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Remote-Access Thyroidectomy: A Multi-Institutional North American Experience with Transaxillary, Robotic Facelift, and Transoral Endoscopic Vestibular Approaches

Jonathon O Russell, MD, **Christopher R Razavi, MD**, **Meghan E Garstka, MD**, **Lena W Chen, BA**, **Elya Vasiliou, MD**, **Sang-Wook Kang, MD**, **Ralph P Tufano, MD, MBA, FACS**, and **Emad Kandil, MD, FACS**

Department of Otolaryngology-Head and Neck Surgery, Johns Hopkins University School of Medicine, Baltimore, MD (Russell, Razavi, Chen, Vasiliou, Tufano) and Division of Endocrine Surgery, Department of Surgery, Tulane University Medical Center, New Orleans, LA (Garstka, Kang, Kandil).

Abstract

BACKGROUND: Many remote-access approaches (RAAs) to the thyroid have been described to circumvent anterior neck scarring, including the transaxillary, robotic facelift, and transoral endoscopic vestibular approaches. These techniques have been popularized in Asia, but adoption has been slow in North America. We aimed to examine multi-institutional North American outcomes with RAA thyroidectomy in the context of these institutions' transcervical approach (TCA) outcomes.

STUDY DESIGN: Cases of lobectomy and total thyroidectomy via transaxillary, robotic facelift, and transoral endoscopic vestibular approaches were reviewed. Demographic characteristics, outcomes, and complications were compared with the same measures in patients undergoing lobectomy and total thyroidectomy via TCA by the primary RAA surgeons at each institution. Patients who underwent parathyroidectomy or other concomitant neck dissection procedures were excluded.

RESULTS: Two hundred and sixteen RAA thyroidectomies were attempted (92 transoral endoscopic vestibular approaches, 70 transaxillary, and 54 robotic facelift) and 410 TCA thyroidectomies were performed. There was no difference in mean index nodule sizes between RAA (2.8 ± 1.6 cm) and TCA (2.9 ± 1.9 cm) cohorts ($p = 0.72$). Median operative times for

Correspondence address: Jonathon O Russell, MD, Department of Otolaryngology-Head and Neck Surgery, The Johns Hopkins School of Medicine, Johns Hopkins Outpatient Center, 601 N Caroline St, 6th Floor, Baltimore, MD 21287. jrusse41@jhmi.edu.

Author Contributions

Study conception and design: Russell, Kang, Tufano, Kandil

Acquisition of data: Razavi, Garstka, Chen, Vasiliou

Analysis and interpretation of data: Russell, Razavi, Garstka, Chen, Vasiliou, Kang, Tufano, Kandil

Drafting of manuscript: Russell, Razavi, Garstka, Chen, Vasiliou, Kang, Tufano, Kandil

Critical revision: Russell, Razavi, Garstka, Chen, Vasiliou, Kang, Tufano, Kandil

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lobectomy were 146 minutes (range 60 to 343 minutes) and 90 minutes (range 25 to 247 minutes) for the RAA and TCA cohorts, respectively ($p < 0.0001$). Median operative time for total thyroidectomy was 170 minutes (range 100 to 398 minutes) vs 126.5 minutes (range 51 to 260 minutes) for the RAA and TCA cohorts, respectively ($p < 0.0001$). There was no difference in the rates of permanent recurrent laryngeal nerve injury between the RAA (0 of 216 [0%]) and TCA (0 of 410 [0%]) cohorts ($p = 0.99$).

CONCLUSIONS: Remote-access approach thyroidectomy can be performed in a select North American patient population with outcomes comparable with TCA.

Surgical techniques and approaches have undergone significant refinement and reformation in an effort to reduce morbidity and mortality during the last 100 years. These include the introduction of laparoscopic and robotic techniques that have allowed for more complex procedures through smaller incisions.[1,2] In contrast, thyroid operations have remained largely stagnant, with the overwhelming majority of these procedures still being performed via an anterior-cervical incision first described by Kocher.[3] This is despite the finding that an anterior-cervical neck scar can negatively impact patient quality of life, regardless of the severity of the scar.[4,5] Although one might assume this is due to the lack of other safe and feasible techniques, this is not the case, as several remote-access approaches (RAAs) to thyroid procedures have been described with good success.[6–19]

