Review Article

Transoral robotic thyroidectomy (TORT): procedures and outcomes

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Abstract: Remote-access approaches to the thyroid gland have seen a rapid evolution recently with the development of various techniques to minimize the cosmetic and quality-of-life impact of a visible scar. Most approaches have required significantly more tissue dissection and have been limited in their extent to treat contralateral disease. The transoral approach is the most recent iteration of "scarless" thyroidectomy and offers various advantages over other techniques including less tissue dissection, equal access to both sides of the neck, and a superb midline view of the anatomy. Transoral thyroidectomy may be performed with either laparoscopic or robotic technology, each with various advantages and disadvantages. Herein, we discuss our experience with transoral robotic thyroidectomy (TORT).

Keywords: Robotic thyroidectomy; remote access; minimally invasive; transoral; transoral robotic thyroidectomy (TORT), thyroidectomy

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Introduction

The advent of modern day thyroid surgery with Theodor Billroth over 150 years ago established the transcervical approach as the standard technique to access the thyroid. Since then, there have been myriad variations of this approach with attempts to minimize the length and visibility of the scar. This has accelerated over the last 2–3 decades with the goal of avoiding a visible cervical scar altogether with remote-access approaches that move the scar to the chest, axilla and/or hairline. Both endoscopic and robotic approaches have been developed, each with their respective limitations and benefits.

Central to any argument about remote-access thyroid surgery is the question: "Is it worth it?" The primary advantage of these approaches is the avoidance of a visible neck scar. Unfortunately, this often requires longer, more complex, more expensive techniques dependent on advanced technologies that may or may not introduce complications and risks that heretofore were not in the realm of standard thyroid surgery. While many traditional thyroid surgeons justly advocate exclusively for the transcervical approach, mounting evidence substantiates the potential quality-of-life impact of a cervical scar on a patient (1,2). This adverse effect of a cervical scar can be particularly distressing in a patient population composed largely of younger, healthy woman in a world that places excessive emphasis on physical appearance and esthetics. This can be compounded in patients with darker skin pigmentation and with a history of hypertrophic and/or keloid scars. Therefore, while many patients would be best served with a transcervical neck approach, there is a subset of patients that remain very motivated to avoid a neck scar and will pursue remote-access thyroid surgery. This evolution, driven by patients and surgeons alike, has thus sought to achieve the goal of safe, scarless thyroid surgery.

History

The first endoscopic approach to the central neck was performed in 1998 (3) for parathyroidectomy. Since this time there have been numerous endoscopic and remote-access approaches to the neck to minimize a cervical scar including the anterior breast approach (4), axillo-bilateral breast approach (5), lateral neck approach (6), bilateral axillary breast approach (BABA) (7), axillo-breast approach (8), and post-auricular axillary approach (9). Recent robotic approaches include the transaxillary (10) and facelift robotic (11,12) approaches. While each approach is far from perfect, the BABA and robotic transaxillary and facelift approaches have garnered the most support in Asia and the West. Nonetheless, each approach fails to satisfy the criteria of minimally-invasive surgery which aims to minimize surgical trauma and tissue dissection.

Any remote-access or "scarless" approach to the thyroid must necessitate a compromise between minimal tissue disruption with a visible scar and extensive tissue disruption with a remote, hidden scar. The balance between the two is critical to the overall success and adoption of the technique. A long, complex, and risky surgery that avoids a visible scar is neither palatable to surgeon nor patient. In contrast, as the operative outcomes continue to improve and approximate those of traditional transcervical thyroid surgery, these approaches become more and more attractive. It is with this goal in mind that the transoral approach to the central neck has been developed.

The transoral approach offers several advantages over other remote-access approaches to the thyroid gland. First and foremost, the distance between the floor of mouth and oral vestibule to the central neck is shorter and requires less tissue dissection than any other remote-access approaches. The midline approach affords access to both thyroid lobes without additional ports as well. Finally, when healed the mucosal incisions are essentially imperceptible and avoid all cutaneous scarring.

