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Indications for reoperative thyroid surgery: Application of modern diagnostic techniques

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Abstract. This study aimed to develop a systematic approach to selecting indications for reoperative thyroid surgery by employing contemporary diagnostic methods for objective assessment of the gland and surrounding tissues. A retrospective analysis was conducted on data from 121 patients treated between 2000 and 2024, including clinical, laboratory, and instrumental examinations. The cohort predominantly comprised women (94.2%) with a mean age of 47.6 years. Reoperations were primarily performed due to progressive nodular pathology (45%) and focal fibrosis in autoimmune thyroiditis (34.7%), whereas malignant tumour recurrence was observed in 8.3% of cases. Most nodules were benign (62%), but 38% exhibited high malignancy risk according to the Thyroid Imaging Reporting and Data System (TI-RADS). In patients with autoimmune thyroiditis, elevated antibody levels correlated with Doppler flow alterations ($r = 0.68$; $p < 0.01$), serving as a disease activity marker. Reoperations carried a high complication risk, particularly in patients undergoing third interventions, where recurrent laryngeal nerve injury due to scar tissue occurred in 13.3% of cases. Utilising ultrasonography, computed tomography, Doppler imaging, and fine-needle aspiration biopsy reduced complication rates by 87% through precise delineation of anatomical variations and pathological processes. The findings underscore the necessity for standardised protocols to enhance surgical outcomes, aligning with international guidelines for thyroid disease monitoring and early diagnosis

Keywords: thyroid nodular pathology; autoimmune thyroiditis focal fibrosis; ultrasound Doppler; computed tomography; thyrotropin

INTRODUCTION

Reoperative thyroid surgery is frequently associated with elevated complication risks due to scar tissue formation and challenging access. Optimal selection of surgical technique and extent is critical for preserving gland functionality and avoiding adverse outcomes. Advances in endocrine surgery include the adoption of minimally invasive approaches and cutting-edge imaging technologies. According to K.N. Patel *et al*. [1], standardisation of surgical methods and the use of ultrasonography and other diagnostic technologies improve treatment outcomes for patients with thyroid disorders. Additionally, O. Shidlovsky *et al*. [2] highlight the efficacy of minimally invasive techniques, such as endoscopic thyroidectomy, in ensuring high-quality surgical intervention.

The work of I. Pavlovskyi *et al*. [3] emphasises the importance of a personalised approach when determining indications for reoperation, incorporating both clinical evaluation and instrumental diagnostics. Particular attention is given to age-related variations in thyroid disease progression, which, as reported by E. Mykhailiuk [4], influence surgical risks and long-term outcomes. Despite notable progress, unresolved challenges persist. For instance, identifying residual tissue and parathyroid glands during reoperations remains complex, necessitating advanced imaging techniques. A.L.S. Karcioglu *et al*. [5] suggest that integrating novel technologies, such as vascular optical tomography, could significantly improve surgical outcomes. Furthermore, correlations between biochemical blood markers and complication risks in thyroid dysfunction patients have been identified, though further research is required.

L.A. Orloff *et al*. [6] report that radiofrequency ablation (RFA) and ultrasound ablation techniques have become

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pivotal in managing both benign and malignant thyroid diseases. RFA, in particular, enables targeted treatment of pathological tissues without open surgery, making it ideal for patients unsuitable for traditional thyroidectomy due to high operative risks. A key advantage is the preservation of unaffected gland regions, crucial for maintaining endocrine function, while minimising anaesthesia-related risks and postoperative recovery time. A crucial aspect of postoperative management is the timely diagnosis and treatment of haematoma, which may develop following thyroid surgery. H.A. Iliff *et al*. [7] have proposed multidisciplinary guidelines aimed at preventing this complication and ensuring its effective resolution. They emphasise that the key preventive measures include meticulous intraoperative haemostasis, adequate postoperative drainage, and rigorous patient monitoring. Their findings underscore that early haematoma detection and prompt surgical intervention significantly reduce the risk of asphyxia and other severe complications.

Parathyroid gland identification and preservation remain central challenges in thyroid surgery. R. Tjahjono *et al*. [8] summarised visualisation techniques to minimise accidental damage or excision. Similarly, C.K. Stefanou *et al*. [9] highlight practical strategies to avoid complications such as recurrent laryngeal nerve injury (leading to vocal dysfunction) and vascular trauma (causing significant bleeding), underscoring the importance of standardised techniques and surgeon training. S. Jin & I. Sugitani [10] further analyse management strategies for postoperative hypocalcaemia and nerve injuries, advocating for individualised treatment informed by recent diagnostic and therapeutic advances.

Given current evidence (as of 2025) and existing gaps, this study aimed to systematise modern approaches to reoperative thyroidectomy using state-of-the-art imaging and diagnostic modalities. The results may reduce complication rates and improve surgical efficacy, ultimately enhancing the quality of life for patients with thyroid disorders.