These RAA procedures have gained favor internationally, particularly in Asia, but the same cannot be said in North America.[10,11] Some have postulated that this is due to differences in the patient populations, with the larger body habitus of the North American cohort often cited as a confounding factor.[8,10,19] Others have suggested that the surgical indications in the Asian cohort are more amenable to the use of these RAA techniques.[10,17] Given this divergent experience between continents and concerns about the generalizability of the robust Asian RAA outcomes, there is a need for multi-institutional North American data with these approaches. In addition, as outcomes with the transcervical approach (TCA) to the thyroid continue to be perfected, this RAA experience must be presented in the context of the TCA data, in an increasingly value-based North American healthcare market.[20] Here we present outcomes with 3 widely used RAA techniques—the robotic-assisted facelift (RF) approach, robotic-assisted transaxillary approach (TA), and the transoral endoscopic thyroidectomy vestibular approach (TOETVA)—from 2 high-volume North American thyroid centers in the context of their TCA outcomes.

METHODS

Cases of RF, TA, and TOETVA performed at the Johns Hopkins Medical Institution and Tulane University Medical Center were retrospectively reviewed from December 1, 2012, to June 29, 2018. Demographic characteristics, outcomes, and complications were collected. For the purposes of this study, only cases of thyroid lobectomy and total thyroidectomy were included for analysis. Additionally, cases where other concomitant procedures, such as parathyroidectomy, central/lateral neck dissection, or Sistrunk operations, were performed were excluded to maintain homogeneity of the data. The overwhelming majority of these cases were completed by 2 high-volume thyroid surgeons (one from each institution) with fellowship training in head and neck endocrine surgery. As such, the RAA data were then

compared with the TCA outcomes from these 2 surgeons between 2015 and 2018 at their respective institutions. In a similar fashion, only cases of thyroid lobectomy and total thyroidectomy were included for review, again with exclusion of those cases with other concomitant procedures.

All included patients met criteria for thyroid lobectomy or total thyroidectomy based on the current American Thyroid Association guidelines at the time of operation.[21,22] Patients included in the RAA cohort were offered these procedures based on selection criteria described previously.[19,23–26] In a broad sense, these included those with a thyroid lobe <10 cm in patients highly motivated to avoid an anterior-cervical scar. Cytopathologically benign and indeterminate nodules and patients with Graves' disease were considered for surgical candidacy. Similarly, select patients with T1 well-differentiated thyroid carcinoma were offered RAA. Of note, given inherent limitations accessing the contralateral lobe with the RF technique, patients opting for or requiring initial total thyroidectomy were not routinely offered RF. Operative technique for RF, TA, and TOETVA have been described previously in detail by our group and in the literature.[12,17,19,23,27]

Non-parametric independent data between the cohorts were compared with the Mann-Whitney U test, and differences in means of parametric outcomes were compared using an unpaired *t*-test. Fisher's exact test was used to compare categorical data. Analysis was performed in Stata Statistical Software, release 15 (StataCorp) using an α of 0.05 for statistical significance. IRB approval was obtained from both Johns Hopkins University School of Medicine and Tulane University Medical Center.

RESULTS

Two-hundred and sixteen RAA (54 RF, 70 TA, and 92 TOETVA) cases were completed compared with 410 TCA cases in the reviewed periods at these institutions. An additional 33 remote-access cases were excluded from the RAA cohort based on the criteria described, that is, these cases included concomitant parathyroid or neck dissection procedures. All TOETVA cases and 20 RF cases were completed at Johns Hopkins Medical Institution, and the remaining RAA cases were completed at Tulane University Medical Center. Of the 216 RAA cases, 169 (78%) were lobectomies (21 completion thyroidectomies) and 47 (22%) were total thyroidectomies. In the TCA cohort, 240 (59%) were lobectomies (93 completion thyroidectomies) and 170 (41%) were total thyroidectomies. Women represented the majority in both cohorts, but there was a significantly higher proportion of women in the RAA cohort (94% vs 75%; $p < 0.0001$). Mean age was younger for the RAA cohort (43.9 ± 12.1 years vs 53.5 ± 14.7 years; $p < 0.0001$). Similarly, mean BMI of the RAA cohort was lower (27.4 ± 5.9 kg/m^2 compared with 31.7 8.3 kg/m^2 for the TCA cohort; $p < 0.0001$). There was no difference in mean index nodule size between RAA and TCA cohorts (Table 1).

