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ORIGINAL SCIENTIFIC REPORT

Remote Access Robotic Facelift Thyroidectomy: A Multi-institutional Experience

William S. Duke[1] · F. Christopher Holsinger[2] · Emad Kandil[3] · Jeremy D. Richmon[4] · Michael C. Singer[5] · David J. Terris[1]

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Abstract

Background Robotic facelift thyroidectomy (RFT) was developed as a new surgical approach to the thyroid gland using a remote incision site. Early favorable results led to this confirmatory multi-institutional experience.

Methods Prospectively collected data on consecutive patients undergoing RFT in five North American academic endocrine surgical practices were compiled. Surgical indications, operative times, final pathology, nodule size, complications, and postoperative management (drain use and length of hospital stay) were evaluated.

Results A total of 102 RFT procedures were undertaken in 90 patients. All but one of the patients (98.9 %) were female, and the mean age was 41.9 ± 13.1 years (range 12–69 years). The indication for surgery was nodular disease in 91.2 % of cases; 8.8 % were completion procedures performed for a diagnosis of cancer. The mean size of the largest nodule was 1.9 cm (range 0–5.6 cm). The mean total operative time for a thyroid lobectomy was 162 min (range 82–265 min). No permanent complications occurred. There were 4 cases (3.9 %) of transient recurrent laryngeal nerve weakness, no cases of hypocalcemia, and 3 (2.9 %) hematomas. There were no conversions to an anterior cervical approach. The majority of patients were managed on an outpatient basis (61.8 %) and without a drain (65.7 %).

Conclusions RFT is technically feasible and safe in selected patients. RFT can continue to be offered to carefully selected patients as a way to avoid a visible cervical scar. Future prospective studies to compare this novel approach to other remote access approaches are warranted.

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✉ David J. Terris
dterris@augusta.edu

[1] Department of Otolaryngology and Endocrinology, Augusta University Thyroid and Parathyroid Center, Augusta University, 1120 Fifteenth Street, BP-4109, Augusta, GA 30912-4060, USA

[2] Division of Head and Neck Surgery, Department of Otolaryngology, Stanford University, Palo Alto, CA, USA

[3] Department of Surgery, Tulane University, New Orleans, LA, USA

[4] Department of Otolaryngology - Head and Neck Surgery, Johns Hopkins University, Baltimore, MD, USA

[5] Department of Otolaryngology - Head and Neck Surgery, Henry Ford Health System, West Bloomfield, MI, USA

Introduction

Remote access thyroid surgery was introduced in Asia in the late 1990s as a way to improve the cosmetic outcomes of thyroid surgery by removing the incision from the anterior neck and concealing it in a hidden location such as the axilla or chest [1, 2]. Although initially not widely embraced in Western practices, the development of a robotic-assisted transaxillary approach in Korea in 2009 [3] led to increased adoption of remote access thyroidectomy in other regions.

However, as this procedure was incorporated into practices in the USA, surgeons encountered technical challenges related to the typical body habitus and volume of disease commonly present in Western patients when trying to reproduce the procedure using the same instruments and methods that were successful in Asia [4–6]. Furthermore, some surgeons reported serious complications in their early attempts not typically associated with thyroidectomy, including brachial plexus injuries and tracheal perforation [4, 7, 8]. As a result of these experiences, the robotic-assisted transaxillary thyroidectomy has not gained wide acceptance in this country.

To overcome the limitations of the transaxillary approach in this patient population, the remote access robotic-assisted facelift thyroidectomy was developed in 2011 [9–11]. Compared with the transaxillary approach, robotic facelift thyroidectomy (RFT) reduces the amount of dissection required to access the thyroid compartment [12] and eliminates the risk of brachial plexus injury [10].

Based on these factors and favorable early outcomes, RFT has been increasingly utilized in the USA and Asia [13, 14]. To date, however, only small case series from individual practices have been reported, and only two institutions in the USA have published results from their initial experiences [10, 11, 15]. To provide a more comprehensive evaluation of RFT, this study evaluates and reports the largest multi-institutional experience of RFT in the literature.

Materials and methods

Data collection

To explore and demonstrate the ability for this technique to be adopted outside of the institution where it was first described, all surgeons in the USA known to have incorporated RFT into their practice were invited to submit data. Surgeons at five academic health centers participated: Augusta University (WSD, DJT), Henry Ford Health System (MCS), Johns Hopkins University (JDR), Stanford University (FCH), and Tulane University (EK). Data were collected on RFT procedures performed between July 2010 and April 2014. Detailed instructions and a standardized reporting form were sent to each author to ensure uniform reporting of information, which included deidentified patient demographic, surgical, pathologic, postoperative management, and complication data.