MATERIALS AND METHODS

Data were obtained from patients treated at the "Medbud Medical Centre" and the Department of Endocrine Surgery at "Kyiv Municipal Clinical Hospital No. 3" (a non-profit communal enterprise) between 2000 and 2024. The dataset included medical histories, laboratory and imaging results, surgical protocols, and postoperative follow-up records. Randomisation was ensured via inclusion/exclusion criteria to minimise bias and ensure representativeness (Table 1).

Table 1. Inclusion and exclusion criteria for evaluating patients prior to reoperative thyroid surgery

Inclusion Criteria	Exclusion Criteria
Previous thyroid surgery with available instrumental diagnostic results (ultrasound Doppler, computed tomography, fine-needle aspiration biopsy) and reliable clinical/laboratory history. Reliable clinical history was defined through analysis of medical records documenting prior diagnoses, previous imaging results, and administered therapies. Laboratory history included evaluation of hormonal levels thyroid-stimulating hormone (TSH), (thyroxine) T4, (triiodothyronine) T3, anti-thyroglobulin (anti-Tg), and anti-thyroid peroxidase (anti-TPO) antibodies, biochemical and haematological parameters.	Severe comorbidities contraindicating surgery, assessed via standardised protocols: Cardiovascular disorders: Class III-IV congestive heart failure (NYHA Functional Classification), unstable angina, recent myocardial infarction (within 6 months); Active metastatic malignancies; Renal dysfunction (glomerular filtration rate <30 mL/min/1.73 m^2) or hepatic impairment (severe liver failure); Decompensated *diabetes mellitus* or other endocrine pathologies complicating metabolic adaptation.

Source: compiled by the author

Medical records, imaging studies, histopathological materials, and laboratory results were analysed. The study adhered to international standards for thyroid disease diagnosis and management [11]. Data were tabulated into structured formats, including key clinical indicators, laboratory results, and imaging findings. Patient data were anonymised and processed in compliance with international ethical guidelines and medical confidentiality standards; all participants provided informed consent for research use of their data [12].

The study cohort comprised 121 patients requiring reoperation for thyroid pathologies. The mean age was 47.6 ± 12.4 years (range: 14-78 years). A significant female predominance was observed (94.2%, n = 114) versus males (5.8%, n = 7), consistent with epidemiological trends [3]. The time interval from the onset of clinical symptoms to the first surgical intervention varied widely, ranging from 2 months to 18 years. The mean duration of this interval was 4.8 years, allowing for the classification of patients into several subgroups: short-term period (up to 1 year) – 12% (15 patients); intermediate period (1-5 years) – 52% (63 patients); and long-term period (>5 years) – 36% (43 patients).

The scope and surgical techniques were determined based on patient classification, which was as follows. Nodular pathology was observed in patients with recurrent or progressive nodular formations. This condition was diagnosed through ultrasound (US) and fine-needle aspiration biopsy (FNAB), enabling the assessment of nodule morphology and potential malignancy. Biopsy samples were obtained from the most suspicious areas of the thyroid nodules under US guidance, including regions with hypoechogenicity, microcalcifications, or increased vascularity. Nodule classification was based on the Thyroid Imaging Reporting and Data System (TI-RADS) to determine malignancy risk [11]. Autoimmune thyroiditis was characterised by active inflammation, verified via Doppler

ultrasound (increased blood flow) and serological testing for specific antibodies (anti-Tg and anti-TPO). The approach adhered to international standards, particularly the American Thyroid Association (ATA) criteria [13], which consider antibody levels (anti-Tg, anti-TPO), US features, and thyroid functional status. Diffuse toxic goitre was diagnosed in patients with severe, medication-resistant disease. Laboratory evaluation of TSH and T4 levels, along with computed tomography (CT), was used to assess the extent of tissue hyperplasia. Thyroid carcinoma was identified in patients with recurrent malignant processes. Diagnosis was confirmed via CT and biopsy, which allowed for characterisation of the lesion and its extent. The Tumour, Node, Metastasis (TNM) staging system was applied to classify disease progression and plan surgical intervention.

Each patient underwent a comprehensive diagnostic workup. Doppler Ultrasound (USG-D): Conducted using the Philips EPIQ 7G system to evaluate echotexture, residual thyroid tissue volume, and peri-/intrathyroidal blood flow. Special attention was given to the spatial relationship between the vascular bundle, trachea, and residual thyroid tissue. Computed Tomography (CT): Performed using the "Siemens SOMATOM Definition AS" scanner with contrast enhancement to assess nodule structure and topographic relations with surrounding organs. Fine-Needle Aspiration Biopsy (FNAB): Conducted under US guidance to verify pathological processes. The collected samples underwent cytological and histological analysis. To assess data reliability and normal distribution, the Shapiro-Wilk test was applied. Intergroup comparisons were performed using Student's t-test, with statistical significance set at $p < 0.05$.

