



REVIEW ARTICLE

Refining strategies in Central Neck Dissection in Thyroid Cancer: A Novel Paratracheal Subclassification for Precision Surgery

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ABSTRACT

Central compartment neck dissection (CCND) is a cornerstone in the surgical management of thyroid gland carcinoma, targeting level VI and VII lymph nodes as the primary lymphatic drainage sites. Despite its established role, controversies persist regarding anatomical definitions, the extent of dissection (prophylactic vs. therapeutic, unilateral vs. bilateral, level VI alone vs. VI and VII), and the balance between oncologic efficacy and morbidity, hypoparathyroidism and recurrent laryngeal nerve (RLN) injury. This review synthesizes current evidence from anatomical, clinical, and technological perspectives, addressing ambiguities in level VI and VII boundaries, the applicability of enbloc resection, and the utility of emerging tools like near-infrared autofluorescence (NIRAF) and indocyanine green (ICG) imaging. We propose refined anatomical subclassifications and advocate for tailored, precision-based strategies to optimize outcomes while minimizing complications.

Introduction

Thyroid gland carcinoma, primarily differentiated thyroid carcinoma (DTC), frequently metastasizes to the central compartment lymph nodes namely Levels VI and VII encompassing prelaryngeal, pretracheal, paratracheal, and superior mediastinal nodes. These nodes represent the “first echelon” of lymphatic spread, making CCND a strong tool in surgeons armamentarium to prevent residual or recurrent disease.

The American Thyroid Association (ATA) guidelines endorse CCND for both therapeutic (clinically node-positive, cN1) and prophylactic (clinically node-negative, cN0) indications, yet its application remains debated due to anatomical variability, oncologic necessity, and risk of post operative morbidity. Key controversies include the limits of level VI and VII compartments, the extent of dissection, and the preservation of parathyroid glands and RLN function. This review integrates insights from multiple studies, review, consensus guidelines to address these issues and propose future course of action.

Controversies in Anatomical Definition

Boundaries of Level VI:

Level VI is defined by the ATA as bounded as follows: Anteriorly: by the strap muscles Posteriorly: by the deep cervical fascia Superiorly: by the hyoid bone Laterally: by the sternohyoid muscles (surgically) by the common carotid arteries (radiologically) Inferiorly: by the suprasternal notch. This delineation while practical, is challenged by imaging limitation and anatomical variations. Xing et al. note ultrasonography’s low sensitivity (39%) for detecting central nodes, emphasizing intraoperative judgment over preoperative planning.¹ Variability in strap muscle positioning and fascia layers further complicates standardization, necessitating clear surgical landmarks.

Borderline Between Level VI and VII:

The inferior boundary of level VI at the suprasternal notch transitions into level VII, defined as superior mediastinal nodes up to the brachiocephalic artery (right) and its axial plane (left). The artery’s oblique course (50°-85° from the aorta) introduces interpersonal variability, rendering it an inconsistent landmark. Authors want to highlight the left brachiocephalic vein’s more stable horizontal

course (variation <5%) is better alternative though it is not universally accepted.

Redefining level VII’s inferior boundary to the vein’s superior margin and lateral borders as the right brachiocephalic artery/common carotid and left common carotid enhances surgical precision, aligning with cadaveric data and practical feasibility (Image). The consensus statement paper on neck dissection has divided superior mediastinum lymph nodes into superior and inferior to Brachiocephalic artery and advised to label superior lymph nodes as group VII, however, in view of oblique course of Brachiocephalic artery, this distinction is not possible in reality as evident from image below.² Authors have clinically experienced that while working in level VII through cervical approach, it is difficult to appreciate the transition of common carotid to brachiocephalic artery due to working in a plane which is medial to medial margin of common carotid artery. In essence, left Brachiocephalic (innominate vein) or to be precise, its superior margin can be considered as a lower (inferior) limit of level VII group of lymph nodes.