The specific preoperative diagnosis was recorded and then further classified as either benign nodular disease or malignancy. Any coexisting functional thyroid disorder (such as hyperthyroidism or Hashimoto's thyroiditis) was noted. Specific medical comorbidities were compiled and classified into major disease or organ system categories.

Each thyroid lobectomy or side of a total thyroidectomy was reported as a distinct procedure. Operative times were recorded, as were any associated procedures performed. The largest nodule size in each thyroid lobe was reported. Final pathologic data were recorded and further classified as benign or malignant.

Postoperative management strategies were examined, including use of a drain and admission status. Patients were considered outpatient if they were discharged on the same day of surgery, and inpatient if they were observed for 23 h or longer. The mean length of stay (LOS) for inpatients was calculated, using 1 day as the LOS value for patients observed for 23 h.

Complications and technical problems were recorded. Recurrent laryngeal nerve (RLN) injury and hypoparathyroidism were reported as either temporary (<12 months) or permanent (>12 months). RLN injury data are reported according to nerves at risk.

This study was approved by the Augusta University institutional review board (Pro00000155).

Inclusion criteria

Patients were selected to undergo RFT at the discretion of the individual surgeon. Selection criteria for RFT have been previously published and include both patient and disease-specific characteristics [11] (Table 1).

Table 1 Selection criteria for robotic facelift thyroidectomy. (adapted from Terris [11])

Patient factors	Disease factors
Highly motivated to avoid cervical scar	Extent of disease appropriate for unilateral surgery
American Society of Anesthesiologists class 1 or 2	Largest nodule ≤4 cm
No prior neck surgery	No thyroiditis
No morbid obesity	No substernal extension
	No extrathyroidal extension
	No pathologic lymphadenopathy

Fig. 1 The robotic facelift thyroidectomy incision is placed in the postauricular crease and then carried into the occipital hairline (used with permission from Terris [11])

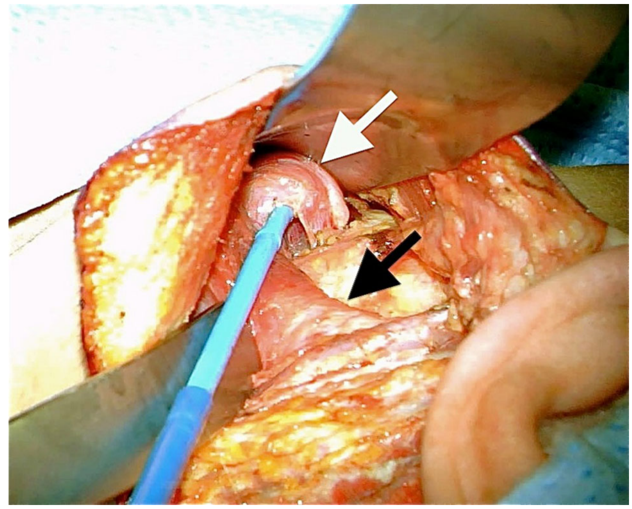

Fig. 2 A musculocutaneous flap is elevated deep to the platysma on the surface of the sternocleidomastoid (*black arrow*) from the mastoid tip to the clavicle, preserving the great auricular nerve and external jugular vein. The SCM is retracted laterally, and a muscular triangle defined by the omohyoid (*white arrow*), sternohyoid, and SCM is identified

Surgical technique

The RFT technique has been described previously [10, 11]. The procedure begins with a postauricular incision that is carried into the occipital hairline (Fig. 1). A subplatysmal flap is elevated along the surface of the sternocleidomastoid (SCM) from the mastoid tip to the clavicle, preserving the great auricular nerve and external jugular vein. The SCM is retracted laterally, and a muscular triangle defined by the omohyoid, sternohyoid, and SCM is identified (Fig. 2). The strap muscles are elevated ventrally, revealing the superior pole of the thyroid lobe. The operative field is maintained by two fixed retractors, one to elevate the strap muscles ventrally and another to hold the SCM laterally. The da Vinci (Intuitive Surgical Inc., Sunnyvale, CA) surgical system is then introduced. A 30^{o} down-facing camera is utilized, along with a Harmonic device (Ethicon Endo-Surgery, Inc., Cincinnati, OH) in the dominant arm and Maryland grasper in the non-dominant arm.