RESULTS

A group of patients with recurrent nodular pathology (45%, 54 cases) exhibited reformation of nodules following prior surgeries, predominantly lobectomy or hemithyroidectomy. In the majority (62%), the nodules were classified as benign based on cytological analysis following fine-needle aspiration biopsy. However, in 38% (20 patients), the nodules were deemed high-risk for malignancy (TI-RADS 4 or 5), necessitating surgical intervention. Focal lesions of autoimmune thyroiditis, identified in 42 patients (34.7%), were characterised by a prolonged chronic course, marked compressive symptoms, significant inflammatory changes on ultrasonography (US), and biochemical markers. In 78% (33 patients), elevated anti-TPO levels were observed, correlating with Doppler ultrasound findings regarding blood flow ($r = 0.68$, $p < 0.01$).

Fifteen patients with diffuse toxic goitre (12.4%), undergoing organ-preserving surgeries, presented with pronounced clinical manifestations of thyrotoxicosis refractory to medical therapy. Laboratory investigations revealed critically low TSH levels (<0.1 mIU/L) in all patients in this group. The necessity for surgical intervention was dictated by the lack of clinical compensation despite thyrostatic treatment. Recurrent thyroid cancer was identified in 10 patients (8.3%), with confirmed malignant recurrence following prior surgeries. The TNM staging system was applied for disease classification: Stage I-II in 70% (7 patients) and Stage III in 30% (3 patients). Based on the analysed data, methodological guidelines were developed in the form of Table 2, outlining clinical patient groups by primary pathologies.

Table 2. Clinical patient groups by primary pathologies

Pathology	Number of patients (%)	Key features
Nodular pathology	54 (44.6%)	Recurrent nodules; 62% benign, 38% high-risk for malignancy
Focal lesions of autoimmune thyroiditis	42 (34.7%)	78% elevated anti-TPO; significant inflammatory changes on US
Diffuse toxic goitre	15 (12.4%)	Severe thyrotoxicosis refractory to therapy
Recurrent cancer	10 (8.3%)	Predominantly TNM Stage I-II (70%)

Source: compiled by the author

Scarring in the surgical wound area was detected in 68% of patients, complicating access to residual thyroid tissue and adjacent structures (trachea, nerves, vessels). In 24 patients (19.8%), compression of surrounding tissues was documented, manifesting as dyspnoea, dysphagia, or vascular compression syndrome. Preoperative preparation emphasised monitoring parathyroid function and hormonal status compensation to reduce postoperative complications, particularly hypocalcaemia. Assessment of parathyroid hormone (PTH), calcium, and vitamin D levels prior to surgery facilitated timely correction of potential imbalances, influencing patient recovery rates. Additional optimisation of thyroid function through pharmacotherapy helped mitigate the risk of thyrotoxicosis or hypothyroid coma postoperatively. This comprehensive approach reduced hospitalisation duration, improved patient well-being, and lowered early postoperative complication rates. The analysis underscored the necessity for earlier recurrence diagnosis to minimise reoperation risks and enhance treatment efficacy for thyroid pathologies.

Most patients (90.1%, $n = 109$) underwent only one reoperation. In this cohort, the primary reason for surgery was inadequate initial thyroid resection (78 patients, 71.6%). The mean interval between primary surgery and first reoperation was 4.6 ± 3.2 years. In 40% of cases, this interval was under 3 years, suggesting early recurrence linked to residual tissue or insufficient prior intervention. Second reoperations were performed in 7.5% of patients ($n = 9$), driven by new nodules in thyroid remnants, malignant recurrence, or compressive syndrome with scar tissue deformation. The mean interval between first and second reoperations was 6.2 ± 4.5 years, indicating challenges in achieving radical resection initially or inadequate post-reoperation monitoring.

A third reoperation was required in 2.4% of patients ($n = 3$). These interventions were characterised by significant technical challenges due to extensive scar tissue changes in the neck region in all patients, as well as the presence of diffuse or nodular alterations that could not be corrected by previous surgeries. The mean interval

between the second and third reoperations was 3.8 ± 2.1 years. The shorter interval compared to prior interventions was associated with the more aggressive nature of the pathology, which led to rapid disease progression.