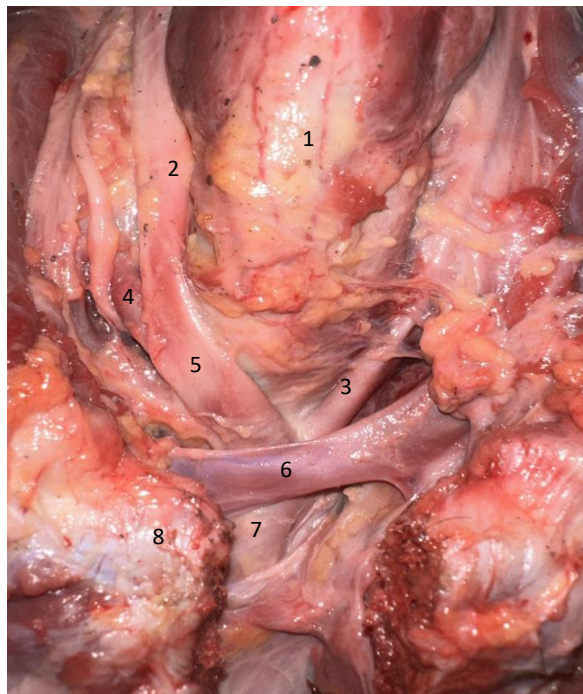


Image - Left Brachiocephalic vein and Brachiocephalic artery in a cadaver

1. Trachea 2. Right common carotid 3. Left common carotid 4. Right subclavian artery
5. Brachiocephalic artery 6. Left brachiocephalic vein 7. Aorta 8. Sternum

Applicability Of En Bloc Resection

Traditional en bloc resection advocating removing lymph nodes with surrounding fibrofatty tissue, aims for comprehensive clearance but is contentious in thyroid surgeries with CCND due to proximity to the RLN and parathyroid glands. Takahashi et al. report a 20.3% persistent hypoparathyroidism rate with aggressive clearance, reflecting disrupted parathyroid vascularity.³ Given DTC's favourable prognosis (10-year survival >90%), selective node removal ("berry picking") may suffice in low-risk cases, a hypothesis supported by Giordano et al. who found comparable oncologic outcomes with reduced morbidity when preserving critical structures.⁴ This practice though is condemned by Head Neck Oncosurgeon and endocrine surgeons as the basic principles of neck dissection albeit for Head Neck malignancies strongly disallows it.

Indications of CCND

Prophylactic vs. Therapeutic Dissection in cN0 Patients:

Therapeutic CCND is standard for cN1 DTC, with Randolph et al. Linking metastatic node size and number to prognosis.⁵ Prophylactic CCND (pCCND) in cN0 disease, however, divides opinion. ATA guidelines do not recommend routine pCCND in cN0 patients due to the lack of demonstrated survival benefit and increased morbidity. However, selective pCCND is considered in high-risk cases, such as patients with T3/T4 tumors, extrathyroidal extension, or aggressive histology. Several studies argue that pCCND may provide staging benefits and reduce recurrence. Rao et al. reported occult metastases in 30%-60% of cN0 cases, with a lower recurrence rate (1.0% vs. 3.6%) when pCCND was performed.⁶ Yin et al. identified younger age (<55 years) and multifocality as key predictors of occult metastases, supporting selective pCCND in high-risk patients.⁷ Lykke et al. conducted a randomized controlled trial (RCT) that found no significant recurrence advantage in low-risk cN0 papillary thyroid carcinoma (PTC), but increased morbidity (transient hypocalcemia 14%-40%).⁸

Unilateral vs. Bilateral Dissection:

Unilateral CCND targets tumor-side level VI nodes, while bilateral dissection includes contralateral nodes. ATA primarily recommends unilateral CCND

unless there is clinical or imaging evidence of contralateral nodal disease, citing increased morbidity, (16% vs. 12% RLN palsy).⁹

Studies suggest bilateral CCND may upstage 25% of cN0 patients to N1a, impacting adjuvant therapy decisions. However, the presence of skip metastases (7%-10%) suggests that contralateral involvement may occur even in unilateral disease. Bilateral CCND is generally reserved for cases with bilateral tumors or ipsilateral nodal positivity.

