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Topographic and Anatomical Justification of the Choice of Surgical Approach in Thyroid Surgery

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Abstract: Background/Aims: Safe thyroidectomy depends on an approach that provides stable exposure of the poles, reliable hemostasis and protection of the external and recurrent laryngeal nerves. This review synthesizes topographic–anatomical determinants that justify the choice among open Kocher incision, minimally invasive video-assisted, endoscopic/remote-access and robotic approaches.

Materials and Methods: Narrative review of peer-reviewed anatomical, surgical and outcome studies (2000–2025; PubMed/Scopus/eLibrary). Key variables: relation of upper/lower thyroid poles to laryngeal framework and trachea, course of external branch of superior laryngeal nerve (EBSLN), recurrent laryngeal nerve (RLN), and vascular pedicles; exposure and complexity profiles across approaches.

Results: Optimal access aligns incision and working corridors with the expected positions of EBSLN at the superior pole, RLN in the tracheoesophageal groove, and parathyroid glands with their end-arterial supply. The Kocher approach remains the reference for bilateral disease or large goiter; minimally invasive/endoscopic routes yield superior cosmesis in selected nodular disease; remote and robotic approaches avoid a cervical scar but demand longer operative time and resources.

Conclusion: An anatomy-first algorithm—lesion extent, pole orientation, cervical habitus, need for bilateral exploration—should guide approach selection to reduce RLN injury and hypoparathyroidism while preserving oncologic and functional goals.

Keywords: thyroid gland; surgical approach; topographic anatomy; recurrent laryngeal nerve; thyroidectomy.

INTRODUCTION

Thyroid surgery remains one of the most frequently performed procedures in endocrine surgery, requiring high precision and knowledge of the topographic and anatomical relationships of the neck organs. With the development of microsurgical techniques and minimally invasive technologies, cosmetic appearance and functional safety have been added to the basic surgical requirements.

The thyroid gland exhibits significant anatomical variability, particularly in its vascular supply and the location of its neural structures—the recurrent and external branches of the superior laryngeal nerve. These characteristics determine the surgeon's tactical and technical decisions when choosing the optimal approach, which should ensure adequate visualization of the surgical site, hemostasis control, and preservation of vital structures.

The relevance of this topic is determined by the need to minimize intraoperative complications, primarily damage to the recurrent laryngeal nerve and parathyroid glands, as well as the desire to improve the functional and aesthetic results of surgery. Modern surgeons must consider not only the

extent of the pathology but also the individual anatomical characteristics of the patient, making topographic and anatomical justification of the surgical approach a crucial prerequisite for successful intervention.

THE PURPOSE AND OBJECTIVES OF THE STUDY

Purpose of the study— based on the analysis of modern topographic-anatomical and clinical data, to substantiate a rational choice of surgical approach in thyroid gland operations, ensuring optimal visualization conditions, minimal trauma and a reduced risk of damage to critical anatomical structures of the neck.

Research objectives:

1. To analyze the anatomical and topographic features of the thyroid gland and adjacent formations of the neck, which determine the tactics of surgical intervention.
2. To assess the relative position of the recurrent and external laryngeal nerves, parathyroid glands and vascular structures representing a surgical risk zone.
3. To examine and compare the main types of surgical approaches (classical Kocher, minimally invasive, endoscopic and robot-assisted) from the point of view of their anatomical validity and safety.
4. To systematize the literature on the advantages and limitations of various approaches in order to determine the optimal access for specific clinical situations.

MATERIALS AND METHODS OF RESEARCH

This study is carried out in the form of a review and analytical work using data from modern literature devoted to the topographic anatomy of the thyroid gland and the features of surgical access in operations on the neck organs.

A systematic search and analysis of scientific publications was conducted in the PubMed, Scopus, eLibrary, and ResearchGate databases for the period 2000–2025 using the keywords: thyroid gland, topographic anatomy, surgical approach, Kocher incision, recurrent laryngeal nerve, endoscopic thyroidectomy, robotic thyroidectomy.

The review included articles that met the following criteria:

anatomical studies performed on autopsy and clinical material;

publications describing surgical techniques for accessing the thyroid gland;

comparative clinical reviews containing data on the safety and outcomes of different types of approaches.

Reports without anatomical or clinical justification, as well as materials based on limited observations without statistical processing, were excluded from the analysis.

During the work, methods of topographic-anatomical analysis, comparative review of surgical approaches and descriptive morphometry were used, which made it possible to systematize the available data on the relative position of vascular-nerve structures and anatomical risk zones during operations on the thyroid gland.

