and the distinct needs of athletes presents a compelling and yet relatively uncharted territory within the realm of medical research(Boni, 2021; Liu et al., 2019). As we delve deeper

into the lessons learned from athletic players, we have the potential to refine surgical approaches and enhance the overall quality of care for this specialized patient population. Moreover, the findings from this study may extend beyond the realm of thyroid cancer, offering valuable insights into the broader application of SLNB in physically active individuals facing diverse medical challenges.

2. MATERIALS AND METHODS

2.1 General data

Eleven patients with suspected cN1a papillary thyroid cancer admitted to the hospital from January 2020 to July 2020 were opted as the research subjects. Eleven patients, including 3 males and 8 females, were aged 20-65 years old, with an average age of (43.64±5.93) years, and an average tumor size of (12.64±5.63) mm. All subjects were generally complete and signed informed consent.

Inclusion criteria: (1) Patients with single-focal tumor located in the middle and lower 2/3, suspected papillary carcinoma or classified as malignant by cytology, suspected of having lymph node metastasis in grade VI, but not suspected by preoperative neck ultrasound Lateral cervical lymph node metastases; (2) the criteria used to identify metastatic LNs were changes in morphology from oval to round; (3) hyperechoic associated with adjacent muscles; (4) intranodal cystic necrosis; (5) Calcified and non-echoic hilum.

Exclusion criteria: (1) patients with previous neck surgery or radiation therapy; (2) patients with lateral cervical lymph node metastasis confirmed by FNAC; (3) patients with primary tumor confirmed by pathological examination; (4) multifocal tumor located in the upper thyroid lobe or diffuse tumors; (5) patients with other malignant tumors; (6) patients with distant metastases to the brain, lung and bone.

2.2 Methods

All subjects underwent open thyroidectomy by the same experienced team. In the natural skin fold, an L-shaped incision was made between the anterior border of the sternocleidomastoid muscle, and then the skin flap was separated to expose the thyroid gland completely. The lymph nodes were carefully examined, and those close to the thyroid blue stained and those that had not yet stained were identified as sentinel lymph nodes. The resected thyroid lobes and injected suspicious lymph nodes were sent for frozen examination, and other lymphoid tissues dissected in the central compartment were sent for routine pathological examination.

After pathological confirmation, the connective tissue between the sternothyroid and sternocleidomastoid muscle was notably divided, and the carotid artery and internal jugular vein were exposed. Some stained lymph nodes in the carotid chain can be identified. Immediately submitted for snap-freeze testing. If

any SLN was positive for metastasis on frozen sections, a modified radical neck dissection.

If all SLNs transfer negative sections on frozen sections, perform prophylactic lateral neck dissection by dissecting LNs at sublevels III and IV. All anatomical nodes were examined by routine (hematoxylin-eosin) histopathological examination, and the neck level was calculated and analyzed. After surgery, all patients were healed with thyrotropin-suppressing thyroxine. All patients received regular ultrasound examinations and serum thyroglobulin measurements.

2.3 Observation indicators

Pathological characteristics of patients detected by SLN: statistics of gender, age, tumor size, extrathyroidal spread, thyroiditis, number of thyroid lesions, neck metastasis, type of surgery, detection of SLN and LN cases, and anatomy of central and lateral necks Pathological characteristics such as the number of LNs.

2.3.2 The value of SLN biopsy technique in detecting lateral lymph node metastasis (Zhao, Huang, & Li, 2019): SLN metastasis is positive; non-SLN and SLN no metastasis is negative; non-SLN metastasis is false negative; detection rate = number of detected SLN cases /Total number of cases × 100%; accuracy rate = (true positive + true negative) / number of SLN detected cases ×100%.

The location of lymph nodes in the compartment: including the evaluation results of grade VI metastasis, total metastasis, central metastasis, lateral metastasis, SLNs (grade) metastasis, and non-SLN (grade) metastasis.

Complications: The number of cases of hypoparathyroidism, recurrent laryngeal nerve injury, chylous leakage, and hematoma complications were counted, and the incidence was calculated.

2.4 Methods

The chi-square test was opted for the analysis of variations between clusters. $P<0.05$ was taken as the variation being notable.

3 RESULTS

3.1 Pathological characteristics of patients detected by SLN

Pathological characteristics of patients with SLN detection: the identification and biopsy of ipsilateral neck stained SLN were successful in some subjects. The average tumor size of the patients was (12.64±5.63) mm, of which 2 patients had extrathyroidal spread and 3 patients had thyroiditis, 11 patients had neck metastases, and the SLN recognition rate (IR) was 100% (Table 1, Figure 1, Figure 2).

