RESEARCH ARTICLE

CYPRUS
JOURNAL OF MEDICAL SCIENCES

DOI: 10.4274/cjms.2020.1749
Cyprus J Med Sci 2021;6(Suppl 1):1-6

Comparison of Cost, Risks, and Benefits of Robotic or Open Thyroidectomy on Thyroid Cancer

Hasan Zafer Acar[1], Ayşe Ülgen[2]

[1]Department of General Surgery, Girne American University Faculty of Medicine, Kyrenia, Cyprus
[2]Department of Biostatistics, Girne American University Faculty of Medicine, Kyrenia, Cyprus

Abstract

BACKGROUND/AIMS: This study aimed to raise awareness of the cost, risk, and benefits of robotic thyroidectomy (RT) and open thyroidectomy (OT) when deciding on the surgical method for thyroid cancer.

MATERIALS and METHODS: Complications, benefits, duration of operation, costs, and other risk factors in thyroid cancer cases, including robotic and OT of large case series followed up for a long time were comparatively analyzed, and results were evaluated.

RESULTS: The comparison of obtained results after a 5-year follow-up revealed significantly higher costs, operative times, and postoperative morbidity rates in RT than OT. The satisfaction of patients in cosmetic terms was higher in RT.

CONCLUSION: Our study results revealed that necessary outside logistics support, a necessary significant amount of operating room extra machines and materials, low patient circulation rate, and the medico-legal problems may arise, and we think that RT decision should be taken under limited conditions in thyroid cancers.

Keywords: Robotıc, thyroidectomy, risks, benefits, cost

INTRODUCTION

Robotic surgery was first used in 1985 to perform the biopsy in the field of brain surgery. Afterward, it has become widely used worldwide, especially in prostate cancer cases.[1] Robotic thyroid surgery has been extensively used in the Far East in the last 20 years;[2] but not in western countries. Since the time of Nobel Prize-winning scientist Theodor Kocher, one of the pioneers of modern surgery, open thyroid surgery has been successfully implemented in many countries worldwide without major changes.

Considering the basic criteria in surgical method selection for cases with surgical indication, such as cost, risk, and advantages,[3] robotic thyroidectomy (RT) and open thyroidectomy (OT) were compared in our study. Therefore, this study aimed to increase the awareness of the surgeons when deciding on the surgical method for thyroid cancers. Additionally, ethical and medico-legal problems that may arise in the selection of operations were evaluated.

MATERIALS and METHODS

Our study evaluated the breast, axillar, bilateral axillary breast, and facelift approaches within the scope of RT. Standard classical thyroidectomies that were not performed by remote control were evaluated as OT.

To cite this article: Acar HZ, Ülgen A. Comparison of Cost, Risks, and Benefits of Robotic or Open Thyroidectomy on Thyroid Cancer. Cyprus J Med Sci 2021;6(Suppl 1):1-6

ORCID iDs of the authors: H.Z.A. 0000-0001-6435-8720; A.Ü. 0000-0002-0872-667X

Address for Correspondence: Hasan Zafer Acar
E-mail: hzacar@gmail.com
ORCID ID: orcid.org/0000-0001-6435-8720

Received: 24.01.2020
Accepted: 30.04.2020

Long-term follow-up and RT and/or OT studies, which consisted of a large number of cases compared the reported results with each other and statistically evaluated and revealed the cost, risk, and advantages. Criteria used to evaluate the advantages and risk factors include operative time, morbidity rates, recurrence rates, and cosmetic results.

Studies conducted by Cabot et al.[4], by Broom et al.[5], and in Turkey[6] compared the RT and OT costs and statistically evaluated results.

Russel et al.[7] conducted a study of total thyroidectomy in 216 RT and 419 OT cases, Lee et al.[8] in 68 RT and 110 OT cases, Kim et al.[9] in 69 RT and 138 OT cases, and Christine et al.[10] in 25 RT and 25 OT cases undergoing lobectomy, wherein mean operation times were compared and results were statistically evaluated.

The morbidity rate in 4751 patients who underwent RT in the study of Kim et al.[11] in the same institute, 1503 patients who underwent OT by Sciuto et al.[12] in the same institute, and 40,025 thyroid cancer cases by Caulley et al.[13] were compared and results were statistically evaluated.