The robotic portion of the procedure begins by mobilizing the superior pole away for the inferior constrictor and identifying the superior laryngeal nerve. The superior vascular pedicle is isolated and divided with the Harmonic device (Fig. 3). The superior pole is then reflected inferiorly and ventrally. The superior parathyroid gland is identified and preserved. The RLN is identified just inferior to the inferior constrictor, then dissected away from the thyroid lobe. The middle thyroid vein and isthmus are divided with the Harmonic device. The inferior pole is mobilized, preserving the inferior parathyroid gland, and the vessels along the inferior aspect of the lobe are divided. A piece of Surgicel (Ethicon, Somerville, NJ) is placed and

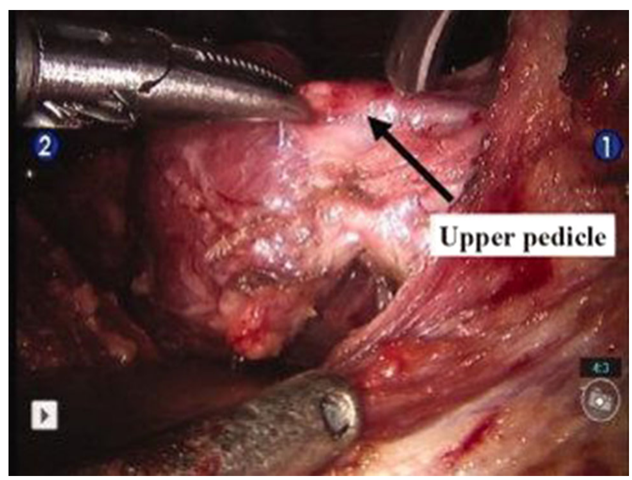

Fig. 3 The superior vascular pedicle is isolated and divided with the Harmonic device (used with permission from Terris [10])

the deep aspect of the wound is closed. The skin edges are sealed with tissue glue and adhesive strips.

Results

Patient demographics and surgical indications

There were 102 RFT procedures in 90 patients (Table 2). Patients ranged in age from 12 to 69 years, with a mean

Table 2 Robotic facelift thyroidectomy experience in each institution

Institution	Patients, *n* (%)	Procedures, *n* (%)
Augusta University	52 (58)	61 (60)
Henry Ford	2 (2)	3 (3)
Johns Hopkins	13 (14)	13 (13)
Stanford	1 (1)	1 (1)
Tulane	22 (24)	24 (24)
Total	90	102

Table 3 Indications for robotic facelift thyroidectomy

	Patients, *n* (%)
Benign	
Nodule	46 (45.1)
Cyst	1 (1)
Multinodular goiter	18 (17.6)
Toxic nodule	3 (2.9)
AUS/FLUS	20 (19.6)
Follicular lesion/SFN	3 (2.9)
SFM	1 (1)
Non-diagnostic	1 (1)
Malignant	
PTC	7 (6.9)
FTC	2 (2)

All surgeries for known malignancies were completion procedures

AUS atypia of undetermined significance, *FLUS* follicular lesion of undetermined significance. *SFN* suspicious for follicular neoplasm, *SFM* suspicious for malignancy, *PTC* papillary thyroid carcinoma, *FTC* follicular thyroid carcinoma

age of 41.9 ± 13.1 years. All but one patient were female (89, 98.9 %). The majority of patients were Caucasian (63, 70 %), African-American (17, 18.9 %), or Asian (5, 5.6 %). One patient had concurrent bilateral procedures (total thyroidectomy); all other patients had discrete thyroid lobectomies.

RFT was performed for benign or indeterminate nodular disease in 93 (91.2 %) patients (Table 3). There were fourteen (13.7 %) completion RFT procedures; nine of these cases were for a diagnosis of cancer after a prior RFT lobectomy. Two patients found to have papillary thyroid carcinoma after RFT had a completion lobectomy through an anterior cervical approach, and 1 patient with papillary thyroid carcinoma had no completion surgery.

The majority of patients had normal thyroid function (83 procedures, 81.4 %). Ten procedures were performed in patients with unspecified hypothyroidism, while 3 were performed on patients with Hashimoto's thyroiditis. Six procedures were performed in patients with hyperthyroidism, three of whom had toxic nodules.