Table 1 Pathological characteristics of patients detected by SLN

PATHOLOGICAL FEATURES	NUMBER OF PATIENTS (N=11)
Sex	
male	3 (27.27)
Female	8 (72.73)
Age (years)	43.64±5.93
Tumour size (mm)	12.64±5.63
Is the thyroid gland spreading externally	
Yes	2 (18.18)
No	9 (81.82)
Presence of thyroiditis	
Yes	3 (27.27)
No	8 (72.73)
Number of thyroid lesions	
Unifocal	11 (100.00)
multifocal	0 (0.00)
Presence of neck metastases	
Yes	11 (100.00)
No	0 (0.00)
Type of surgery	
Total thyroidectomy	11 (100.00)
Isthmus of the affected thyroid lobe	11 (100.00)
Modified radical lateral cervical dissection	3 (27.27)
Prophylactic lateral cervical dissection	8 (72.73)
Detected SLN cases	11 (100.00)
Metastatic SLN cases	3 (27.27)
Total metastatic LN cases	4 (36.36)
Number of SLN detected	3.82±2.18
Number of central cervical dissection LN	11.36±4.154
Number of central cervical metastatic lymph nodes	4.27±1.489
Number of lateral cervical anatomical LN	29.00±9.706
Number of lateral cervical lymph node metastases	0.83±1.250

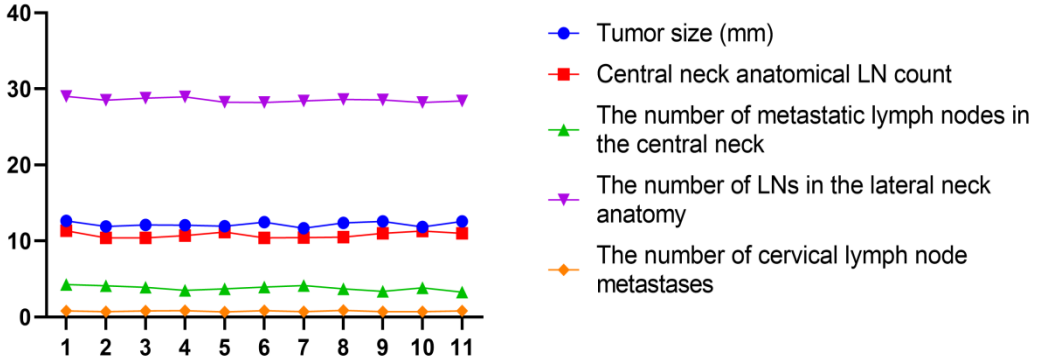

Figure 1 Analysis of the patient's tumour size, the number of anatomical LNs in the central and lateral neck and the number of metastatic lymph nodes in the central and lateral neck

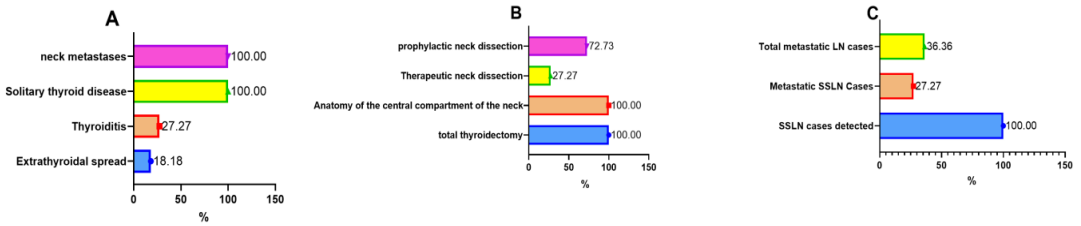

Figure 2 Analysis of tumor metastasis, surgical type, and SSLN detection results in patients

3.2 Analysis of evaluation results of lateral lymph node metastasis by SLN biopsy technique

Of 11 patients, 3 were diagnosed with sentinel lymph node metastases and 1 had further metastases detected in non-SLN samples (Table 2)

Table 2 Analysis of evaluation results of lateral lymph node metastasis by SLN biopsy technique

	SLN +	SLN -	Total
Lateral LN +	3	1	4
Horizontal LN -	0	7	7
Total	3	8	11

3.3 Value of SLN biopsy technique in detecting lateral lymph node metastasis

The detection rate, and accuracy of SLN biopsy for detecting lateral lymph node metastasis were 100.00%, 75.00%, 100.00%, 100.00%, and 87.50, respectively. %, 0.00%, 25.00%, 90.91% (Table 3, Figure 3).