An increasing number of reoperations was associated with a rising risk of intraoperative and postoperative complications. In 100% of patients undergoing a third reoperation, extensive scar formation was observed, complicating access to the residual thyroid tissue, nerves, blood vessels, and adjacent organs. The primary surgical complications included recurrent laryngeal nerve injury, occurring in 8.2% of cases during the second operation and 13.3% during the third. To mitigate this risk, intraoperative neuromonitoring is advisable, as it enables real-time nerve identification and reduces the likelihood of accidental damage. Additionally, the application of surgical techniques that minimise traction-related nerve injuries – such as meticulous tissue dissection and the use of microsurgical instruments – is recommended. Postoperative hypoparathyroidism was observed in 10% of patients in the second group and 23.3% in the third group due to injury or excision of the parathyroid glands along with scarred tissues. To prevent this complication, intraoperative fluorescent visualisation of the parathyroid glands is recommended, as it enhances their identification and reduces the risk of inadvertent removal. Furthermore, autotransplantation of parathyroid glands into the forearm muscles or sternocleidomastoid muscle can be an effective method for preserving their function. The incidence of infectious complications increased following surgical interventions due to altered microcirculation within scarred areas. Considering this, surgeons should prioritise minimally invasive techniques to reduce tissue trauma and adhere to international guidelines for prophylactic antibiotic therapy. The use of absorbable sutures and local antiseptics may also contribute to lowering the risk of postoperative infections.

The expansion of scar tissue in access zones necessitated the use of microsurgical techniques. However, even with such technologies, the precision of tissue dissection was often limited. To improve the efficacy of multi-stage interventions, advanced diagnostic methods were utilised in 87% of cases. Contrast-enhanced computed tomography (CT) facilitated the visualisation of scar changes, the boundaries of residual tissue, and the topography of neurovascular structures, aiding in surgical planning. Comprehensive laboratory diagnostics, including the assessment of TSH, T4, T3, and thyroglobulin antibodies, enabled a more accurate evaluation of the functional status of residual tissue and the perioperative risk profile. Additionally, Doppler ultrasound provided insights into peripheral blood flow and the vascular supply of residual thyroid tissue, which was crucial for preventing postoperative tissue ischaemia.

The analysis of multi-stage interventions revealed certain limitations in standard surgical treatment protocols. Unified protocols often fail to account for individual patient characteristics, including tissue condition, the extent of scarring, and anatomical variations. The lack of tailored approaches for managing complex recurrent pathologies significantly increases the risk of complications. The individualisation of treatment strategies, particularly the adaptation of diagnostic methods and preoperative preparation, significantly improves surgical outcomes and reduces risks in reoperations. This necessity becomes evident based on an analysis of multi-stage surgeries, highlighting the need to incorporate broader a nd more detailed criteria for different patient cohorts into treatment protocols.

The group of patients with nodular pathology constituted the largest segment (45% of the total cohort). Within this group, colloid nodules predominated (67%), typically exhibiting a benign course without active inflammation or significant thyroid dysfunction. These nodules were characterised by dense colloid content and an absence of pronounced cellular proliferation in histological sections. A substantial proportion of patients (33%) had nodules with a high risk of malignancy, classified as TI-RADS categories 4 and 5. Fine-needlew aspiration biopsy indicated cytological atypia in these nodules, necessitating surgical intervention. Such nodules exhibited a denser structure with microcalcifications, a feature frequently associated with malignant neoplasms.

Focal fibrotic conglomerates of autoimmune thyroiditis (AIT) were diagnosed in 35% of patients, confirmed through clinical and laboratory-instrumental methods. In 89% of cases, Doppler ultrasound revealed significantly increased blood flow within the thyroid tissue, indicative of an active inflammatory response often accompanied by increased echogenicity. Antibody analysis showed that 78% of AIT patients had elevated titres of anti-thyroglobulin (anti-Tg) or anti-thyroid peroxidase (anti-TPO) antibodies. Additionally, 64% of patients exhibited thyroid dysfunction, necessitating hormone replacement therapy. Histologically, the pathology was characterised by lymphoid infiltration, focal fibrosis, follicular destruction, and thyrocyte atrophy.

Diffuse toxic goitre (DTG) recurred following organ-preserving surgeries in 12% of patients. The mean duration of preoperative medical treatment was 3.5 ± 1.2 years. Despite adequate therapy with antithyroid drugs, these patients demonstrated persistent hyperthyroid symptoms and significant thyroid enlargement, indicating treatment failure. Ultrasound examination revealed an enlarged thyroid gland with diffuse hypoechogenicity and vascularisation following the “thyroid inferno” pattern. Histologically, the glandular tissue exhibited signs of thyrocyte hyperplasia with large hyperchromatic nuclei. In 21% of cases, a history of thyrotoxic crisis was confirmed, necessitating immediate surgical intervention.

The recurrence rate of malignant thyroid pathology was 8%. The most common histological types were papillary (70%) and follicular (22%) carcinomas. In 63% of patients, the disease stage was classified according to the TNM system (predominantly Stages I-II), indicating early diagnosis and a relatively favourable prognosis. Histological studies identified the presence of psammoma bodies and atypical proliferating cells in papillary-type tumours. In cases of follicular carcinoma, invasive capsular penetration and vascular involvement were observed. Treatment for these patients included surgical intervention followed by radioactive iodine therapy. For more aggressive cancer forms, a combined approach was employed, incorporating additional diagnostic methods to assess distant metastases,

particularly in lymph nodes and lungs. This underscores the importance of a multidisciplinary approach in managing this pathology.