Seul and et al.[14] conducted a study in 245 RT and 494 OT cases, Kim et al.[15] in 41 RT and 102 OT cases, and Billmoriave et al.[16] in 10,247 OT cases, wherein results were compared and statistically evaluated.

The study results of Lee et al.[17] in 66 OT and 62 RT cases and of Kyung et al.[18] in 75 RT and 226 OT cases were compared and statistically evaluated.

Statistical Analysis

Independent t-test between the samples at the α=0.01 level of significance was performed for large samples and the Wilcoxon-Rank-Sum test for samples of <30. Standard deviations and sample sizes were obtained from reference articles and t-statistics, and two-sided *p*-values were obtained for significance. When standard deviations were not given, range values (R) were used to estimate the standard deviation by using s = (max − min)/4.

Ethics Committee Approval

Ethics committee approval was received for this study from Girne American University Ethics Committee (approval date: 01.13.2020, approval number: 2020-009).

RESULTS

The results that compare the obtained data from the publications in which the costs were determined in RT and OT cases are presented (Table 1).

Table 1 shows the comparison of the costs in cases with RT or OT. A significant difference was determined in the cost between RT and OT (p <0.0001) in all cases; RT cases being significantly more costly compared to OT cases.

The results of the comparison of the mean operation times in the reported publications of RT and OT cases are shown in Table 2.

Table 2 shows the mean operation times compared in the reported publications of RT and OT cases. The RT times are significantly longer than that of OT in all cases.

Table 1. Comparison of costs in DTC cases with RT or OT

Study	Cost	RT	OT	*p*-value
Cabot[4]	Total cost	$13.670 ± $1384	$9.028 ± $891	<0.0001*
Broom[5]	Relative cost	$5.795	$2.668	<0.0001*
Turkey SUT + RA[6]	Relative cost	₺ 28.000	₺ 1.200	<0.0001*

DTC, Differentiated thyroid cancer; SUT, Turkey's Health Ministry communiqué health implementations; RA, Robotic arm; OT, Open thyroidectomy; RT, Robotic thyroidectomy; * statistically significant.

Table 2. Comparison of operation times in patients with RT and OT

Study	Type of operation	Mean surgical time RT (min)	Mean surgical time OT (min)	*p*-value
Russell[7]	Total thyroidectomy	170 (n=216) (R=398–100)	126.5 (n=410) (R=260–51)	<0.0001*
Lee H[8]	Total thyroidectomy	141.4±36.35 (n=68)	95.4±23.69 (n=110)	<0.0001*
Kim[9]	Total thyroidectomy	196 (n=69)	81 (n=138)	-
Christine[10]	Lobectomy	121 (n=25) (R=74–199)	68 (n=25) (R=41–112)	<0.0001*

OT, Open thyroidectomy; RT, Robotic thyroidectomy; *statistically significant.

Morbidity rates in patients with thyroid cancer undergoing RT and OT are shown in Table 3.

Table 3 shows the comparison of morbidity rates in patients with thyroid cancer undergoing RT and OT. The morbidity rates between the two groups were significantly different from each other, and morbidity rates were significantly higher in the RT group compared to the OT group.

Recurrence rates in patients who were followed for >5 years and underwent robotic total thyroidectomy (RTT) and open total thyroidectomy (OTT) (Table 4).

Table 3. Comparison of morbidity rates in patients with thyroid cancer undergoing RT and OT

Study	RT MR	OT MR	*p*-value
Kim[11]	24.1 (n = 4751)	-	<0.0001*
Sciuto[12]	-	12.6 (n=1503)	<0.0001*
Caulley[13]	-	7.74 (n = 40.025)	-

MR, Morbidity rate; OT, Open thyroidectomy; RT, Robotic thyroidectomy; *statistically significant.

Table 4 shows the recurrence rates in patients with thyroid cancer undergoing RTT and OTT. Results show no statistically significant differences between RTT and OTT in recurrence rates.

The comparison of cosmetic results of RT and OT is shown in Table 5.

