Well-differentiated thyroid cancer represents most cases of thyroid cancer, whose incidence continues to increase. This cancer has a high propensity for regional spread, with 15% to 20% of nodal recurrence. Nodal metastases are known to increase the rate of regional recurrence, and in high-risk patients this may be correlated with an increased risk of cancer-related mortality. The first level of lymphatic spread is the central compartment of the neck, namely, the paratracheal lymph nodes and the prelaryngeal and pretracheal lymph nodes. The importance of central neck dissection (CND) in patients with metastatic paratracheal lymph nodes is well established, but its role as an elective procedure is still debatable. A recent meta-analysis found a significantly lower risk of locoregional recurrence (4.7% vs 8.6%) in the group undergoing prophylactic CND. Consequently, CND is the therapeutic treatment of choice for patients with evidence of metastases in that region or an elective procedure in selected patients.

Central neck dissection may carry an increased morbidity, namely, hypoparathyroidism and recurrent laryngeal nerve (RLN) injury. The increased rate of temporary (26.0% vs 10.8%) and permanent (14% vs 0%) hypoparathyroidism has been reported by Henry et al. Bilateral CND or recurrent CND present with the highest risk of hypocalcemia. Recur-
rent laryngeal nerve injury is usually transient and occurs in 1% to 2% of patients. Injury to neighboring structures, such as blood vessels, esophagus, and thoracic duct, is less common.

The limits of a CND are bordered by the hyoid bone superiorly, the suprasternal notch inferiorly (including the upper mediastinal lymph nodes), the common carotid artery laterally, and the trachea medially. The delphian nodes and the pretracheal lymph nodes should be removed as part of such dissection. Central nerve dissection refers to removal of the unilateral or bilateral paratracheal regions.

The upper part of the paratracheal region lies between an imaginary line that is drawn between the curve of the RLN and the upper parathyroid gland (the nerve curve line; Figure) inferiorly and the hyoid bone superiorly. Dissection of the region above this line may increase the risk of jeopardizing the blood supply to the upper parathyroid gland and in rare occasions may increase the risk of RLN injury.

The hypothesis of this study was that the upper part of the paratracheal region is devoid of lymphatic structures and need not be dissected as part of a routine paratracheal neck dissection (PTND). The purpose of this study was to examine the presence of lymphatic tissue and/or metastatic nodes in the upper part of paratracheal region (ie, above the nerve curve line corresponding to the upper limit of the cricoid) to determine the need to dissect this region as part of a PTND.

Methods

The study was approved by the Assuta Medical Center Institutional Review Board, and it was determined that no informed consent was required.

During a 9-month period, from June 1, 2010, through March 31, 2011, a total of 27 patients with thyroid carcinoma (median age, 43 years; range, 21-74 years; male to female ratio, 4:23) underwent 31 PTNDs as part of their surgical treatment in the Head and Neck Surgery Unit, Assuta Medical Center, Tel Aviv, Israel. All patients with planned CND were prospectively enrolled. Twenty-one patients were newly diagnosed as having thyroid carcinoma. The other 6 patients underwent previous thyroidectomy for papillary thyroid carcinoma and were diagnosed as having recurrence in the paratracheal region (Table 1). The diagnosis for all patients was established by ultrasonography-guided fine-needle aspiration biopsy to the suspected tumor or metastatic lymph nodes. All patients underwent preoperative fiber optic laryngoscopy to ensure normal vocal cord mobility.

The CND consisted of removal of all fibroadipose tissue between the trachea and carotid sheath from the hyoid bone superiorly to the upper mediastinum and the subclavian or innominate artery inferiorly. The delphian nodes and the pretracheal nodes were removed as part of the specimen.

The PTND specimen was examined for normal and metastatic lymph nodes as 2 separate specimens: the upper and lower segments. The upper PTND specimen was defined as the section above the level of the nerve curve line and the lower PTND specimen as the section below that line. Calcium levels were measured twice daily for 48 hours after the surgical procedure, and the mobility of the vocal cords was assessed 1 week after the operation.

Results

Twenty-seven patients underwent PTND as part of their treatment for a suspected thyroid carcinoma with lymph nodes suggestive of disease according to ultrasonography or biopsy re-
sults. Four patients underwent bilateral PTND, and 23 patients underwent ipsilateral PTND.

Total thyroidectomy was performed in 19 patients with newly diagnosed disease and hemithyroidectomy in 2 patients based on frozen section analysis. Nine patients also underwent therapeutic lateral neck dissection (levels II-IV) based on a positive result of a needle biopsy of the jugular lymph nodes. Twenty-four of 27 patients (89%) were diagnosed as having papillary carcinoma. One patient had goiter with reactive lymph nodes in the paratracheal region, 1 patient had a Hurthle cell neoplasm, and 1 had medullary carcinoma of the thyroid.

The morbidity of the surgical procedure was minimal. There was no permanent hypocalcemia or permanent RLN paralysis. Temporary hypocalcemia was not assessed because of preventive calcium administration in every patient undergoing CND. One patient developed temporary vocal cord palsy (disappeared 4 months after surgery); 1 patient had minimal chyle leak (<100 mL), which resolved spontaneously; and 1 patient had wound infection, which resolved after conservative treatment.