The morphological characteristics of nodules and the overall condition of thyroid tissue directly influenced surgical outcomes and patient prognosis. For instance, colloid nodules, which were benign, typically allowed for uncomplicated surgical resection due to the absence of proliferative changes and fibrosis, facilitating technical ease. In contrast, nodules with high malignant potential – particularly those exhibiting microcalcifications and cellular atypia – required meticulous dissection and wide excision of affected tissues, increasing the risk of damage to surrounding structures. Patients with diffuse toxic goitre, owing to marked thyrocyte hyperplasia and pronounced vascularity, faced elevated intraoperative bleeding risks, necessitating careful vessel coagulation and stringent surgical control.

Malignant tumours, especially papillary and follicular carcinomas, warranted a more radical surgical approach, including total thyroidectomy with potential lymph node dissection. In such cases, tumour morphology – such as capsular invasion and vascular permeation – dictated further treatment strategies, including radioiodine therapy and metastasis monitoring. Patients with autoimmune thyroiditis, characterised by chronic inflammatory changes and significant fibrosis, were at higher risk of intraoperative damage to adjacent tissues, particularly the parathyroid glands and recurrent laryngeal nerves. This demanded delicate surgical techniques and additional measures to preserve functionality. Thus, morphological features determined surgical tactics and directly impacted postoperative recovery and long-term prognosis.

Diagnosis of thyroid disorders formed the basis for therapeutic decision-making. Modern techniques include Doppler ultrasound, CT, and advanced laboratory testing, each contributing unique insights to enhance diagnostic accuracy. Doppler ultrasound (USG) assessed morphological features and vascular patterns, which are critical in inflammatory and nodular pathologies. The mean peak systolic velocity in residual tissue vessels was 23.8 ± 4.2 cm/s, providing an objective measure of vascularisation – a key parameter in autoimmune thyroiditis or diffuse toxic goitre.

In 82% of patients with focal autoimmune thyroiditis, zones of increased blood flow (resistive index RI > 0.75) were identified. This correlated with inflammatory activity, distinguishing active disease from remission. In 35% of cases, elevated perinodular echogenicity reflected fibrotic changes due to chronic pathology or prior surgeries. Doppler imaging also monitored post-operative vascularisation; atypical areas with pathological flow suggested recurrence or malignancy, warranting further investigation.

Contrast-enhanced computed tomography (CT) was preferred for evaluating large nodules and structural changes, particularly when ultrasound yielded limited data. Studies showed that large (>2 cm) nodules with destructive architecture and calcifications were present in 15% of cases. Calcifications often indicated chronicity or malignant potential. Nodule margin enhancement visualised peripheral tissue involvement in 73% of malignant cases, guiding resection boundaries and assessing invasion risks. In thyroid cancer, CT refined TNM staging by evaluating nodal metastases and adjacent organ involvement. It was indispensable for complex cases, such as retrosternal goitre, clarifying anatomical relationships and potential compression of vascular or tracheal structures.

Laboratory diagnostics remained pivotal. A strong positive correlation ($r = 0.68$, $p < 0.01$) was found between elevated blood flow (via Doppler) and anti-TPO levels, implicating autoimmunity in gland dysfunction and justifying comprehensive diagnostics. Regression analysis indicated that patients with diffuse toxic goitre and TSH < 0.1 mIU/L had significantly higher reoperation risks (OR = 2.13; 95% CI 1.35-3.56), highlighting the need for early functional assessment to prevent complications.

Diagnostic methods provide highly accurate tools for a comprehensive assessment of the thyroid gland, particularly in complex or recurrent pathologies. The use of Doppler ultrasound, computed tomography (CT), and advanced laboratory studies significantly enhances diagnostic efficacy, optimises therapeutic strategies, and minimises the risk of repeat surgical interventions. An individualised approach, incorporating these data, forms the foundation of modern patient management for thyroid diseases.

Based on the obtained data, a differentiated approach to selecting surgical techniques has been developed, aiming to maximise thyroid gland functionality preservation and minimise the risk of complications. For nodular formations, partial thyroidectomy is recommended, preserving unaffected thyroid segments to reduce hormonal function loss. The application of intraoperative ultrasound monitoring facilitates the confirmation of complete removal of affected areas and reduces recurrence risk in cases of multiple nodules, ensuring a balance between the patient's functional needs and surgical radicality.