Most patients had no medical comorbidities (61 procedures, 59.8 %). Significant comorbidities in the remaining patients included hypertension ($n = 16$, 15.7 %), neurologic disorders ($n = 10$, 9.8 %), other cancers ($n = 9$, 8.8 %), cardiovascular disease ($n = 5$, 4.9 %), hematologic disorders ($n = 4$, 3.9 %), or autoimmune disease ($n = 2$, 2 %). Diabetes, pulmonary disease, hepatic disease, a history of keloids, or renal disorders were each present in only 1 % of the procedures. The mean body mass index (BMI) was 27.8 kg/m^2 (range 13.4–51.9 kg/m^2).

Operative data

There were 100 (98 %) discrete lobectomies. One patient (2 lobectomies) had a concurrent total thyroidectomy through separate bilateral incisions. The incision lengths, which were recorded for 64 procedures, ranged from 7.8 to 15 cm (mean 10.2 ± 1.1 cm). RFT is divided into several steps, including creation of the open operative pocket, docking of the robotic cart, robotic dissection, and wound closure. The pocket creation time, available for 99 procedures, ranged from 14 to 137 min (mean 68 ± 25.4 min). The time to position the robotic console, which ranged from 3 to 40 min (mean 13.5 ± 6.9 min), was available for 87 procedures. The robotic portion of the dissection, available for 99 procedures, ranged from 6 to 136 min (mean 44.2 ± 24.8 min). The total operative time was available for all cases. However, 1 case was performed as a total thyroidectomy, and the amount of time to allocate to each lobectomy for purposes of calculating mean operative times for each individual lobe was not discernable. Therefore, excluding this case (2 procedures), the mean total operative time for the remaining 100 procedures was 161.9 ± 31.1 min (range 82–265 min).

The RLN was identified in 101 cases (99 %), although identification was by stimulation only (rather than visualization) in 3 cases. RLN identification was not recorded in 1 case. The energy device used was recorded in 78 procedures. The Harmonic device was utilized in 75 of these cases, and the LigaSure device (Covidien, Dublin, Ireland) was used in 3.

RFT was performed independently in 86 cases (84.3 %) and was combined with a secondary procedure in 16 (15.7 %) cases. These included a cervical rhytidectomy ($n = 6$), parathyroid reimplantation ($n = 5$), lymph node biopsy ($n = 4$), and lateral neck dissection ($n = 1$).

Final pathology

The largest mean nodule size was 1.9 ± 1.3 cm (range 0–5.6 cm). The final pathology was benign in 76 (74.5 %) lobes and malignant in 26 (25.5 %) lobes. Benign findings included adenomas ($n = 29$), multi-nodular goiter ($n = 39$), toxic adenoma ($n = 1$), and a thyroid cyst ($n = 1$). Three patients had no pathologic findings (diffuse goiter or completion surgery for cancer diagnosed after a prior lobectomy). Hashimoto's thyroiditis was present in 8 cases.

Papillary thyroid carcinoma was diagnosed in 21 lobes, including 5 lobes with papillary thyroid microcarcinoma. There were 4 cases of follicular thyroid carcinoma and 1 case of sclerosing mucoepidermoid carcinoma.

Postoperative management

The majority of the procedures were performed on an outpatient basis ($n = 63$, 61.8 %). There were 39 (38.2 %) procedures performed as inpatient surgery. Most of the inpatient procedures were discharged after an overnight stay ($n = 35$). Three patients were observed for 2 days and 1 patient for 3 days. Each hospitalization over 1 day was associated with a bleeding event. The mean length of stay for the inpatient procedures was 1.1 ± 0.4 days.

Most procedures were performed without the use of a drain ($n = 67$, 65.6 %). The use of drains varied among institutions. At Augusta University, a drain was used in the first RFT ever performed, but then never again. No drains were used at Henry Ford Hospital. Drains were used uniformly at Stanford and Tulane University and selectively at Johns Hopkins University.

Complications

The majority of procedures were performed without complication ($n = 88$, 86.3 %) (Table 4). Most complications were minor and transient, including temporary RLN weakness ($n = 4$, 3.9 %) and seromas ($n = 4$, 3.9 %), which did not require intervention. There were no cases of permanent RLN weakness and no cases of hypoparathyroidism, even after completion thyroidectomy. There was 1 case each of cellulitis and transient spinal accessory nerve weakness that was treated with physical therapy. Bleeding from a common facial vessel occurred during one procedure; this was controlled intraoperatively without sequela. Postoperative hematoma occurred after 3 procedures (2.9 %), including 1 which occurred on postoperative day 7. Each of these was treated with drainage. No cases required conversion to an anterior cervical approach.