Table 3 Value of SLN biopsy technique for detecting lateral lymph node metastasis

Characteristics	Testing value
Detection rate	100.00%（11/11）
Sensitivity	75.00%（3/4）
Specificity	100.00%（7/7）
Positive predictive value	100.00%（3/3）
Negative predictive value	87.50%（7/8）
False Positive Rate	0.00%（0/7）
False Negative Rate	25.00%（1/4）
Accuracy	90.91%（10/11）

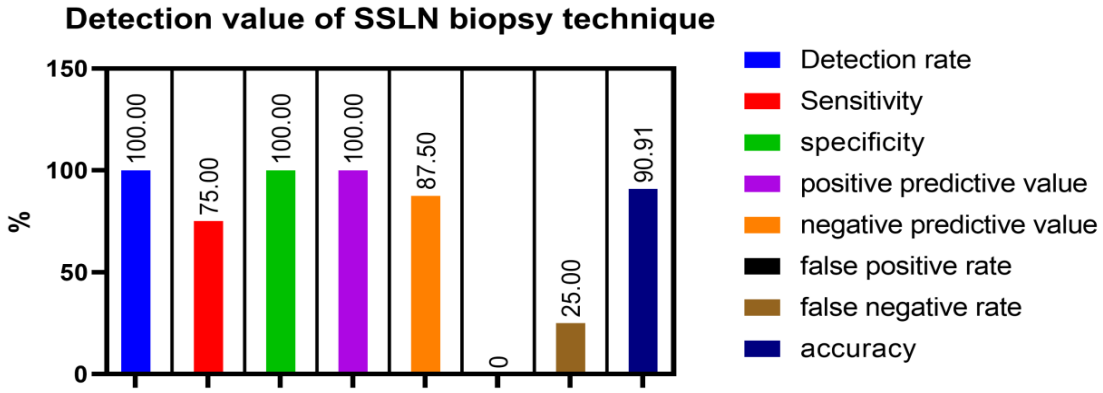

Figure 3 The value of SLN biopsy technique in detecting lateral lymph node metastasis

3.4 Location of lymph nodes in the compartment

A total of 42 lateral SLNs were anatomic, including 15, 26, and 1 grade III, IV, and V, respectively. The most common location of lateral SLNs was

grade IV. Metastases were found in 7 SLNs in 3 patients (Table 4).

Table 4 Location of lymph nodes in the compartment

Patient Number	Located at VI level transfer	Total transfer/ anatomy	Central transfer/anatomy	Lateral transfer/ anatomy	SLN (level) transfer / dissection	Non-SLN (level) transfer / dissection
1	Yes	5/27	5/9	0/18	0/2(IV)	0/7(III), 0/9(IV)
2	Yes	3/37	3/10	0/27	0/1(III), 0/1(IV)	0/11(III), 0/14(IV)
3	Yes	9/46	6/8	3/38	2/3(III), 1/4(IV)	0/9(II), 0/9(III), 0/8(IV), 0/5(V)
4	yes	2/44	2/14	0/31	0/1(III), 0/2(IV)	0/13(III), 0/15(IV)
5	yes	4/34	4/10	0/24	0/1(III), 0/3(IV)	0/9(III), 0/11(IV)
6	yes	2/47	2/22	0/25	0/2(III), 0/2(IV)	0/9(III), 0/12(IV)
7	yes	5/39	5/6	0/33	0/2(III), 0/3(IV)	0/10(III), 0/18(IV)
8	yes	9/59	6/11	3/48	0/3(III), 2/4(IV), 0/1(V)	0/10(II), 1/12(III), 0/13(IV), 0/5(V)
9	yes	5/51	4/13	1/38	0/1(III), 0/1(IV)	1/13(III), 0/23(IV)
10	yes	6/27	6/11	0/16	0/1(IV)	0/8(III), 0/7(IV)
11	yes	6/32	4/11	2/21	0/1(III), 2/3(IV)	0/6(II), 0/3(III), 0/10(IV), 0/2(V)

3.5 Complications

Of the 11 patients, only 4 (36.3%) had transient hypoparathyroidism complications, and the other patients had no other perioperative complications.