Table 5 shows the comparison of cosmetic results in RT and OT cases. A significant difference was seen between the RT and OT cases, wherein RT cases were significantly more satisfied compared to OT cases.

The advantages and disadvantages of RT compared to OT in thyroid cancer cases (Table 6).

DISCUSSION

OT surgeries can be performed together with support staff with basic operating room knowledge and experience in all hospitals that can provide second-degree health services that do not require advanced technological logistic support. The patient can be taken to surgery immediately after surgical indication and complete routine preparations. RT operations require

Table 4. Recurrence rates in patients with thyroid cancer undergoing RTT and OTT

Study	Type of surgical tumor size	RT rec. rate (%)	OT rec. rate (%)	*p*-value
Seul GI[14]	Total, <1 cm	1.2 (n=245)	1.2 (n=494)	0.991*
Kim M[15]	Total, <1 cm	2.4 (n=41)	2.9 (n=102)	0.869*
Bilimoria[16]	Total, <1 cm	-	1.0 (n=10.247)	0.734*

RTT, Robotic total thyroidectomy; Rec rate, Recurrence rate; OT, Open thyroidectomy; RT, Robotic thyroidectomy; OTT, Open total thyroidectomy; Type of op., Type of operation; *statistically insignificant.

Table 5.

	Exteremely satisfied (1)		Satisfied (2)		Acceptable (3)		Dissatisfied (4)		Exteremely dissatisfied (5)		*p*-value
Study	OT	RT	OT	RT	OT	RT	OT	RT	OT	RT	
Lee et al.[17]	22	46	26	10	10	6	5	0	3	0	<0.0001*
Posop 6th month:	OT (n=66); RT (n=62)										
Kyung et al.18											<0.01
Posop 3rd month:	OT (n=226) 3.00+1.04; RT(n=75) 1.61+0.87										

OT, Open thyroidectomy; RT, Robotic thyroidectomy; *statistically significant.

Table 6. Advantages and disadvantages of RT according to OT in thyroid cancer cases

Advantages	Disadvantages
• Better cosmetic results	• Higher cost • Longer operation time, more dissection, more bleeding • Higher morbidity rates • The patient circulation process is long and cumbersome • Extra complications (such as drowsiness in the breast skin) • Medico-legal problems

RT, Robotic thyroidectomy; OT, Open thyroidectomy.

operator and support staff that passed the course with sufficient knowledge and experience.[19]

RT operations require approximately 3 million USD investments in operating theaters.[20]

Once these machines are supplied, establishing relations with companies for every logistic need before each operation is necessary. This situation makes the patient's circulation significantly difficult and cumbersome.[21]

The comparison of OT and RT surgery costs revealed a significant difference (Table 1). The robotic arm payment that needs to be changed in each operation is approximately ₺ 3,000. This charge is not payable by the National Insurance Institution (SGK).[6] SUT prices in OT operations are ₺ 1,200 in Turkey. It can be done with operating room materials in medium-sized hospitals without any extra logistic requirements. Hospitals, where RT surgeries can be performed, have quite high operating costs apart from the need for extra logistics and is approximately ₺ 25,000.[22] The evaluation of both surgical methods in "cost, risk, and benefits" revealed that RT was disadvantageous in "cost" compared to the OT.

Operation times under general anesthesia significantly increase morbidity. Myocardial infarction, renal failure, thromboembolic complications, arrhythmia, atelectasis, and other pulmonary complications can occur in the postoperative period. A meta-analysis conducted by Cheng et al.[23] revealed that an increased postoperative complication rate by 14% with every half-hour increased operation time. The comparison of operating times in RT and OT in patients with thyroid cancer revealed a significantly higher RT time than OT (Table 2). RT cases undergoing total thyroidectomy have approximately 40 min longer operating times. Few studies have reported a statistically insignificant difference between the cases with RT and OT.[24] The number of studies with higher operation times in RT is more.[7,8,10,19] According to these study results, longer operation times seem to be a major disadvantage of RT.

