

LONG-TERM OUTCOMES OF VARIOUS VOLUMES OF SURGICAL INTERVENTIONS FOR MULTINODULAR EUTHYROID GOITER

DOI: 10.35805/BSK2025IV003

Saidova F.K.,
<https://orcid.org/0000-0002-9511-7927>Shahsuvarov O.M.,
<https://orcid.org/0000-0003-3734-5320>Huseynov R.H.,
<https://orcid.org/0000-0000-1413-2248>Alakbarova S.I.,
<https://orcid.org/0009-0002-2164-6487>Mayilova A.A.,
<https://orcid.org/0009-0008-5383-032X>Muradov N.F.,
<https://orcid.org/0000-0002-4839-5764>

Saidova F. Kh., Shakhshvarov O.M., Huseynov R.H.,
Alakbarova S.I., Mayilova A. A., Muradov N.F.

Scientific Center of Surgery named
after M.A. Topchubashov, Baku, Azerbaijan

received: 11.11.2025
accepted: 21.11.2025

Author for correspondence:

Saidova F.K.

Doctor of Medical Sciences,
Professor, Head of the Department of
Endocrine Surgery,
Scientific Center of Surgery
named after M.A. Topchubashov,
Baku, Azerbaijan.

E-mail: farida.s.x@mail.ru
ORCID: <https://orcid.org/0000-0002-9511-7927>
Phone: +994 50 337 27 67

Conflict of interest:

The authors declare that there are no
conflicts of interest.

Keywords:

multinodular euthyroid goiter,
thyroidectomy, hemithyroidectomy,
hypothyroidism, recurrence.

Abstract

Background: The objective of the study was to evaluate the long-term results of various volumes of surgical intervention for multinodular euthyroid goiter.

Material and methods: The study involved 235 patients with multinodular euthyroid goiter who underwent surgical treatment. Of these, 76 (32.3%) patients with bilateral multinodular goiter underwent total thyroidectomy, 72 (30.6%) with bilateral multinodular euthyroid goiter underwent subtotal thyroidectomy, 35 (14.9%) with bilateral multinodular euthyroid goiter underwent Dunhill operation, and 52 (22.1%) individuals with unilateral multinodular euthyroid goiter underwent hemithyroidectomy. The age of the patients ranged from 20 to 77 years. Among them, 218 (92.7%) were women and 17 (7.2%) were men.

Results: The recurrence rate after subtotal thyroidectomy was 23.6%, after Dunhill operation was 11.4%, and after hemithyroidectomy was 11.5%. The quality of life for patients after hemithyroidectomy was significantly better: 78.8% of individuals with multinodular euthyroid goiter did not require the burden of constant hormonal therapy. Postoperative hypothyroidism was noted in 21.2% of patients who underwent hemithyroidectomy for unilateral multinodular euthyroid goiter. Patients in this group received a minimally reduced dose of levothyroxine compared to other groups of individuals ($40.9 \pm 5.1 \mu\text{g}$) ($p < 0.001$).

Conclusions: Thus, performing hemithyroidectomy for unilateral multinodular euthyroid goiter represents the optimal volume of surgical intervention. However, the final choice of procedure should be a joint decision between the surgeon and the patient, made with consideration of individual risk factors for recurrence and postoperative hypothyroidism.

Introduction

Thyroid pathology ranks second in terms of prevalence among endocrine diseases worldwide and is observed in 6% of the population.¹ The majority of them are patients with nodular goiter.² Ultrasound examinations in apparently healthy adults indicate that thyroid nodules may be detected in 50–60% of individuals, most of which are benign, asymptomatic, and do not require treatment.³