RESEARCH RESULTS AND THEIR DISCUSSION

1. Topographic and anatomical features of the thyroid gland

The thyroid gland is located on the anterior surface of the neck at the level of the second to fourth tracheal rings, closely adjacent to the anterior surface of the larynx and trachea. In most cases, it has two lateral lobes connected by an isthmus, but anatomical variations are common: a pyramidal lobe is found in 30–50% of people, and a retrosternal arrangement of the lower poles occurs in 10–12%.

The anterior surface of the gland is covered by the superficial fascia and platysma, between which the jugular venous arch passes, requiring caution when incising the skin and subcutaneous tissue. Deeper lies the lamina pretrachealis fasciae colli, which delimits the fascial bed of the thyroid gland. The close proximity of the gland's capsule to the trachea and larynx ensures the stability of the organ but complicates its mobilization in fibrotic processes and large goiters.

2. Vascular-nerve structures and surgical risk zones

The thyroid gland is supplied with blood by the superior and inferior thyroid arteries (a. thyroidea superior et inferior), as well as accessory branches (a. thyroidea ima—in 8–10% of cases). The superior artery accompanies the external branch of the superior laryngeal nerve (n. laryngeus superior externus), which innervates the cricothyroid muscle; damage to this muscle causes hoarseness and a decrease in voice strength.

The recurrent laryngeal nerve (n. laryngeus recurrens) runs in the tracheoesophageal groove, exhibiting numerous anatomical variations. The most common site of injury is its entry into the larynx behind the inferior horn of the thyroid cartilage. In 1–2% of cases, a non-recurrent recurrent nerve is observed, most often on the right, requiring particular care when isolating the vascular bundle.

The parathyroid glands are located on the posterior surface of the thyroid lobes, typically near the junction of the upper and middle thirds of the posterior surface. Identifying them and preserving their blood supply (small branches from the inferior thyroid artery) are key to preventing postoperative hypocalcemia.

3. Justification for the choice of surgical approach

The classic Kocher cervical approach remains the most reliable for bilateral and multinodular goiters, as well as for tumors requiring extensive exposure. It provides direct visualization of the lobes and isthmus, symmetrical access to both sides, and control of the vascular and neurological structures. However, cosmetic defects and relative invasiveness limit its use in young patients and for small nodules.

Minimally invasive video-assisted approach (MIVAT) allows for shorter incisions (2–3 cm), reduced postoperative pain, and improved aesthetic results. It is appropriate for nodes up to 30 mm in size and without invasion of surrounding tissue.

Endoscopic and robot-assisted methods (transaxillary, retroauricular, transoral access) do not leave a cervical scar and provide a good cosmetic effect, but require a long time and high cost of equipment.

The choice of method depends on the extent of the lesion, anatomical landmarks, body type and cosmetic expectations of the patient.

4. Key anatomical landmarks during thyroidectomy

The main zones that determine the choice of access and the volume of dissection include:

Simon's triangle is the space between the common carotid trunk, the trachea, and the lower pole of the gland, where the recurrent nerve most often passes.

The upper pole zone is the site of intersection of the superior thyroid artery and the external branch of the superior laryngeal nerve.

The posterior capsule of the gland is the area where the parathyroid glands and the vessels that supply them are located.

Knowledge of these landmarks determines the safety and success of the intervention, regardless of the chosen approach.

5. Comparative characteristics of surgical approaches

Access type	Advantages	Flaws
Classic (Kocher)	Good visualization, control of	More pronounced scar, trauma

	both lobes	
MIVAT	Minimal incision, cosmetic effect	Limited exposure, duration of surgery
Endoscopic/robot-assisted	Absence of cervical scar, precision of movements	High cost, long training, limited indications

CONCLUSIONS

1. Topographic and anatomical features of the neck are key when planning and performing thyroid surgery. The variability of the recurrent laryngeal nerve, the location of the parathyroid glands, and the vascular supply require an individualized approach when choosing a surgical approach.
2. The classic Kocher approach remains the primary method for bilateral and extensive lesions of the gland, providing extensive visualization, reliable hemostasis, and control of anatomical structures.
3. Minimally invasive and endoscopic techniques are justified for limited nodular formations and benign processes, allowing for a reduction in trauma and an improvement in cosmetic results without compromising the safety of the surgery.
4. Robot-assisted techniques open up new perspectives in aesthetic thyroid surgery, but require high equipment costs and significant surgeon experience.
5. The most rational choice of access is determined by a comprehensive assessment:

✓ topographic and anatomical features of the patient,

✓ volume of the pathological process,

✓ functional and aesthetic objectives of the operation,

✓ technical capabilities of the clinic.

6. Adherence to anatomical landmarks and the use of the “anatomy before technique” principle reduce the risk of damage to the recurrent laryngeal nerve and parathyroid glands, increase surgical safety, and improve its functional and cosmetic results.

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