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Proposal for Anatomical Classification of the Superior Pole in Thyroid Surgery

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Abstract

Objective—To propose a distinct anatomical classification for the superior thyroid pole that may serve as a surgical landmark and could help reduce complications in thyroid surgery.

Materials and Methods—A comprehensive anatomical study based on existing literature and surgical observations.

Results—The proposed superior pole classification is based on two parameters that closely interact: one is the shape of the superior pole and the other is the structure of the vascular pedicle of the superior pole. We have come up with three distinct types of superior thyroid pole anatomical structure that may be predictive of the risk for both hemorrhage and nerve injury.

Conclusions—Superior pole classification may serve as a guiding tool during thyroid surgery in order to reduce complications such as bleeding and injury to the external branch of the superior laryngeal nerve.

Keywords

thyroidectomy; superior pole; superior thyroid artery; external branch of the superior laryngeal nerve

INTRODUCTION

The thyroid gland is located in the lower anterior neck and extends from the level of C5 superiorly to T1 inferiorly. The gland has a typical “butterfly” shape and is comprised of two lobes that are connected by an isthmus. The average length of each lobe is 50–60 mm and the whole gland usually weighs around 25–30 grams. Often there is an additional pyramidal lobe extending from the isthmus cephalad that occasionally may be connected to the hyoid bone by fibromuscular structure that is also called the *levator glandulae thyroideae*. The thyroglossal duct is sometime present as a remnant fibrous band but may also persist as a thyroglossal duct cyst.

The thyroid gland is innervated by the autonomic nervous system. The vagus nerve carries the parasympathetic innervation whereas sympathetic innervation arrives via the sympathetic

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chain. The visceral fascia envelops the gland. Two ligaments attach the gland to the laryngotracheal complex. The anterior suspensory ligament plasters each lobe to the cricoid and thyroid cartilage and the posterior suspensory ligament, also known as the ligament of Berry, connects the gland to the cricoid cartilage and the first and second tracheal rings. The relations between the recurrent laryngeal nerve and the ligament of Berry is variable, as sometimes the nerve may be found deep to it and in other cases it may be crossing between the sub-ligaments. The strap muscles are wrapping the gland anteriorly and laterally. They include the sternothyroid muscle, which covers the lateral aspect and attaches to the thyroid cartilage cephalad to the superior pole. The sternohyoid muscle and the superior belly of the omohyoid muscle cover the anterior surface of each lobe as the sternal head of the sternocleidomastoid muscle does it inferiorly. The last two strap muscles form are connected in the midline by the *linea alba* that should divided in order to provide proper exposure of the gland during thyroid surgery [1].

Blood supply to the thyroid gland originates from the superior and inferior thyroid arteries. However, in some cases there can be found a *thyroidea ima*. These arteries have abundant collateral anastomoses with each other, ipsilaterally and contralaterally. The superior thyroid artery is the first anterior branch of the external carotid artery. However, rarely it may originate from the common carotid artery proximal to the carotid bifurcation. The course of the superior thyroid artery is lateral to the larynx and deep to the strap muscles. The artery runs superficially on the anterior border of the lobe, branching before entering the gland, and forms collaterals with the contralateral lobe vessels [2].

The external branch of the superior laryngeal nerve has a variable course, but is usually in close proximity with the superior thyroid artery before entering the cricothyroid muscle. Ligation of the superior thyroid artery during thyroid surgery may put the external branch of the superior laryngeal nerve at risk if this is done too high along the vascular pedicle. This type of nerve injury results in an inability to regulate pitch during voice production [3].

PATIENTS AND METHODS

Rational

We sought to classify the superior thyroid pole anatomy according to surgical observations made by a single thyroid surgeon at Memorial Sloan–Kettering Cancer Center during 35 years in practice. The classification is based on the observation that the anatomical structure of the superior pole manifests in three distinct variations that can be recognized intraoperatively by the surgeon. By identifying these unique anatomical variations one can try to avoid surgical complications, specifically hemorrhage, and nerve injury.

Graphic Illustrations

A computerized graphics artist who specializes in medical illustrations created all graphic illustrations under the surgeon's guidance and supervision.

RESULTS

Type 1

This type manifests as a narrow pyramid-shaped superior pole with narrow vascular pedicle (Fig. 1). This variation enables a relatively easy dissection of the superior pole and ligation of the vascular pedicle with minimal risk to the external branch of the superior laryngeal nerve and for hemorrhage.

Type 2

With this type we often see a wider superior pole than in Type 1 with -shaped vascular pedicle (Fig. 2). This variation may pose some risk to the external branch of the superior laryngeal nerve if the surgeon is attempting to reach the root of the vascular pedicle superiorly.

Type 3

Probably the most complex of all, this type entails a very wide superior pole with wide vascular pedicle and multiple branching blood vessels (Fig. 3). This variation may carry a risk for both external branch of the superior laryngeal nerve injury as in Type 2 and may also increase the chance of bleeding due to multiple blood vessels within the vascular pedicle.

DISCUSSION

In the present study, we propose a novel anatomical classification system for the superior thyroid pole.

This classification may serve as an important tool for the thyroid surgeon in order to try to avoid intraoperative and postoperative complications. Specifically, hemorrhage from the superior thyroid artery vessel system and nerve injury to the external branch of the superior laryngeal nerve. When addressing the superior thyroid pole, the surgeon should be able to expose the vascular pedicle by opening Joll's triangle medially, dissecting the sternothyroid muscle superiorly, and separating the great vessels laterally. This exposure is very much dependent on the size and the shape of the superior pole as described in this article.

In an anatomical review, Naidoo and co-workers concluded that it is better to stay on the substance of the superior pole of the thyroid gland when ligating the superior thyroid artery, as the nerve is extremely close in relation to the superior pole of the normal thyroid gland [4]. This is mainly relevant in Type 2 and 3 according to our proposed classification. Another systematic review by Morton et al. described the complex anatomical variations of the superior laryngeal nerve as described by previous studies [5]. Nonetheless, a more structured and well-defined classifications are needed in order to easily guide the common thyroid surgeon during surgery.

The second complication in thyroid surgery that needs to be addressed is hemorrhage. Previous reports showed a steady incidence of 1–2% of postoperative hemorrhage following thyroidectomy with a mortality rate of up to 0.32% [6]. In a comprehensive study, Chen and co-workers found that the sources of post-thyroidectomy hemorrhage were identified more

frequently in the blood vessels supplying the infrahyoid muscles that originate from the superior pole and near the recurrent laryngeal nerve [7]. These findings are consistent with our classification, which concur that the risk for hemorrhage may be increased as the vascular anatomy becomes more complex as described in Type 2 and more robustly in Type 3.

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Fig. 1.
Type 1 superior thyroid pole featuring a narrow pyramid-shape superior pole with narrow vascular pedicle.

Fig. 2.
Type 2 superior thyroid pole is characterized by a Y-shape vascular pedicle.

Fig. 3.
Type 3 superior thyroid pole has a very wide structure with wide vascular pedicle and multiple branching blood vessels.