A total of 31 PTND specimens were sent for pathologic evaluation as separate specimens (upper and lower). A median of 8 nodes were retrieved (range, 2-21). The mean number of negative lymph nodes identified in CND specimens was 5.3, and the mean number of positive lymph node metastases was 2.5. Lymph node metastases were detected in the specimens of 21 patients, 3 of them in the bilateral CND group. In 6 patients, the lymph nodes were normomalignant, although they were suspected to be malignant preoperatively. All metastatic lymph nodes were detected in the lower paratracheal region, and similarly all lymphatic structures were also located in the lower CND specimen. The upper specimens were devoid of lymphatic tissue or cancer-bearing lymph nodes and consisted of fibrofatty connective tissue only.

Discussion

The upper paratracheal region is the region between the hyoid bone and a line drawn between the upper parathyroid gland and the curve of the RLN (the nerve curve line). Paratracheal neck dissection is based on removal of all fatty and cancer-bearing lymphoid tissue from the entire paratracheal region to avoid recurrence of the cancerous process.

Preoperative imaging has low sensitivity for the diagnosis of occult lymph node metastases in the paratracheal region, especially in patients who did not have their thyroid removed. Ultrasonography and computed tomography rarely identify occult nodes in the central part of the neck (ultrasonography, 23%-52%; computed tomography, 41%).

The highest accuracy of magnetic resonance imaging (76%) could be obtained for a minimal lesion size of 2.9 cm. Consequently, imaging has a limited role in the surgical planning for central compartment dissection. However, the relatively frequent occurrence of metastases in the lateral part of the neck (jugular chain) with no metastases in the paratracheal region, especially from upper pole tumors, makes preoperative imaging imperative in detecting all clinically significant nodal metastases.

The main complications of CND are hypocalcemia and RLN injury. Even though the left and right RLNs run a different course, the segment above the point of intersection with the inferior thyroid artery becomes almost similar on both sides. The greatest risk to inadvertent injury to the RLN is probably dissection of the nerve's curve before its entry into the larynx. The risk of RLN injury seems to be uncommon in PTND and is comparable to total thyroidectomy alone. In a study of 1087 patients by Giordano et al, no significant differences were found between thyroidectomy alone vs thyroidectomy and PTND concerning transient (P = .40) and permanent (P = .10) RLN palsy. The same result was documented by Raffaelli et al in their prospective evaluation of patients with papillary thyroid carcinoma. Sadowski et al found no significant statistical difference in terms of nerve injury between thyroidectomy alone or in combination with PTND but found a positive association between the RLN injuries and larger tumors (P = .04).

The superior parathyroid glands are most commonly situated 1 cm above the intersection between the RLN and the inferior thyroid artery, lateral to the curve of the RLN. Injury to the parathyroid gland may result from 1 of 2 options. Less common is an unintentional excision of the superior parathyroid gland, which, if recognized, may be autotransplanted. More
common is devascularization of the upper parathyroid gland that may occur more frequently after a PTND, especially when dissecting the upper part of the specimen. The arterial supply of superior parathyroid glands emerges in many cases from the inferior thyroid artery and from anastomosis between the superior and inferior thyroid arteries. The study performed by Halsted and Evans\(^22\) found that the single source of arterial supply of the parathyroid glands is a small parathyroid artery entering the hilus of the gland. A presence of another 1 or 2 similar arteries is possible, but these usually supply the fibrofatty surrounding tissue around the gland and not the glandular substance. The anatomical correlations of the superior parathyroid artery suggests that its blood supply is usually from an inferior source. Alveryd\(^23\) reported that in 76% to 86% of cases the superior parathyroid artery may be an important vascular supply to the superior parathyroid gland in some patients.

Hypoparathyroidism after PTND is common and should be compared with thyroidectomy alone as a reference. A meta-analysis by Chisholm et al\(^25\) compares the risks of RLN palsy and hypoparathyroidism in 2 patient groups: those undergoing thyroidectomy alone vs those undergoing thyroidectomy and PTND. They concluded that the most common adverse effect of PTND is temporary hypocalcemia. Patients undergoing bilateral PTND are at greatest risk of developing hypoparathyroidism (transient and permanent) (Table 2).

Palestini et al\(^26\) compared thyroidectomy alone with thyroidectomy combined with ipsilateral and bilateral CND and found a higher rate of parathyroid autotransplantation in patients after CND compared with thyroidectomy alone (59%-64% vs 29%, \(P < .001\)). Similar results were observed for transient hypoparathyroidism (27%-31% vs 13%, \(P = .003\)). Son et al\(^27\) compared comprehensive (including bilateral paratracheal, pretracheal, and prelaryngeal lymph nodes) with limited (all except contralateral paratracheal lymph nodes) CND and found that transient hypocalcemia was more frequent in the first group (48.3% vs 26.8%, \(P = .02\)).

Medina et al\(^28\) reported that lymph nodes become sparser at the upper part of the RLN. However, there are no hard data regarding the presence of lymphoid tissue in the upper paratracheal segment, although dissection of that region is routinely advised.

### Conclusions

This series, as small as it is, demonstrates the absence of lymphatic tissue in the upper paratracheal region. It challenges the need to dissect this area routinely as a part of CND for patients with well-differentiated thyroid cancer.

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Upper Limits of Central Neck Dissection

Original Investigation Research

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