Two-hundred and fifteen of 216 (99.5%) RAA cases were completed via the intended approach. One TOETVA lobectomy was converted to TCA after superior pole bleeding was encountered that could not be controlled transorally. This case was completed without recurrent laryngeal nerve (RLN) injury, or other complication, in 123 total minutes with the

patient discharged to home on the day of operation. This case was not included in calculation of median operative time for the RAA or TCA cohorts.

No patients in either the RAA or TCA cohorts had permanent (deficits lasting >3 months) RLN injury (0 of 216 vs 0 of 410; p = 0.99). There was also no significant difference in rate of temporary RLN injury between RAA (7 of 216 [3.2%]) and TCA (6 of 410 [1.5%]) cohorts (p = 0.15). All cases of temporary RLN injury had evidence of recovery of true vocal fold function on flexible fiberoptic laryngoscopy within 3 months. Median time to recovery across all 13 cases was 18.5 ± 24.9 days (range 7 to 82 days). No patients had permanent hypoparathyroidism in the RAA (0 of 68 [0%]) or TCA (0 of 263 [0%]) cohorts (p = 0.99) (Table 2). Permanent hypoparathyroidism was defined in the at-risk population (total and completion thyroidectomies) based on biochemical parameters with a duration lasting >6 months.[28] On subgroup analysis of RAA techniques, there was no significant difference in rates of temporary or permanent RLN injury, and similarly, no significant differences in rates of permanent hypoparathyroidism (Table 3).

With regard to RAA technique-specific complications, there was no incidence of permanent (deficits lasting >3 months) mental nerve injury or CO_2 embolism in the TOETVA subgroup. Similarly, there was no incidence of brachial plexus injury in the TA subgroup. Notably, somatosensory evoked potential monitoring was used during all TA cases as a tool to prevent this complication as has been described previously.[29] One of 54 patients in the RF subgroup required sacrifice of a small branch of the great auricular nerve to facilitate dissection. Therefore, only 1 of 216 (0.5%) patients in the RAA cohort had a complication specific to their respective RAA technique. There were no postoperative neck infections in the RAA cohort, regardless of technique. There was no significant difference in rate of hematoma between the cohorts, with an incidence of 3 of 216 (1.4%) vs 1 of 410 (0.2%) in the RAA and TCA cohorts, respectively (p = 0.12) (Table 2). Though, all postoperative hematomas occurred in the RF subgroup, which reached statistical significance compared with TOETVA (p = 0.048), but not TA (p 0.08) (Table 3). There was no statistically significant difference in rate of seromas with an incidence of 5 of 216 (2.3%) vs 2 of 410 (0.5%) in the RAA and TCA cohorts, respectively (p 0.051). Similarly, there was no difference in seroma rate between any RAA subgroups, with 3 cases of seroma in the RF cohort, 2 cases in the TA cohort, and 1 case in the TOETVA cohort (Table 3). All seromas were managed with outpatient aspiration without need for a subsequent operative procedure.

Median operative time (incision to closure) for RAA lobectomies was 146 minutes (range 60 to 343 minutes), significantly longer than the TCA cohort, which had a median operative time of 90 minutes (range 25 to 247 minutes) (p < 0.0001). Similarly, median total thyroidectomy operative time in the RAA cohort was significantly longer than the TCA cohort; 170 minutes (range 100 to 398 minutes) vs 126.5 minutes (range 51 to 260 minutes) (p < 0.0001). When performing a subgroup analysis among RAA techniques, both TA (139 minutes; p < 0.0001) and TOETVA (126 minutes; p < 0.0001) were significantly faster than RF (179 minutes) in performing thyroid lobectomy. However, there was no significant difference in operative time between TA and TOETVA for lobectomy or total thyroidectomy. No analysis was performed comparing RF with the other RAA techniques for total thyroidectomy, given only 1 such case was performed via RF (Table 3). One-hundred and

nine of 169 (64%) RAA lobectomies were discharged on the day of operation, and 44 of 47 (94%) RAA total thyroidectomies were discharged to home on postoperative day 1 or sooner.

DISCUSSION

Although multiple international studies have demonstrated the safety and efficacy of RAA in thyroid surgery, there has been a paucity of North American case volume and, therefore, literature.[8,10,11,15,30–32] Early North American experiences with RAA were marked by complications not encountered with TCA.[7,23,33] These were attributed, in part, to dissection planes, which were unfamiliar to most thyroid surgeons, but also to differing patient characteristics in the Asian cohort, such as BMI and index nodule size.