One of the essential methods for treating nodular pathology is surgery, which has been refined in recent years with the introduction of new technologies and has become safer. The concept of nodular goiter involves the presence of nodules in the TG tissue, either a sin-

gle nodule (uninodular) or several nodules (multinodular), which necessitates the performance of various volumes of surgical intervention. If a single benign nodule is present, hemithyroidectomy (HT) and sufficient completion of the thyroidectomy is considered necessary. For multinodular benign goiter, the question of the volume of surgical intervention remains debatable to this day.^{1,4,5,6} Until the end of the last century, subtotal thyroidectomy (ST) was considered the surgery of choice for this pathology. However, the recurrence rate after its performance was high—up to 41.2%.^{7,8} This ultimately prompted surgeons to transition to performing more radical volumes of surgery: total or near-total thyroidec-

tomy (TT).⁹⁻¹¹ The subsequent increase in the number of publications related to parathyroid insufficiency,¹⁰ and recurrent laryngeal nerve injury.¹² Highlights the serious side effects caused by total thyroidectomy, such as hypocalcemia, myocardial damage, and atrial fibrillation.^{13,14} Hypothyroidism, considering that hormonal therapy requires regular monitoring, represents a crucial complication for many patients. Even the fact of daily morning medication intake is burdensome for patients.

In light of the above, the performance of hemithyroidectomy in unilateral multinodular TG pathology is currently being discussed. The advantage of this volume of surgery is that it theoretically allows for the avoidance of replacement therapy with levothyroxine, and in the event of recurrence, the risk of complications after a repeat operation is reduced, since the contralateral lobe remains untouched during the primary surgery.⁵

Research aim is evaluate the long-term results of various volumes of surgical intervention for multinodular euthyroid goiter.

Material and methods

235 patients with multi nodulareuthyroid goiter (MNEG) were studied, who underwent surgical treatment. Of these, 76 (32.3%) patients with bilateral MNEG underwent total thyroidectomy, 72 (30.6%) with bilateral MNEG underwent subtotal thyroidectomy, 35 (14.9%) with bilateral MNEG underwent Dunhill operation (OD), and 52 (22.1%) individuals with unilateral MNEG underwent hemithyroidectomy. The age of the patients ranged from 20 to 77 years. Among them, 218 (92.7%) were women and 17 (7.2%) were men. Was performed

hormones levels TG and pituitary (T4 free and TSH), as well as ultrasound of the TG, and fine-needle aspiration biopsy (FNAB) when necessary.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and Helsinki declaration and its later amendments or comparable ethical standards. This study was approved by the Institutional Review Board of the Scientific Center of Surgery named after M.A. Topchubashov (Approval No: 77; Dated: 08.10.2025).

Statistical analysis. For the comparison of continuous variables between independent groups, parametric and non-parametric statistical approaches were applied as appropriate. Between-group comparisons were assessed for numerical variables, and the Chi square test and Fisher's exact test were used for categorical variables. $P \leq 0.05$ was considered statistically significant. Analysis of main risk factors for recurrent and the corresponding causal relationship was evaluated by calculating the odds ratio (OR).

Results

Let us consider each group of operated patients with MNEG separately. 107 patients with bilateral MNEG were examined, including 72 (67.3%) who underwent subtotal thyroidectomy and 35 (32.7%) who underwent Dunhill operation. The age of the patients ranged from 20 to 70 years. Among them, there were 101 (94.4%) women and 6 (5.6%) men (Table 1). Gender analysis showed that the risk of relapse in women is 3.47 times higher than in men, p value = 0.403.

		Young & middle-aged			Elderly		Total	OR	95%CI	P value
		19-30	31-40	41-50	51-60	61-70				
Male	n	-	1	4	-	1	6	3.47	[0.2;64.1]	0.403
	Recurrence	-	-	-	-	-	-			
Female	n	8	20	30	23	20	101			
	Recurrence	1	1	4	9	6	21			

Table 1. Characteristics of patients with MNEG who underwent ST and OD

Type of surgery	ST	5	10	23	21	13	72	2.40	[0.7;7.7]	0.145
	Recur- rence	1	1	3	8	4	17			
	OD	3	11	11	2	8	35			
	Recur- rence	-	-	1	1	2	4			
Dura- tion (years)	up to 5	3	14	8	6	8	39	3.44	[0.9;12.4]	0.05*
	Recur- rence	1	-	-	1	1	3			
	6 or >	5	7	26	17	13	68			
	Recur- rence	-	1	4	8	5	18			
* P value < 0.05 statistically significant; ST - Subtotal thyroidectomy; OD - Dunhill operation										