In cases of autoimmune thyroiditis, radical thyroidectomy is justified in the presence of extensive tissue fibrosis or compressive complications such as respiratory or swallowing difficulties. However, in the absence of such factors, organ-preserving surgery with regular patient monitoring should be considered. It is crucial to account for the increased risk of hypoparathyroidism, particularly in long-standing disease cases. For thyroid cancer, total thyroidectomy is recommended as the standard surgical treatment. If regional lymph node involvement is confirmed, additional lymphadenectomy should be performed, with maximal preservation of laryngeal nerve structures and parathyroid glands. In cases where the tumor is inoperable, a multimodal treatment approach, including radioiodine therapy, is the optimal choice.

An analysis of surgical treatment outcomes revealed an overall complication rate of 11%. The most common complications were laryngeal nerve paresis (5%) and hypoparathyroidism (4%). Specifically, among patients with nodular pathology, laryngeal nerve paresis was observed in 3%, and hypoparathyroidism in 2%. In the autoimmune thyroiditis group, laryngeal nerve paresis occurred in 5%, while hypoparathyroidism was recorded in 3%. Patients with diffuse toxic goitre exhibited the highest risk of laryngeal nerve paresis (10%), while hypoparathyroidism was observed in 7%. In the recurrent thyroid cancer group, laryngeal nerve paresis reached 10%, with an equal incidence of hypoparathyroidism (10%) (Table 3).

Table 3. Frequency of complications depending on pathology type and intervention

Parameters	Nodular pathology (n = 54)	Autoimmune thyroiditis (n = 42)	Diffuse toxic goitre (n = 15)	Recurrent cancer (n = 10)
Laryngeal nerve palsy	2 cases	2 cases	2 cases	1 case
Hypoparathyroidism	1 case	1 case	1 case	1 case

Source: compiled by the author

Patients undergoing partial interventions demonstrated significantly lower complication rates compared to those undergoing radical surgeries. The incidence of long-term complications in the radical thyroidectomy group reached 16% (24 cases), exceeding the corresponding rate for partial interventions (7%, or 8 cases, $p < 0.05$). In the partial intervention group, the most common long-term complications included transient vocal cord dysfunction (3%) and mild hypoparathyroidism, which resolved after short-term calcium therapy (2%). Conversely, the radical surgery group exhibited higher rates of permanent hypoparathyroidism (7%) and prolonged voice recovery (6%).

DISCUSSION

Current findings indicate that routine drainage is unnecessary if meticulous hemostasis is achieved during surgery, as supported by the study of Z. Wang *et al*. [14], which associates the omission of routine drainage with improved patient comfort without increasing complication risks. The findings also highlight the positive impact of technological advancements, particularly Doppler ultrasonography, in reducing complications during repeat thyroid surgeries, aligning with data from R.P. Tufano & K.M. Ali [15]. However, complication rates remain high in tertiary interventions due to extensive scar tissue formation, complicating access to critical structures. The authors further note that while emerging technologies mitigate risks, they do not eliminate them entirely, emphasising the need for continued surgical technique refinement.

Studies suggest that external factors, such as prolonged noise exposure, significantly affect thyroid hormone levels, potentially complicating treatment. M. Khosravipour *et al*. [16] demonstrated that chronic noise exposure alters thyroid function, leading to decreased thyroxine levels, which may justify metabolic changes and overall patient health deterioration in endocrine disorders. These factors must be considered when selecting treatment strategies. Current study also confirmed the importance of thorough preoperative evaluation for patients with nodular formations. According to M.H. Usmanova & S.I. Ismoilov [17], optimised diagnostic methods, including fine-needle aspiration biopsy and ultrasound imaging, enhance diagnostic accuracy, thereby improving surgical outcomes.

The study established those intraoperative techniques, such as Doppler ultrasonography, reduce the risk of parathyroid gland injury. This aligns with the conclusions of A. Wong *et al*. [18], who emphasise the significance of novel technologies, particularly optical and fluorescence-guided methods, in improving parathyroid preservation accuracy. However, complication rates remain high in repeat surgeries due to scarring and anatomical variability. The study data also underscore the necessity of thorough preoperative diagnostics, particularly for thyroid gland developmental anomalies. This is corroborated by B. Mettias *et al*. [19], who recommend expanded use of imaging modalities, including CT and MRI, for precise localisation and characterisation of pathological formations before surgery. This study revealed that the use of combined assessment methods for thyroid gland structure reduces intraoperative complications; however, in cases of significant fibrotic tissue remodelling, diagnostic accuracy remains limited. Furthermore, the study by M.S. Demarchi *et al*. [20] underscores the importance of intraoperative parathyroid gland identification to prevent their injury and the development of postoperative hypoparathyroidism. A similar approach is observed in the current study, where considerable attention was given to imaging techniques and meticulous tissue dissection during reoperations, particularly in the presence of scar tissue. Comparable conclusions are presented in the work of F. Medas *et al*. [21], who note an increased risk of recurrent laryngeal nerve and parathyroid gland injury during reoperative procedures.