The RAA cohort had a significantly higher proportion of women and patients undergoing lobectomies compared with the TCA cohort. In addition, the RAA cohort was younger and BMI was lower than in the TCA cohort. These findings are not surprising, given that these RAA techniques are only offered to a highly selected patient population, though criteria have begun to expand.[10,24,25] It is important to note that there was no significant difference in mean index nodule size between cohorts.

The largest study to date describing the South Korean TA experience by Ban and colleagues[8] reported a mean nodule size of 0.66 cm. In contrast, the RAA cohort in our series had a mean nodule size of 2.8 cm, more than 4 times larger, and consistent with the typical North American thyroid cohort. Additionally, mean BMI in our RAA cohort was 27.5 kg/m^2 compared with 22 kg/m^2 reported by Ban and colleagues. Despite this discrepancy, outcomes and complications were commensurate between our RAA cohort and this series mentioned. More importantly, outcomes and complications were not significantly different between our RAA and TCA cohorts. There was no difference in rate of permanent RLN injury, permanent hypoparathyroidism, or postoperative hematoma, and only 1 of 216 (0.4%) patients had a complication specific to the RAA technique. Notably, this complication was a deliberate sacrifice of a small branch of the great auricular nerve during flap elevation in the RA subgroup, as opposed to an unintentional iatrogenic injury. Additionally, there was also no significant difference in rate of temporary RLN injury between RAA and TCA cohorts. This finding might suggest the ability of these RAA techniques to perform fine dissection of the RLNs in addition to their identification and preservation.

Previous studies have proposed that characteristics inherent to TOETVA might allow for enhanced visualization and protection of the RLNs.[34] The TOETVA allows for visualization of the bilateral RLNs at their insertion points, a view familiar to experienced thyroid surgeons. In addition, the approach allows for a favorable angle of dissection along the nerve. These hypotheses have held true in our TOETVA cohort, with no permanent RLN injuries to date. Similarly, the robotic-assisted RAA techniques provide a magnified view of critical anatomy, and the wristed instrumentation facilitates safe dissection of the RLNs. This allowed for preservation of all RLNs in our cohort of robotic-assisted techniques. We believe these benefits with the RAA techniques are maximized only after the learning curves

for these techniques have been met, and important to consider is that the learning curves for the robotic-assisted techniques, including RF and TA, are notably longer than TOETVA. Studies estimate a learning curve of 35 to 50 cases for robotic-assisted RAA techniques vs 7 to 11 cases for TOETVA.[16,17,19,35–37]

There was a significant difference in operative time between the RAA and TCA cohorts. Consistent with earlier literature, RAA techniques were found to have longer operative times for both thyroid lobectomy and total thyroidectomy.[10,11,16] Among the RAA techniques, RF was found to take significantly longer than both TA and TOETVA, and there was no significant difference in operative time between TA and TOETVA on subgroup analysis (Table 3).

In our series, we found that RF takes significantly longer than the other RAA techniques, only allowing for adequate ipsilateral lobe access, and with a higher rate of postoperative hematoma (3 of 54 [5.6%] vs 0 of 162 [0%]; $p = 0.015$). As such, both institutions have moved away from this technique in favor of TA and TOETVA, respectively. Importantly, these trends in outcomes seen with RF at our institutions might be related to our respective case volumes in relation to the learning curve for the procedure, as others have reported favorable outcomes with the technique.[6,11,19]

Although the RAA outcomes are in the context of a significantly smaller BMI than the TCA cohort, the mean BMI of 27.4 kg/m^2 is on par with the US national average of 28.7 kg/m^2 as per a 2012 study.[38] This suggests that our RAA cohort is an appropriate reflection of the North American patient population with regard to body habitus. In addition, both TA and TOETVA were successfully used to perform thyroidectomy in patients with BMI >40 kg/m^2 without complication. Future studies are needed to examine how BMI might affect case complexity and therefore operative time and complication rate via these RAA techniques.