With an increase in the volume of surgery, the frequency of MNEG recurrence decreases: after performing ST, it was 23.6% (n=17), and after OD, it was 11.4% (n=4). The Odd ratio (OR) of recurrence after ST is 2.4 times higher than after OD, p value = 0.145. Furthermore, the recurrence rate increases with the age of the patients and the duration of follow-up: recurrences are more often observed in patients older than 50 years (34%) and after 6 years of postoperative follow-up (28.1%) (Table 1). Since the development of recurrence requires a certain amount of time, it must be assumed that in patients operated at a young age, unlike older patients,

the possibility of recurrence development exists. Characterizing the recurrent nodules, it should be noted that less than 2 cm in size were observed in 9 (42.8%) of patients, less than 3 cm in 9 (42.8%) of patients, and only in 3 (14.3%) of patients were they larger than 3 cm. The risk of relapse increases after 6 years or more by 3.44 times than in the first 5 years, statistically significant, p value = 0.05. The group of patients who underwent TT included 76 patients with bilateral MNEG, aged 20 to 77 years. Their characteristics by sex, age, duration of follow-up after surgery, and postoperative replacement therapy are shown in Table 2.

Table 2.
Characteristics of
patients with bilateral
MNEG who underwent
TT

Age	N	Sex		Duration of follow-up (years)				Hormonal status		
		Male	Fe- male	1-2	3-5	6-10	11 and more	Euthy- roid	Hypo thyroid	Hiper Thy- roid
19-30	4		4	3	-	1	-	2	1	1
31-40	13		13	3	4	4	2	7	5	1
41-50	21		21	4	4	10	2	10	10	1
51-60	19	1	18	6	6	7	-	11	7	1
61 and more	19	1	18	5	8	4	3	15	3	1
Total %	76	2 (2.6%)	74 (97.4%)	21 (27.6%)	22 (28.9%)	26 (34.2%)	7 (9.2%)	45 (59.2%)	26 (34.2%)	5 (6.6%)

Age (years)	N	Sex		Duration of follow-up / years			Levotiroksin intake		Hormonal status		HT	
		Male	Fe- male	1-3	4 - 5	6 - 10	Done	Not done	Nor- mal	Sub- clin hypo- thyroid	Left	Right
19-30	10		10	1	7	2	2	8	8	2	4	6
31-40	10	1	9		6	4	1	9	8	2	4	6
41-50	16	4	12		11	5	2	14	14	2	7	9
51-60	10	3	7	1	6	3	3	7	9	1	4	6
61 and more	6	1	5	1	4	1	3	3	3	3	3	3
Total (%)	52	9 (17.3%)	43 (82.7%)	3 (5.8%)	34 (65.4%)	15 (28.8%)	11 (21.2%)	41 (78.8%)	42 (80.7%)	10 (19.2%)	22 (42.3%)	30 (57.7%)
HT - Hemithyroidectomy												

Table 3.
Characteristics of
patients with unilateral
MNEG who
underwent HT

As seen from Table 2, the predominant majority of examined patients were women (97.4%), aged 41 years and older (75%). The largest number of patients (34.2%) was observed during 6-10 years after the surgical intervention.

More than was evaluated the long – term results of surgical treatment of 52 patients with unilateral MNEG (aged 20 to 65 years). The characteristics of these patients are presented in Table 3.

As shown in Table 3, the predom-

inant majority of patients were women (82.7%), aged 41-50 years (30.8%). Almost all patients (94.2%) were followed up for 4 to 10 years. Two or more nodules or a conglomerate of nodules were located in the right lobe in 57.7% of cases, and in the left lobe in 42.3%.

A comparison of replacement therapy levels in MNEG patients who underwent various volumes of surgery is presented in Table 4.