Postoperative morbidity rates were considered as an important risk factor in determining the surgical methods for thyroid cancers. Among the studies performed on RT and OT in thyroid cancers, especially those with a high number of cases were included in this study. The comparison of the morbidity rates in RT and OT cases revealed that morbidity rates are higher in RT cases (Table 3). The study conducted by Kim et al., where the largest case series with RT in thyroid cancers have been published so far, revealed the average morbidity rate of 24.1. Cases that were followed up for an average of 52.5 months were divided into 4 periods and revealed that morbidity rates were 25.8 in the first period, 23.2 in the second period, and 29.5 in the third period, which reduced to 14.7% in end-stage patients with 964 cases.[11] However, a large series of 40,025 cases with OT thyroid cancer cases published by Caulley et al. revealed an average of 7.74 morbidity rate.[13] There are small case series where the difference between the morbidity rates in heterogeneous patient groups performed RT and AT is meaningless.[7]

One of the most important reasons for higher postoperative complications in thyroid cancer cases with RT may be the longer operation time.[22] The high amount of dissection in RT causes more bleeding.[21] Comparative studies revealed significantly more bleeding in patients who performed RT than those who had OT.[8,21,25] Although not seen in cases with OT, some complications are seen in RT cases such as spinal accessory nerve palsy,[11] hypoglossus injury,[25] numbness in the brachial plexus distribution (breast skin) on the operation side,[10] induration due to dissection under the breast skin and suspicious image in related mammography,[21] and Horner syndrome.[11] The comparison of morbidity rates revealed that RT is riskier.

Some factors affected the recurrence rates in thyroid cancers, especially papillary thyroid cancers (PTC) are likely to be multicentric (MC) tumor and is approximately 20%.[26] Cervical lymph node metastases and tumor recurrence rates are high in MC PTCs.[27] Recurrence rates of tumors were higher in PTC cases with BRAFV600E mutation.[28] Results of studies in large differential thyroid cancer (DTC) series revealed increased recurrence rates after age 45 years and in males.[29] Tumor diameter is an important factor in increasing recurrence rates in differentiated thyroid cancers. Recurrence rates increase after the operation in cases of >1 cm.[30]

The series of thyroid cancer cases in our study with RT and followed for >5 years are very few. Current studies revealed no statistically significant difference between the recurrence rates in patients with RT of <1 cm in diameter and patients with RT and OT in thyroid cancer cases (Table 4). Many cases that are considered recurrences in thyroid cancers reported no relapse but residual tissue.[31] Considering approximately 20% of DTC cases are MC, thyroid cancers should remove all the thyroid tissue.[32] Removing the tissue completely by harmonic dissection especially at the level of the Zuckerkandl protrusion in RT is very difficult.[21] Recurrence rates were investigated in some non-homogeneous patients with DTC who underwent RT and OT and are followed for <5 years and revealed no significant differences.[9,32] Many studies compared RT and OT surgeries and do not recommend RT in risky cases because it increases morbidity and recurrence rates.[19,24] When risky patients are separated, the patient group suitable for RT decreases.

Mortality rates could not be compared as a risk factor in both surgical methods since the absence of case series in which 10 years of follow-up was reported in patients undergoing RT.

RT and OT studies that compared the results related to cosmetic satisfaction after the operation revealed a significantly higher

patient satisfaction in patients with RT (Table 5). This situation is an advantage in favor of RT. In patients who underwent OT without lateral neck dissection, scarring is avoided if incisions are made with the appropriate surgical technique parallel to the skin lines.[33] Thus, if the patient does not want any scar tissue on his neck, the higher risks of RT surgery than OT should be clearly explained to the patient for ethical reasons.[21] However, even if the patient prefers RT, it should be kept in mind that medical problems that may arise since RT may cause legal and criminal problems, despite the detailed consent form.

The advantages and disadvantages of RT are collectively shown in Table 6. According to these results, the only advantage of RT seems to be better cosmetic results.

CONCLUSION

According to our study results, RT decisions should be taken under limited conditions in thyroid cancers based on necessary outside logistic support, a significant amount of operating room extra machines and materials, low patient circulation rate, and the medico-legal problems that may arise.

Main Points

• RT is a new surgical method whose long-term follow-up results are unclear.

• RT is several times more expensive than OT and requires specialized personnel who are relatively trained, thus cannot be performed in every hospital.