Moving forward, we might understand that differences in outcomes between North American and Asian series observed initially were due to the lower case volume and differing levels of progress on the learning curves of these procedures, rather than inherent differences in patient population. As RAA techniques gain favor in North America once again, particularly with the recent interest in TOETVA, it is important that we maintain a framework for educating surgeons and institutions on the learning curves and ideal methods for successfully performing these techniques.[25,35]

Ultimately, although this study demonstrates that these procedures can be performed safely, their widespread adoption will be dependent on the value they can provide, particularly in our current healthcare climate. Although cost is a frequent concern with these RAA techniques, other factors, such as quality of life outcomes and patients' willingness to pay to avoid cervical incisions, must be considered in determining value.[39] We understand that, similar to TCA, cost can be minimized when these RAA cases are performed by high-volume surgeons and centers.[40] In addition, as experience continues to grow with these techniques—particularly TOETVA, given its relative infancy and the fact that it does not use a surgical robot—we may see an additional decrease in operative time and, subsequently, cost.[35]

CONCLUSIONS

The RAA thyroidectomy is safe and feasible in a North American patient population when performed by high-volume head and neck endocrine surgeons, with no significant differences in rates of RLN injury or hypoparathyroidism compared with TCA. Although there is an associated increase in operative time with these RAA techniques, they can ultimately provide healthcare value in the appropriately selected patient and with the appropriate high-volume surgical teams. Accordingly, RAA approaches, particularly TA and TOETVA, are reasonable surgical options for thyroidectomy in a select North American patient population wishing to avoid an anterior-cervical scar.

Abbreviations and Acronyms

RAA	remote-access approach
RF	robotic-assisted facelift approach
RLN	recurrent laryngeal nerve
TA	transaxillary approach
TCA	transcervical approach
TOETVA	transoral endoscopic thyroidectomy vestibular approach

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Table 1.

Demographic Characteristics of the Remote-Access Approach and Transcervical Approach Cohorts

Variable	Remote-access approach	Transcervical approach	p Value
Lobectomy, n/N (%)	169/216 (78)	240/410 (59)	<0.0001 *
BMI, kg/m^2, mean ± SD	27.4 ± 5.9	31.7 ± 8.3	<0.0001 *
Nodule size, cm, mean ± SD	2.8 ± 1.6	2.9 ± 1.9	0.72
Age, y, mean ± SD	43.9 ± 12.1	53.5 ± 14.7	<0.0001 *
Women, n/N (%)	202/216 (94)	307/410 (75)	<0.0001 *

* Statistically significant.

Table 2.

Outcomes and Complications

Variable	Remote-access approach	Transcervical approach	p Value
Lobectomy OT, min, (median)	146 (43–343)	90 (25–247)	<0.0001 *
Total thyroid OT, min, (median)	170 (100–398)	126.5 (51–260)	<0.0001 *
Permanent RLN injury, n/N (%)	0/216 (0)	0/410 (0)	0.99
Temporary RLN injury, n/N (%)	7/216 (3.2)	6/410 (1.5)	0.15
Permanent hypoparathyroidism, † n/N (%)	0/68 (0)	0/263 (0)	0.99
Hematoma, n/N (%)	3/216 (1.4)	1/410 (0.2)	0.12
Seroma, n/N (%)	5/216 (2.3)	2/410 (0.5)	0.051

*Statistically significant.

†Calculated only it at-risk population of total thyroidectomies and completion thyroidectomies.

OT, operative time; RLN, recurrent laryngeal nerve.

Table 3.

Subgroup Analysis of Remote-Access Techniques

Variable	Robotic facelift approach	Robotic-assisted transaxillary approach	Transoral endoscopic thyroidectomy vestibular approach
Lobectomy OT, min, median (range)	179 (114–293)	139 (85–226)	126 (60–343)
p Value *	<0.0001 †	<0.0001 †	0.30
Total thyroidectomy OT, min, median (range)	NA	164.5 (100–241)	172.5 (127–398)
p Value *	NA	NA	0.11
Permanent RLN injury, n/N (%)	0/54 (0)	0/70 (0)	0/92 (0)
p Value *	0.99	0.99	0.99
Temporary RLN injury, n/N (%)	2/54 (3.7)	1/70 (1.4)	4/92 (4.3)
p Value *	0.58	0.99	0.39
Permanent hypoparathyroidism, n/N (%)	0/8 (0)	0/30 (0)	0/30 (0)
p Value *	0.99	0.99	0.99
Hematoma, n/N (%)	3/54 (5.6)	0/70 (0)	0/92 (0)
p Value *	0.08	0.048 †	0.99
Seroma, n/N (%)	3/54 (5.6)	2/70 (2.9)	1/92 (1.1)
p Value *	0.65	0.14	0.58

* First value represents column 1 vs 2, second 1 vs 3, and third 2 vs 3.

† Statistically significant.

OT, operative time; RLN, recurrent laryngeal nerve.