Level VI Alone vs. Combined VI and VII Dissection:

ATA Guidelines recommend Level VI dissection alone is standard for cN0 cases, while level VII dissection is reserved for cN1 cases or when imaging suggests involvement.

Alternative Perspectives given by articles like Rossi et al. found that 15% of cN0 patients had occult level VII involvement and suggested that combined VI and VII dissections in advanced disease may reduce mediastinal recurrence.¹⁰ However, level VII dissection increases hypocalcemia risk (52% vs. 40%), raising concerns about balancing oncologic benefit with functional preservation.

Preservation of Parathyroid Function

Hypoparathyroidism: Incidence and Impact

Hypoparathyroidism is a major CCND complication, with transient rates of 52% and persistent rates of 20.3% post-dissection.³ Giordano et al. link this to devascularization during fibrofatty clearance, with in-situ preservation of ≥ 3 glands achieving normocalcemia in 80% of cases.⁴

Autotransplantation recovers function in 70% of cases, though success varies with gland integrity.^{11,12}

Anatomical and Technical Challenges

Parathyroids, supplied by inferior thyroid artery (ITA) branches (80%-90%), are vulnerable due to their small caliber (<2 mm) and variable descent.¹³

ITA absence (2%-3%) complicates preservation, particularly on the left. Wang et al.'s "TBP" technique (thyroid-parathyroid-blood supply preservation) reduces hypoparathyroidism to 15% vs. 25% with standard methods, emphasizing meticulous capsular dissection.¹⁴

Technological Advances

Magnification ($\geq 2.5\times$ loupes) and ICG imaging reduce hypocalcemia by 10%, while NIRAF cuts persistent hypoparathyroidism to 5% (OR=0.45).^{6,9,15,16} Huang et al.’s trial combining NIRAF-ICG achieves 95% parathyroid viability, dropping postoperative hypocalcemia to 8%.¹⁷ These tools enable real-time parathyroid identification, shifting CCND toward precision surgery.

Table

Paratracheal lymph node group of Level VI	Sub group nomenclature	
	Superior to ITA	Inferior to ITA
Right	Rt Superior paratracheal	Rt Inferior paratracheal
Left	Lt Superior paratracheal	Lt Inferior paratracheal

Discussion

CCND’s controversies stem from balancing oncologic clearance with functional preservation. The brachiocephalic vein as a level VII boundary addresses arterial variability, improving consistency. Prophylactic CCND’s high occult metastasis rate (56%) supports its staging role in high-risk cN0 DTC, though morbidity (transient hypocalcemia 52%, RLN palsy 16%) mandates selective use. Bilateral and level VII dissection suit cN1 or advanced cN0 cases, while unilateral VI dissection suffices for low-risk PTC.

Parathyroid preservation remains paramount. En bloc clearance, suited to lateral neck dissections, mismatches DTC’s biology and central compartment anatomy.

NIRAF-ICG and magnification reduce hypoparathyroidism to single digits, aligning with our proposed paratracheal subclassification for selective node removal. Limitations include limited level VII metastasis data and the need for long-term recurrence studies. Future research should validate these proposals via RCTs, integrating molecular markers (e.g., BRAF V600E) for risk stratification.

Conclusion

CCND for thyroid carcinoma navigates a complex landscape of anatomy, oncology, and function. Refining level VII’s boundary to the brachiocephalic vein and subclassifying paratracheal nodes address

Proposed Paratracheal Subclassification

We propose subclassifying paratracheal nodes into superior (above ITA) and inferior (below ITA) subgroups for right and left sides (Table). Superior paratracheal “berry picking” avoids fibrofatty clearance near superior parathyroids, preserving function in DTC where soft tissue deposits are rare (<1%). Inferior paratracheal dissection, leveraging NIRAF-ICG, ensures ITA branch preservation. This subclassification enhances anatomical precision and awaits prospective validation.

anatomical ambiguities. Prophylactic CCND benefits high-risk cN0 patients, with bilateral and VII dissection reserved for advanced cases. Precision technologies like NIRAF-ICG minimize morbidity, heralding a tailored approach to optimize outcomes in this evolving field.

Conflict of Interest:

None.

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