• Operation time is significantly longer in RT than OT. Therefore, postoperative complication rates are higher than OT.

• RT has no obvious superiority over OT. When an appropriate operation technique is applied, very few scars remain in the neck in OT. Even without a scar on the patient's neck, numbness can occur on the breast skin, as well as stiffness under the breast skin, which may give false-positive results in future mammograms for tumor risk assessments.

• A patient who does not want any scar on her neck and if she insists on RT surgery, risks of RT should be clearly explained before surgery for medico-legal reasons.

ETHICS

Ethics Committee Approval: Ethics committee approval was received for this study from Girne American University Ethics Committee (approval date: 01.13.2020, approval number: 2020-009).

Informed Consent: It was obtained.

Peer-review: Externally peer-reviewed.

Author Contributions

Concept: H.A.; Design: H.A.; Supervision H.A.; Resources: H.A.; Data Collection and/or Processing: H.A.; Analysis and/or Interpretation: A.Ü.; Literature Search: H.A.; Writing: H.A.; Critical Review: H.A.

DISCLOSURES

Conflict of Interest: The authors declare no conflicts of interest.

Financial Disclosure: The authors declared no financial support for this study.

REFERENCES

1. Lane T. A short history of robotic surgery. *Ann R Coll Surg Engl*. 2018;100:5-7.
2. Kyung T, Yong BJ, Chang MS, et al. Robotic and endoscopic thyroid surgery: evolution and advances. *Clin Exp Otorhinolaryngol*. 2019;12:1-11.
3. McPherson K, Bunker JP. Costs, Risks and Benefits of Surgery: a milestone in the development of health services research. *JR Soc Med*. 2007;100:387-390.
4. Cabot JC, Lee CR, Brunaud L, et al. Is robotic thyroidectomy too expensive for routine use in the US? *Surgery*. 2012;152:1016-1024.
5. Broome JT, Pomeroy S, Solorzano CC. Expense of robotic thyroidectomy: a cost analysis at a single institution. *Arch Surg*. 2012;147:1102-1106.
6. 3 bin TL'ye DaVinci! Sağlık haberleri www.habertürk.com sağlık. Available at: https://www.haberturk.com/saglik/haber/653608-3-bin-tlye-da-vinci
7. Russell J, Razavi CR, Garstka ME, et al. Remote-access thyroidectomy: a multi-institutional North American experience with transaxillary, robotic facelift, and transoral endoscopic vestibular approaches. *J Am Coll Surg*. 2019;228:516-522.
8. Lee JH, YiJ W, Kim Y. Comparison of transoral endoscopic and open surgery in thyroid cancer by single surgeon. *European J Surg Oncol*. 2019;45:E2. doi: https://doi.org/10.1016/j.ejso.2018.10.107
9. Wan W, Kim JS, Kim S, et al. Is robotic surgery superior to endoscopic and open surgeries in thyroid cancer? *World J of Surg*. 2011;35:779-784.
10. Christine S, Landry MD, Elizabeth G, et al. Robot-assisted transaxillary thyroid surgery in the United States: is it comparable to open thyroid lobectomy? *Ann of Surg Oncol*. 2012;19:1269-1274.
11. Kim MJ, Nam KH, Lee SG, et al. Yonsei experience of 5000 gasless transaxillary robotic thyroidectomies. *World J Surg*. 2018;42:393-401.
12. Sciuto R, Romano L, Rea S, et al. Natural history and clinical outcome of differentiated thyroid carcinoma: a retrospective analysis of 1503 patients treated at a single institution. *Ann of Oncol*. 2009;20:1728-1735.
13. Caulley L, Johnson-Obaseki S, Luo L, et al. Risk factors for postoperative complications in total thyroidectomy: A retrospective, risk-adjusted analysis from the National Surgical Quality Improvement Program. *Medicine*. 2017;96:5752.
14. Lee SG, Lee J, Kim J, et al. Long-term oncologic outcome of robotic versus open total thyroidectomy in PTC: a case-matched retrospective study. *Surg Endosc*. 2016;30:3474-3479.
15. Kim MJ, Lee J, Lee SG, et al. Transaxillary robotic modified radical neck dissection: a 5-year assessment of operative and oncologic outcomes. *Surg Endosc*. 2017;31:1599-1606.
16. Bilimora KY, Bentrem DJ, Ko CY, et al. Extent of surgery affects survival for papillary thyroid cancer. *Ann Surg*. 2007;246:381-384.