Patient group	Levothyroxine dose, µg	P value (TT)	P value (ST+OD)
TT, n=76	120.1±3.9 (50-200)	-	-
ST+OD, n=107	99.6±4.9 (50-200)	<0.001	-
HT-MNEG, n=52	40.9±5.1 (25-75)	<0.001	< 0.001
TT- Total thyroidectomy; ST - Subtotal thyroidectomy; OD - Dunhill operation; HT - hemithyroidectomy			

Table 4.
Levels of replacement
therapy in MNEG pa-
tients who underwent
various volumes of sur-
gical intervention (M±m)

As seen from Table 4, the highest doses of levothyroxine are necessarily taken by patients who underwent TT, and approximately 2.5 times lower doses are taken by patients who underwent ST and OD, and three times lower doses are taken by patients who underwent hemithyroidectomy compared to patients who underwent CT and OD.

Discussion

Lin YS *et al.* compared four different volumes of surgical intervention (total thyroidectomy, Dunhill operation, subtotal thyroidectomy, and hemithyroidectomy) for multinodular goiter. The recurrence rate was highest with ST (21.6%), but only 1.8% of patients required a repeat operation.¹⁵ According to the data from this study, only 5% of patients with goiter

required repeat surgery.¹⁰ In our study, only 4 (5.5%) patients who underwent ST and had recurrence were presumed to require a repeat surgical intervention. Indications for surgery were: symptoms of compression, nodule size greater than 3 cm, conclusion of cytological examination corresponding to category *Betesda* IV. Recurrences that developed after OD were clinically insignificant. In our study, the role of a hereditary factor in the development of recurrence was confirmed: cases of repeated TG involvement were noted among 14 (66.7%) of patients with recurrence. Other authors, evaluating family history, did not find significant differences between the overall examined group and the group of individuals with MNEG recurrences.¹ Literature data on

the role of replacement therapy in the development of nodular goiter recurrences are contradictory. Some authors believe that patients with MNEG require careful and individually selected replacement therapy in the postoperative period, since postoperative hypothyroidism is the driving force behind the development of nodular goiter recurrences.^{16,17} Other authors report that levothyroxine replacement or suppression therapy does not effectively prevent recurrence in patients with multinodular euthyroid goiter.^{18,19} Postoperative replacement therapy was prescribed to all patients who underwent ST and OD. As a result of the examination, the patients were divided into 3 groups. The first group – 60 (56.1%) patients – took levothyroxine in a replacement dose, regularly attended consultation with the treating physician. The second group – 31 (28.9%) patients – did not take levothyroxine, did not attend the necessary consultations, and did not regularly check the TSH level, due to the fact that their TSH levels were above the reference range during the examination. The third group consisted of 16 (14.9%) patients who took levothyroxine irregularly, with interruptions and without controlling the TSH level. Among patients with MNEG recurrences, 33.3% were individuals who took levothyroxine in the required dose, 66.7% were those who did not take or took levothyroxine in an insufficient dose; 4 (19.1%) patients took it in an insufficient dose, being in a state of hypothyroidism. The literature emphasizes the role of lymphocytic infiltration in the development of postoperative hypothyroidism and MNEG recurrence.^{20,21} After all, this activity reflects the activity of immune disorders that are a risk factor for the development of postoperative hypothyroidism, leading to recurrence.²¹ In our study, lymphocytic infiltration of the TG tissue was observed in 8 (38.1%) patients with recurrences.

Analysis of the hormonal background in patients who underwent TT, revealed that 59.2% who were taking levothyroxine were in a euthyroid state; 40.8 % of patients were not compensated: some of them did not take levothyroxine at all or took it irregularly, others took it in an inadequate dose (34.2%) were hypothyroid, 6.6% were hyperthyroid. In this regard, when complaints were presented, they

reported a mass of complaints: weakness, bone pain, dry skin, hair loss, palpitations, irritability, etc.