A comprehensive approach to minimising postoperative complications is based on meticulous planning. For instance, J. Lukinović & M. Bilić [22] stress in their review the importance of optimising surgical techniques and selecting operative strategies according to clinical circumstances, while also noting the high incidence of recurrent laryngeal nerve injury and hypoparathyroidism following reoperative thyroid surgery. In the present study, the incidence of postoperative hypoparathyroidism was slightly higher, which may be attributed to patient selection criteria and surgical methodology.

The obtained results indicate a high recurrence rate of nodular pathology following primary surgical interventions, confirming the need for refinement of surgical strategies [23]. These findings are consistent with the conclusions of Y. Ito *et al*. [24], who emphasise the importance of detailed preoperative planning and risk assessment, particularly in cases of malignant nodules. The high complication rate, including compression of surrounding tissues and recurrent laryngeal nerve injury, necessitates improvements in intraoperative monitoring and the application of imaging techniques. The results also demonstrate the efficacy of preoperative parathyroid hormone level assessment in reducing the risk of hypoparathyroidism, in line with the recommendations of G. Mauri *et al*. [25] regarding the importance of metabolic preparation prior to surgery. At the same time, the observed complication rate following reoperative thyroidectomies was somewhat higher than the data presented by M.D. Poveda *et al*. [26], which may be due to differences in surgical approaches and the availability of intraoperative monitoring technologies. The use of neural monitoring significantly reduces the incidence of recurrent laryngeal nerve injury, as corroborated by both current results and the study of R. Simó *et al*. [27], which demonstrates the efficacy of immediate surgical nerve repair.

The findings demonstrate the efficacy of surgical treatment for recurrent thyroid nodular pathology but also confirm the need to consider minimally invasive alternatives in select cases. The study by E. Papini *et al*. [28] indicates that image-guided ablation techniques, such as laser or radiofrequency ablation, may be effective in treating benign nodules without the need for open surgical intervention. In comparison, current study shows that recurrent nodules more frequently require reoperation due to the risk of malignant transformation, underscoring the necessity of refining preoperative diagnostic approaches, particularly for determining the optimal treatment method at early stages.

An important aspect of the study is the impact of preoperative preparation on reducing complication risks, particularly hypoparathyroidism. The work of C.C. Solórzano *et al*. [29] confirms that near-infrared fluorescence imaging is an effective method for identifying and preserving parathyroid glands during thyroidectomies. The results also showed that patients who underwent detailed preoperative parathyroid hormone assessment had a lower risk of postoperative hypoparathyroidism. The consistency of these findings highlights the need for implementing intraoperative imaging technologies to minimise complication risks.

Diagnosing the malignant potential of nodules is critical for selecting appropriate treatment strategies. The study by M.J. Livhits *et al*. [30] demonstrated that molecular testing significantly improves diagnostic accuracy for indeterminate nodules, reducing the need for unnecessary surgical interventions. Current study found that 38% of patients with recurrent nodules had a high malignancy risk according to TI-RADS, necessitating surgery; however, the absence of molecular testing may have led to excessive surgical intervention. This underscores the necessity of integrating molecular tests into standard diagnostic algorithms to improve preoperative risk stratification and optimise treatment selection. Overall, the results confirm the efficacy of diagnostic and surgical approaches but indicate the need for further research to refine and widely implement these methods, as preoperative diagnostic accuracy remains a key determinant of successful treatment. As noted by P. Seifert *et al*. [31], the application of ultrasonography with standardised protocols significantly enhances the evaluation of thyroid lesions. This study corroborates the utility of such methods for improving diagnostic precision.

Modern thyroidectomy techniques hold significant potential for reducing complication risks. B. Ludwig *et al*. [32] advocate for the adoption of minimally invasive approaches and advanced instrumentation, such as neuromonitoring and haemostatic devices. Similar methods were employed in the present study, with the obtained results confirming their efficacy in reducing the incidence of recurrent laryngeal nerve injury and haemorrhage. The study by J.J.V. Branca *et al*. [33] underscores the importance of meticulous evaluation of thyroid gland vascular anatomy, particularly in the context of surgical interventions. The work analyses variations in glandular vascular supply, including anatomical anomalies of arteries and veins that may complicate surgical access. The data from this study corroborate the critical role of precise vascular anatomy mapping in ensuring safe thyroidectomy execution and preventing intra- and postoperative bleeding. Identification of vascular anatomical variants enables surgeons to optimise access planning and apply appropriate haemostatic techniques.

In summary, the study findings align with current scientific evidence and reaffirm the necessity of an integrated approach to planning and performing reoperative thyroid surgery. Consideration of technical, anatomical, and individual patient characteristics contributes to reduced complication rates and enhanced treatment efficacy. A limitation of this study was its retrospective design, which precludes accounting for potential interpatient variability and generalising results to atypical clinical cases. Further prospective studies employing larger cohorts and advanced imaging technologies could substantially refine these conclusions.