Table 4 Complications in robotic facelift thyroidectomy

Complication	*n* (%)
Temporary RLN weakness	4 (4)
Permanent RLN weakness	0 (0)
Hypocalcemia	0 (0)
Hematoma	3 (3)
Seroma	4 (4)
Temporary accessory nerve weakness	1 (1)
Cellulitis	1 (1)
Conversion to anterior approach	0 (0)

RLN recurrent laryngeal nerve

Discussion

Remote access thyroid surgery became popular for selected Western patients with the introduction of the robotic-assisted transaxillary approach in 2009 [3]. Unfortunately, the excellent results obtained in Korea and other Asian countries using this technique were not able to be consistently duplicated in the USA. An alternative approach, the robotic facelift thyroidectomy, was subsequently developed and appeared to have promise in single-institution reports [10, 11, 15]. This study represents the first multi-institutional assessment of this technique in the USA and the largest report to date in the medical literature.

RFT offers a number of advantages over the transaxillary approach. There is no risk of positional brachial plexus injury, and the surgical approach and anatomy are familiar to the head and neck surgeon. The vector of approach permits early identification of the recurrent laryngeal nerve, near its most constant location just inferior to its insertion under the inferior constrictor muscle. This allows the nerve to be safely reflected away from the thyroid for the remainder of the dissection. The dissection pocket, which is smaller than that required for the transaxillary approach [9], is shallow enough that commercially available nerve stimulating devices can be employed to assess the functional integrity of the nerve, if desired. The procedure can be accomplished safely without postoperative drainage, though some surgeons in this series chose to employ them. Finally, the procedure may be accomplished on as outpatient basis in most patients. The primary shortcoming of the RFT procedure, however, is that the angle of approach does not safely permit bilateral thyroid surgery to be performed through the unilateral postauricular incision.

This early experience shows that thyroid lobectomy using the RFT approach has a favorable complication profile when compared to the initial reports of lobectomy performed with the transaxillary approach in patients in the USA. The rates of hematoma (2.9 vs. 6–12 %) [4, 5], transient recurrent laryngeal nerve injury (3.9 vs. 6–20 %) [4, 5], seroma (3.9 vs. 12 %) [4], and infection (1 vs. 8 %) [4] were all lower in this series of RFT procedures than for those previously published on the transaxillary approach in North American patient populations. The complication rates from this early experience in RFT also compare favorably to conventional thyroid surgery in large multi-institutional reviews. The overall complication rate of

13.7 % in this series is similar to the 14.4 % reported by Kandil et al. [16] in a review of 46,261 total thyroidectomy operations. With regard to specific complications, Bergenfelz et al. [17] reported an operative hematoma rate of 2.1 %, an infection rate of 1.6 %, and unilateral recurrent laryngeal nerve injury in 3.0 % of nerves at risk in a series of 3600 patients undergoing thyroid surgery in Scandinavia. Additionally, Sosa et al. reviewed thyroidectomy complications in 5860 patients in a single-state registry in USA and found a hematoma rate of 1.2–2.0 % and a recurrent laryngeal nerve injury rate of 1.1–4.6 % depending on the preoperative diagnosis and extent of surgery performed [18]. These results suggest that RFT can be performed as safely as conventional thyroid surgery in carefully selected patients.

Despite these outcomes, the number of remote access robotic-assisted thyroid operations, including RFT, performed in the USA remains small. This may reflect that only a limited number of patients in this population meet the selection criteria for these procedures, especially RFT, but may also be due partially to changes in the corporate support for robotic-assisted thyroid surgery. This operation is more difficult to perform than a traditional anterior cervical approach thyroidectomy, although surgeons who are facile with robotic surgery should be able to master it, and those who are pursuing transaxillary thyroid surgery should find RFT easier if they choose to transition to it, instead. Finally, there are insufficient case numbers to yet characterize the learning curve to achieve proficiency with this technique, although this will become better defined as the numbers of procedures continue to increase. Because of these barriers to broad and rapid implementation, performing RFT or any other non-traditional approach at high-volume centers of excellence probably is more reasonable and consistent with patient safety and quality outcomes. However, this multi-institutional experience demonstrates that RFT is safe and feasible in patients in the USA and is a viable option for patients seeking to maximize the cosmetic benefit of personalized thyroid surgery. As groups in the USA abandon robotic transaxillary thyroid surgery [6] and groups in other countries begin to explore RFT [19, 20], it is possible and likely that RFT will replace other remote access approaches, particularly when unilateral surgery is appropriate.

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