The above indicates that patients in the postoperative period irregularly and reluctantly visit the endocrinologist and the operating surgeon. In patients with multinodular euthyroid goiter who present with bilateral nodules, total thyroidectomy is frequently recommended to minimize the risk of recurrence and to avoid the need for re-operation.¹⁴ However, there are patients with asymmetric multinodular goiter, in whom several nodules or a conglomerate of nodules are located in one lobe and a share of the isthmus. Recurrence rates after hemithyroidectomy for multinodular goiter have been reported to range from 5% to 34%, and recurrence is strongly associated with the length of postoperative follow-up.¹⁵ Recurrence can be subclinical, which occurs in most cases and is determined by ultrasound as new foci (more 5 mm) in the contralateral lobe of the thyroid gland even after primary surgery, or it can be clinically obvious in the form of a palpable nodule. Currently, hemithyroidectomy in this group of patients is a controversial and relevant issue. The reason for its performance is the low recurrence rate and postoperative hypothyroidism (23% and 31%, respectively).²²

In our research postoperative replacement therapy (levothyroxine) was received by 11 (21.2%) patients with unilateral MNEG, 5 of whom received a dose of 50 µg, 5 received 25 µg, and 1 received 75 µg. Of these, 72.7% had lymphocytic infiltration of the TG tissue and 63.6% had a hereditary gene for the disease. Postoperative hypothyroidism was found in 21.2% of patients, which is consistent with the data of other authors.²³⁻²⁵ Follow-up duration of 6 (11.5%) patients developed recurrence, and in all cases, a nodule with a diameter up to 1cm emerged, with a subclinical nature, revealed by ultrasound. Recurrences developed more often at a young age (up to 40 years), after 6 years of surgery in patients with a hereditary gene for the disease and those in a state of subclinical hypothyroidism. The recurrence rate after hemithyroidectomy for unilateral MNEG and after the Dunhill operation is practically identical (11.5% and 11.4%),

but in the former case, a larger volume of functioning TG tissue is preserved.

Limitations. This study has several limitations. First, its retrospective design and single-center setting may restrict the generalizability of the findings. Second, the variability in follow-up duration among patients may have influenced the observed rates of recurrence and postoperative hypothyroidism.

What's Known? Multinodular euthyroid goiter is a common thyroid disorder, and the optimal extent of surgical intervention remains a matter of debate. Total and subtotal thyroidectomy reduce recurrence risk but are associated with higher rates of postoperative complications and life long hormone dependence. Hemithyroidectomy has been proposed as a less radical alternative for selected patients, yet long-term outcomes remain insufficiently clarified.

What's New? Our analysis provides new evidence that hemithyroidectomy offers favorable long-term outcomes for patients with unilateral multinodular euthyroid goiter, demonstrated in lower recurrence rates and significantly reduced dependence on life long hormone replacement compared with more extensive surgical approaches. The study also highlights key risk factors influencing postoperative hypothyroidism and recurrence, including age, follow-up duration, hereditary predisposition, and lymphocytic infiltration, thereby refining patient selection criteria and decision-making in surgical management.

Conclusions

The frequency of MNEG recurrences after subtotal thyroidectomy was 23.6%, after the *Dunhill* operation was 11.4%, and after hemithyroidectomy was 11.5%. The quality of life of patients after hemithyroidectomy was significantly better: 78.8% of individuals with MNEG did not require the burden of constant hormonal therapy. Patients in

this group with hypothyroidism received a minimally reduced dose of levothyroxine compared to patients who underwent TT, CT, and OD (40.9 ± 5.1 mcg ($p < 0.001$)). Postoperative replacement therapy is insufficiently effective: 66.7% of MNEG patients with recurrences who underwent ST either did not take levothyroxine at all or took it in an insufficient dose, and 66.7% of individuals with recurrences after unilateral MNEG were in a state of subclinical hypothyroidism. Risk factors for the development of postoperative MNEG hypothyroidism include a hereditary gene for the disease, lymphocytic infiltration of the TG tissue, and duration of follow-up. Risk factors for the development of MNEG recurrence include young age of the patient, presence of replacement therapy, presence of a hereditary gene for the disease, duration of follow-up, and presence of lymphocytic infiltration. Performing hemithyroidectomy for unilateral MNEG is the optimal volume of surgical intervention. However, the final choice of procedure should be a joint decision between the surgeon and the patient, made with consideration of individual risk factors for recurrence and postoperative hypothyroidism.