CONCLUSIONS

The study of patients requiring reoperative thyroid surgery confirmed a significant female predominance (94.2%), consistent with established epidemiological trends for thyroid pathologies. The mean patient age was 47.6 ± 12.4 years. The primary indications for reoperation were progress ive nodular disease (45%) and focal autoimmune thyroiditis (34.7%). The malignant recurrence rate was 8.3%, underscoring the importance of adequate initial surgery and subsequent monitoring. Recurrent thyroid nodules (62%) were predominantly benign, though 38% exhibited high malignancy risk. Core needle biopsy remained the key diagnostic modality for nodule characterisation. In autoimmune thyroiditis (AIT) patients, anti-TPO antibody titres were significantly elevated (78%), correlating with Doppler ultrasonographic blood flow alterations ($r = 0.68$, $p < 0.01$). These parameters proved valuable for disease activity monitoring and thyroid status assessment. In the Graves' disease cohort (12.4%), surgery was necessitated by thyrotoxicosis refractory to medical therapy and compressive symptoms from gland enlargement. Recurrent cancer (8.3%) was predominantly papillary carcinoma (70%), diagnosed at early stages (TNM I-II), demonstrating the efficacy of prima ry surveillance in preventing disease progression.

Complication risks escalated with successive operations. All patients undergoing third reoperations exhibited substantial scar tissue, complicating surgical access and increasing recurrent laryngeal nerve injury rates (13.3%). Ultrasonography (US and Doppler), CT, and laboratory assessments (anti-TPO, anti-Tg antibodies) were pivotal for evaluating disease activity, delineating residual tissue margins, and planning reinterventions. These modalities reduced operative complication risks in 87% of cases. The conducted analysis underscores the importance of adapted approaches in thyroid surgery. Standardised protocols require expansion and the consideration of individual clinical and anatomical characteristics of patients to reduce the risk of recurrences and complications. The obtained results confirm the feasibility of an individualised treatment approach, which decreases the incidence of postoperative hypocalcemia and nerve injuries.

The appropriateness of drainage application in the postoperative area plays a crucial role in preventing postoperative complications, facilitating faster patient recovery, and reducing the risk of repeated surgical interventions. Timely diagnosis, precise planning of revision surgeries, and the use of instrumental diagnostic methods

significantly improve treatment outcomes, particularly in the context of multistage surgical interventions. The study's limitations include a restricted patient sample within each pathology subgroup, which affects the statistical reliability of certain conclusions. Future research may focus on investigating the long-term consequences of surgical interventions and developing criteria for predicting individual complication risks.

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Показання до реоперативних операцій на щитоподібній залозі: застосування сучасних методів діагностики

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Анотація. Метою даного дослідження було розробити системний підхід до вибору показань до реоперативних операцій на щитовидній залозі із застосуванням сучасних методів діагностики для об'єктивної оцінки стану залози та навколишніх тканин. Проведено ретроспективний аналіз даних 121 пацієнта, які проходили лікування з 2000 по 2024 роки, включаючи клінічні, лабораторні та інструментальні обстеження. Когорту переважно складали жінки (94,2 %) із середнім віком 47,6 року. Реоперації переважно проводилися з приводу прогресуючої вузлової патології (45 %) та вогнищевого фіброзу при аутоімунному тиреоїдиті (34,7 %), тоді як злоякісне переродження пухлини спостерігалося у 8,3 % випадків. Більшість вузликів були доброякісними (62 %), але 38 % демонстрували високий ризик злоякісності відповідно до системи звітності та даних візуалізації щитовидної залози (TI-RADS). У пацієнтів з аутоімунним тиреоїдитом підвищені рівні антитіл корелювали зі змінами допплерометрії ($r = 0,68$; $p < 0,01$), що служило маркером активності захворювання. Повторні операції мали високий ризик ускладнень, особливо у пацієнтів, яким проводили треті втручання, де повторне пошкодження гортанного нерва через рубцеву тканину виникало в 13,3 % випадків. Використання ультразвукового дослідження, комп'ютерної томографії, допплерографії та тонкоголкової аспіраційної біопсії знизило частоту ускладнень на 87 % завдяки точному визначенню анатомічних змін і патологічних процесів. Результати підкреслюють необхідність стандартизованих протоколів для покращення хірургічних результатів, які відповідають міжнародним рекомендаціям щодо моніторингу захворювань щитовидної залози та ранньої діагностики

Ключові слова: вузлова патологія щитоподібної залози; вогнищеві ущільнення аутоімунного тиреоїдиту; ультразвукова доплерографія; комп'ютерна томографія; тиреотропний гормон