17. Lee J, Kwon IS, Bae EH, et al. Comparative analysis of oncological outcomes and quality of life after robotic versus conventional open thyroidectomy with modified radical neck dissection in patients with papillary thyroid carcinoma and lateral neck node metastases. *J Clin Endoc Metab*. 2013;98:2701-2708.

18. Kyung T, Yong BJ, Seok HC, et al. Early surgical outcomes of robotic thyroidectomy by a gasless unilateral axillo-breast or axillary approach for papillary thyroid carcinoma: 2 years' experience. *Head Neck*. 2012;34:617-625.

19. Berber E, Bernet V, Fahey TJ, et al. American thyroid association statement on remote-access thyroid Surgery. *Thyroid*. 2016;26:331-337.

20. Türkiye'de 21 ameliyathanede robot cerrah bulunuyor – Hürriyet. www.hurriyet.com.tr › Ekonomi Haberleri. Available at: https://www.hurriyet.com.tr/ekonomi/turkiye-de-21-ameliyathanede-robot-cerrah-bulunuyor-25225265

21. Perrier ND: Why I have abandoned robot-assisted transaxillary thyroid surgery. *Surgery*. 2012;152:1025-1026.

22. Türkiye'de ilk kez robotik cerrahi ile izsiz tiroid ameliyatı. https://www.medimagazin.com.tr › guncel › genel › tr-turkiyede-ilk-kez-r. Available at: https://www.medimagazin.com.tr/guncel/genel/tr-turkiyede-ilk-kez-robotik-cerrahi-ile-izsiz-tiroid-ameliyati-basariyla-gerceklestirildi-11-681-77729.html

23. Cheng H, Cleimer JW, Chen BPH, et al. Prolonged operative duration is associated with complications: a sistematic review and meta-analysis. *J Surg Res*. 2018;229:134-144.

24. Meghan G, Khuzema M, Daniah BA, et al. Well-differentiated thyroid cancer and robotic transaxillary surgery at a North American institution. *J Surg Res*. 2018;228:170-178.

25. Suk WA, Kyung HK. Hypoglossal nerve palsy following the robotic thyroidectomy for the papillary thyroid carcinoma: a case report. *Int J Surg Case Rep*. 2015;14:133-135.

26. Zhang XJ, Yang T, Li SH, et al. Multicentric papillary thyroid carcinoma. *Int J Clin Exp Pathol*. 2016;9:5680-5686.

27. Al AA, Williams BA, Rigby MH, et al. Multifocal papillary thyroid cancer increases the risk of central lymph node metastasis. *Thyroid*. 2015;25:1008-1012.

28. Xing M, Alzahrani AS, Carson KA, et al. Association between BRAF V600E mutation and recurrence of papillary thyroid cancer. *J Clin Oncol*. 2015;33:42-50.

29. Wenvu DK, Horiuchi H, Tokumitsu A, et al. Time-varying pattern of mortality and recurrence from papillary thyroid cancer: lessons from a long-term follow-up. *Thyroid*. 2019;29:802-808.

30. Hundahl SA, Fleming ID, Fremgen AM, et al. A National Cancer Data Base report on 53,856 cases of thyroid carcinoma treated in the U.S., 1985-1995. *Cancer*. 1998;83:2638-2648.

31. Bates MF, Lamas MR, Randle RW, et al. Back so soon? – Is early recurrence of Papillary Thyroid Cancer really just persistent disease? *Surgery*. 2018;163:118-123.

32. Lee S, Lee CR, Lee SC, et al. Surgical completeness of robotic thyroidectomy: a prospective comparison with conventional open thyroidectomy in papillary thyroid carcinoma patients. *Surg Endosc*. 2014;28:1068-1075.

33. Acar H. Editor. Tiroid ve Paratiroid Cerrahisi. Ankara. Birinci baskı. Art yayıncılık; 2011. ISBN: 978-605-61078-0-1, p: 209.