Acknowledgments: The authors declare that they have no acknowledgments.

Author Contributions: S.F., Sh.O.: conceived the study and developed the research design; H.R., A.Sh., M.A.: contributed to data collection, clinical evaluation, and verification of patient records; M.N., Sh.O.: performed the statistical analysis and assisted in data interpretation; S.F.: drafted the initial manuscript; H.R., M.A., A.Sh.: critically revised the text for important intellectual content. All authors reviewed and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

Funding. None.

References

1. Makay O. Less than total thyroidectomy for goiter: when and how? *Gland Surg.* Dec 2017;6(Suppl 1):S49-S58. doi:10.21037/gs.2017.10.02
2. AlSaedi AH, Almalki DS, ElKady RM. Approach to Thyroid Nodules: Diagnosis and Treatment. *Cureus.* Jan 2024;16(1):e52232. doi:10.7759/cureus.52232
3. Roy M, Ghander C, Bigorgne C, et

- al. An update on management of cytologically indeterminate thyroid nodules. *Ann Endocrinol (Paris)*. Apr 2025;86(2):101711. doi:10.1016/j.ando.2025.101711
4. Sengul I, Sengul D. The 2023 Bethesda system for reporting thyroid cytopathology: novi sub sole, subdivision is no more debatable, in thyroidology. *Rev Assoc Med Bras (1992)*. 2023;69(12):e20231124. doi:10.1590/1806-9282.20231124
5. Bharath S, Yadav SK, Sharma D, et al. Total vs less than total thyroidectomy for benign multinodular non-toxic goiter: an updated systematic review and meta-analysis. *Langenbecks Arch Surg*. May 19 2023;408(1):200. doi:10.1007/s00423-023-02941-1
6. Lee YB, Kim JY, Cho H, et al. Modified Bethesda system informing cytopathologic adequacy improves malignancy risk stratification in nodules considered benign or atypia(follicular lesion) of undetermined significance. *Sci Rep*. Sep 10 2018;8(1):13503. doi:10.1038/s41598-018-31955-9
7. Alwadi F, Alessa M, Abdulkarim Alamer E, et al. Risk of malignancy in thyroid nodules Bethesda III sub classification into nuclear atypia and architectural atypia. A retrospective study. *Saudi Med J*. Apr 2025;46(4):425-428. doi:10.15537/smj.2025.46.4.202040805
8. Yoldas T, Makay O, Icoz G, et al. Should subtotal thyroidectomy be abandoned in multinodular goiter patients from endemic regions requiring surgery? *Int Surg*. Jan 2015;100(1):9-14. doi:10.9738/INTSURG-D-13-00275.1
9. Boutzios G, Tsourouflis G, Garoufalia Z, Alexandraki K, Kouraklis G. Long-term sequelae of the less than total thyroidectomy procedures for benign thyroid nodular disease. *Endocrine*. Feb 2019;63(2):247-251. doi:10.1007/s12020-018-1778-y
10. Gharib H, Papini E, Garber JR, et al. American Association of Clinical Endocrinologists, American College of Endocrinology, and Associazione Medici Endocrinologi Medical Guidelines for Clinical Practice for the Diagnosis and Management of Thyroid Nodules--2016 Update. *Endocr Pract*. May 2016;22(5):622-39. doi:10.4158/EP161208.GL
11. Ross DS, Burch HB, Cooper DS, et al. 2016 American Thyroid Association Guidelines for Diagnosis and Management of Hyperthyroidism and Other Causes of Thyrotoxicosis. *Thyroid*. Oct 2016;26(10):1343-1421. doi:10.1089/thy.2016.0229
12. Sorensen JR, Lauridsen JF, Dossing H, et al. Thyroidectomy Improves Tracheal Anatomy and Airflow in Patients with Nodular Goiter: A Prospective Cohort Study. *Eur Thyroid J*. Nov 2017;6(6):307-314. doi:10.1159/000480348
13. Deshmukh H, Papageorgiou M, Aye M, England J, Abdalla M, Sathyapalan T. Hyperthyroidism and bone mineral density: Dissecting the causal association with Mendelian randomization analysis. *Clin Endocrinol (Oxf)*. Jan 2021;94(1):119-127. doi:10.1111/cen.14330
14. Li X, Zhang T, Zhang H, Liu S, Tian L. Effects of levothyroxine therapy on bone and mineral metabolism in hypothyroidism: a systematic review and meta-analysis. *BMC Endocr Disord*. Jan 14 2025;25(1):11. doi:10.1186/s12902-024-01819-7
15. Lin YS, Wu HY, Yu MC, Hsu CC, Chao TC. Patient outcomes following surgical management of multinodular goiter: Does multinodularity increase the risk of thyroid malignancy? *Medicine (Baltimore)*. Jul 2016;95(28):e4194. doi:10.1097/MD.00000000000004194
16. Apostolou K, Paunovic I, Frountzas M, et al. Posthemithyroidectomy Hypothyroidism: Updated Meta-Analysis of Risk Factors and Rates of Remission. *J Surg Res*. Jan 2024;293:102-120. doi:10.1016/j.jss.2023.08.020
17. Al-Hakami HA, Kouter DA, Alsharef JF, et al. Total Thyroidectomy Versus Partial Thyroidectomy for Non-Toxic Multinodular Goiter: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Indian J Surg Oncol*. Dec 2024;15(4):920-930. doi:10.1007/s13193-024-02057-y
18. Shakir MKM, Brooks DI, McAninch EA, et al. Comparative Effectiveness of Levothyroxine, Desiccated Thyroid Extract, and Levothyroxine+Liothyronine in Hypothyroidism. *J Clin Endocrinol Metab*. Oct 21 2021;106(11):e4400-e4413. doi:10.1210/clinem/dgab478
19. Chen Q, Su A, Zou X, et al. Clinicopathologic Characteristics and Outcomes of Massive Multinodular Goiter:

- A Retrospective Cohort Study. *Front Endocrinol (Lausanne)*. 2022;13:850235. doi:10.3389/fendo.2022.850235
20. Beisa V, Kazanavicius D, Skrebutinas A, Simutis G, Ivaska J, Strupas K. Prospective analysis of risk for hypothyroidism after hemithyroidectomy. *Int J Endocrinol*. 2015;2015:313971. doi:10.1155/2015/313971
21. Cao Z, Liu R, Wu M, Xu X, Liu Z. Risk factors for thyroid hormone replacement therapy after hemithyroidectomy and development of a predictive nomogram. *Endocrine*. Apr 2022;76(1):85-94. doi:10.1007/s12020-021-02971-z
22. Kaya S, Yuksek MO, Sari R, Altin O, Sikar H, Kucuk H. Is hemithyroidectomy sufficient in unilateral benign nodular goitre? *Minerva Endocrinol (Torino)*. Dec 2021;46(4):406-412. doi:10.23736/S2724-6507.20.03203-4
23. Ahn D, Sohn JH, Jeon JH. Hypothyroidism Following Hemithyroidectomy: Incidence, Risk Factors, and Clinical Characteristics. *J Clin Endocrinol Metab*. Apr 2016;101(4):1429-36. doi:10.1210/jc.2015-3997
24. Babu RP, Christy A, Hegde A, Manjrekar P, D'Souza V. Do premenopausal hypothyroid women on levothyroxine therapy need bone status monitoring? *Clin Med Insights Womens Health*. 2015;8:1-6. doi:10.4137/CMWH.S22114
25. Bolat H, Erdogan A. Benign nodules of the thyroid gland and 25-hydroxy-vitamin D levels in euthyroid patients. *Ann Saudi Med*. Mar-Apr 2022;42(2):83-88. doi:10.5144/0256-4947.2022.83