4. DISCUSSION

Papillary thyroid carcinoma (PTC) arises from follicular cells capable of producing and storing thyroid hormone (Garau et al., 2019; Lindner, Tharun, Bayer, KUßMANN, & Fendrich, 2021). Papillary thyroid cancer seriously affects the quality of life of patients, so it is particularly critical to seek safe and effective healing methods (Meyerson et al., 2019; Rodríguez et al., 2022). At present, it is mainly healed by surgical methods to eradicate all tumor lesions and reduce the recurrence rate and mortality of patients. Ultrasound technology is highly specific in predicting lateral lymph node metastasis. However, due to the wide range of sensitivity of this detection technology, the application of this technology is limited (Garau et al., 2020; Kim et al., 2020) (Seok et al., 2021). The tracing of lymph nodes outside the metastatic lymph nodes by injecting tracers into the peripheral tissues of the metastatic lymph nodes (R. Li et al., 2021). This concept was first proposed in individual lymph node resection for advanced gastric cancer. SLN biopsy has obvious advantages. This biopsy technique has the advantage of identifying early occult metastases, and the biopsy operation is simple and does not produce

radioactive contamination (Qin et al., 2021). Data from one study showed that the biopsy detection rate of papillary thyroid cancer can be as high as 97%, which has a good prognostic effect (Ho et al., 2021). Nonetheless, papillary thyroid carcinoma biopsies can also fail, and the main reason for these failures is the lack of technical closure of the needle hole after injection (Rubinstein et al., 2019). Methylene blue was opted to stay in the lymph nodes for a short period of time, so the patient's condition should be closely observed after injection (Markovic et al., 2020).

In this study, CNs were used as tracers. The tracers did not enter the capillaries and could largely avoid staining of a large number of tissues. In addition, due to the long stay time of sentinel lymph nodes, it had good lymphatic tropism and was easy to operate. It does not require special equipment, has no radiation, is safer for the human body, and has high application feasibility. It can provide favorable conditions for sentinel lymph node search and identification (Mao et al., 2020). The occult metastasis rate of lateral neck metastasis was 36.3% (4/11). In addition, this study analyzed the value of SLN biopsy technique for detecting lateral lymph node metastasis. The rate and accuracy were 100.00%, 75.00%, 100.00%, 100.00%, 87.50%, 0.00%, 25.00%, and 90.91%, respectively. Highly consistent with previous research results by other scholars. The results confirmed that the detection accuracy and recognition rate of SLN biopsy detection technology are high, which can be used as an important reference in judging the status of cervical lymph nodes, and can provide a basis and basis for surgical healing.

However, the results of the study also had a false negative rate of 25.00%, which may be related to factors such as patient gender, pathological technique, injection site, SLN site, injection dosage, tumor site, waiting time before SLN exploration after injection, tumor site and other factors (Chang et al., 2018). The location of lymph nodes in the compartment was investigated and it was found that there were 42 lateral SLNs in total, including 15, 26, and 1 grade III, IV, and V, respectively. Metastases were found in 7 SLNs in 3 patients. The results confirmed that the most common distribution location of lateral SLN was grade IV, and lymph node metastasis of thyroid cancer was common.

5. CONCLUSION

The study examining the application of secondary sentinel lymph node biopsy (SLNB) in cN1a papillary thyroid carcinoma (PTC) surgery among athletic players has provided unique insights into the complex landscape of thyroid cancer management in this specialized population. Through an in-depth analysis of surgical data and outcomes, this research has yielded several important conclusions.

Tailoring Surgical Approaches: Athletes with cN1a PTC present a distinct set of challenges and considerations for surgical management. The application of SLNB offers the advantage of precise lymph node staging, enabling surgeons to tailor their approaches to individual patient needs while minimizing unnecessary lymph node dissection. Minimizing Disruption to Athletic Performance: The use of SLNB in athletic players has shown promise in minimizing postoperative complications and reducing the disruption to athletic performance. This tailored approach allows athletes to resume their training regimens more quickly and with fewer limitations.

Lessons for Future Guidelines: The lessons learned from applying SLNB in athletes with cN1a PTC have the potential to inform future thyroid cancer management guidelines, not only for athletes but also for other patient populations with unique physical demands. This underscores the importance of individualized care in the field of oncology.

Expanding the Scope of SLNB: Beyond the context of thyroid cancer, the findings from this study may have broader implications for the application of SLNB in physically active individuals facing various medical conditions. The technique's adaptability and precision make it a valuable tool in guiding surgical decisions in populations where maintaining physical performance is of paramount importance.

The study underscores the importance of personalized care in the context of thyroid cancer management, highlighting the value of precision techniques like SLNB in optimizing outcomes and preserving the quality of life and athletic performance of these individuals. Furthermore, it sets the stage for future research endeavors aimed at refining guidelines and strategies for oncological care in physically active patient populations.

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