To better understand the biology of thyroid malignancies, it is extremely important to have a thorough understanding of the thyroid’s relationship to its surrounding structures, both anatomically and functionally. This would allow a clinician to understand and predict the behavior of such factors as local invasion, regional lymph node, as well as distant metastasis. This short review focuses on some aspects of thyroid anatomy and physiology that are clinically relevant to the diagnosis and management of thyroid cancer.

THYROID ANATOMY, HISTOLOGY, AND EMBRYOLOGY

The thyroid gland is a butterfly-shaped organ located anteriorly to the trachea at the level of the second and third tracheal rings. Its name originates from the Greek term “thyreos,” which means shield (named after the laryngeal thyroid cartilage). It consists of two lobes connected by the isthmus in the midline. Its bilateral symmetry is an important clinical fact because the presence of malignant cells on one or both sides can significantly alter the management of the patient, e.g., requiring more extensive surgery, such as bilateral neck dissections if there is local extension of the tumor. Each lobe is about 3–4 cm long, about 2 cm wide, and only a few millimeters thick. Because of its very close anatomic relationship to the rounded trachea, nodules arising from the posterior aspect of the gland are usually inaccessible to the examining fingers and therefore often missed on a routine clinical examination. The isthmus is 12–15 mm high and connects the two lobes. Occasionally, a pyramidal lobe is located in the midline, superior to the isthmus (Fig. 1). It represents a remnant of the thyroglossal duct, as the primitive thyroid gland descends from the base of the tongue to its final location in the neck during embryonic development. Anatomic variations of the thyroid gland occur and are encountered in clinical practice; one of the more common is thyroid hemiagenesis (1), with only one lobe and an isthmus of the gland. Hemiagenetic thyroid lobes are susceptible to the same abnormalities as are normal thyroid glands, including nodules and thyroid cancer.

A fibrous capsule covers the thyroid gland. Nodules within the parenchyma of the gland may also have a capsule or pseudocapsule. Surgical pathology reports may refer to tumor invasion “through the capsule,” and for staging purposes, prognosis, and management, it is important to know if this represents extension through the capsule of the gland into the surrounding perithyroidal tissues. Several key structures are located in relation to the capsule and should be considered in the context of surgery on the thyroid gland, such as the parathyroid glands and the recurrent laryngeal nerve. This is particularly significant with total thyroidectomy in patients with thyroid cancer. The small parathyroid glands are located in the posterior aspect of this capsule. Their identification and preservation is critical during surgery and can be particularly difficult with invasive cancers that require extensive surgery for complete resection, including modified lymph node dissections. Also, close monitoring of their function by measurements of serum total and ionized calcium in the early postoperative period is important to avoid or adequately treat surgical hypoparathyroidism in a timely manner.

The recurrent laryngeal nerves are the other notable structures in this regard. These nerves provide an essential part of the innervation of the larynx, and any injury can result in symptoms that range from a hoarse voice to stridor and the need for a tracheostomy. They originate from the vagus nerve at the level of the aortic arch and turn superiorly toward the tracheoesophageal groove. Several anatomic variations have been described, and the recurrent laryngeal nerve runs laterally to the tracheoesophageal groove most commonly on the right side (2,3). It runs close to the inferior thyroid artery and can be found anteriorly, posteriorly, or in between the branches of the blood vessel. Several surgical approaches have been proposed to try to identify and preserve this nerve during surgery of the thyroid gland. Most investigators recommend identifying the nerve before ligating the artery to
prevent inadvertent injury to the nerve, but there are variations in the proposed methods to achieve this. As the nerve travels superiorly in or laterally to the tracheoesophageal groove, it is located directly posterior to the thyroid gland itself and can be adherent to it. This requires special attention by the thyroid surgeon to prevent damage to the nerve as the thyroid lobe is removed. Another variation is a division of the recurrent laryngeal nerve before entering the larynx (2,3). In less than 1% of cases, an anomalous non-recurrent nerve has been reported, originating from the cervical portion of the vagus nerve (also called the “inferior laryngeal nerve”), instead of the recurrent laryngeal nerve. This nerve is usually seen on the right side of the neck (4).

The gland’s blood supply comes from two sets of arteries bilaterally: the superior thyroid arteries originate from the external carotid arteries. They descend to the superior poles of the thyroid gland and are accompanied by the superior laryngeal nerve. This nerve originates from the inferior vagus ganglion. As it approaches the larynx, it divides into the external and internal branches. The internal branch supplies sensory innervation to the supraglottic larynx, and the external branch innervates the cricothyroid muscle (5). It is usually recommended during a complete thyroidection. The surgeon should ligate the superior thyroid artery as close to the thyroid gland as possible to try to avoid damaging any branches of the superior laryngeal nerve.

Clearly, the type of symptoms a patient will develop postoperatively is highly dependent on the experience and skill of the surgeon and the type of nerve injury. Unfortunately, it is not rare that the surgeon may have to sacrifice one of the recurrent laryngeal nerves in an en bloc resection because cancer has directly invaded the nerve.