In 2009, Benhidjeb *et al.* (13) reported the first series of transoral thyroidectomy on live patients. This approach, adopted by other investigators (14-16), involved a sublingual incision through the floor of the mouth. In 2010, Richmon *et al.* (17) expanded this endoscopic approach using the da Vinci robot (Intuitive Surgical, Inc. Sunnyvale, CA, USA) in cadavers. The central camera was passed through a sublingual incision while the two lateral effector arms passed through vestibular incisions anterior to the mandible. The transoral robotic thyroidectomy (TORT) approach sought to overcome many of the limitations of endoscopic surgery such as non-wristed instrumentation, two-dimensional visualization, and difficulty of manipulating the endoscopic camera during dissection. In contrast, the robot allows for bimanual, wristed instrumentation, a high-definition, three dimensional view, tremor-filtration, precise movement with motion scaling, and individual camera operation.

In 2011, Richmon *et al.* (18) modified this approach to avoid the floor of mouth route because rotation along the axis of the camera was restricted by the maxillary and mandibular dentition. This limitation, along with early reports of high complication rates with endoscopic thyroidectomy through the floor of mouth in live patients, made the sublingual approach particularly unattractive and it is now nearly completely abandoned in clinical practice. Instead, all three ports were placed through the vestibule anterior to the mandible to access the subplatysmal space and the floor of mouth was not violated. This modification allowed for greater manipulation of the camera with exposure down to the innominate artery with the ability to perform thyroidectomy and central neck dissections. This approach was further refined in cadavers (19) and pig models (20). Most recently the technique has been shown to be promising using the newest generation of the da Vinci robot, the Xi platform, which has several technologic advantages over previous iterations (21).

Lee (22) and his team reported the first experience in 2015 of performing TORT in 4 live human patients. While the surgeries were completed successfully, three patients suffered temporary paresthesias of the mental nerve, a complication unique to the transoral approach. This was secondary to the insertion site of the lateral trocars low in the vestibule close to the emergence of the mental nerves where they are more likely to be stretched. Concern over mental nerve injury temporarily halted further exploration of the TORT technique. A modification in the positioning of the lateral ports towards the free edge of the lip was supported by Anuwong (23) in his initial series of transoral endoscopic thyroidectomy (personal communication) that did not develop any mental nerve injuries. This led to greater mobility of the lateral trocars without imparting excessive tension on the mental nerves. With the mental nerve injury problem addressed, a renewed vigor to TORT began in 2016 after the First Transoral Thyroid NOTES Conference in Bangkok, Thailand. Both authors returned to their respective institutions in the United States and Korea and successfully initiated TORT in the spring of 2016.

Surgical procedure

As our experience continues to grow with TORT, so do the inclusion and exclusion criteria, and we recognize that increasingly advanced disease may be amenable to this approach as experience is accumulated. In general, TORT may be offered to patients with benign, suspicious, and small well-differentiated thyroid cancer with limited disease. Lesions included were benign or suspicious thyroid nodules smaller than 6 cm and the differentiated thyroid cancer smaller than 1 cm. We excluded patients with previous a history of neck surgery or neck radiation or lateral neck disease. The patient must be very motivated to avoid a visible neck scar or may have a history of hypertrophic or keloid scars.

Pre-operative imaging includes a thyroid ultrasound and/or a CT scan of the neck. All patients should receive an ultrasound guided fine needle aspiration prior to surgical intervention so the appropriate procedure can be planned. Informed consent is obtained from all patients, including a review of the novel nature of this procedure and the associated risks. Additionally, the fact that the da Vinci robot is not approved by the Food and Drug Administration (FDA) for this approach needs to be reviewed with each patient and included in the consent.

The patient is positioned supine and intubated with a 6-0 or 7-0 nerve monitoring endotracheal tube (Medtronic, Inc.). A 2 centimeter (cm) inverted U shape incision is marked out in the midline of the lower lip at approximately 1 cm above the frenulum of the lower lip. Electrocautery is then used to approach the mandible in the midline. Once the periosteum is identified, the neck is injected with 1:500,000 epinephrine using a fat injection syringe to hydro-dissect the subplatysmal plane. Next, a blunt-tipped dilator is used to develop the submental and subplatysmal plane atraumatically in the midline. Lateral stab incisions through the lateral aspect of the lower lip close to the free edge are made and injected with the epinephrine solution. The robotic ports are passed through the three mucosal incisions and advanced to the inferior edge of the mandible. A 12 mm bariatric cannula is passed centrally for the camera, and 5 mm ports are passed lateral for the effector arms. Insufflation tubing is attached to one of the cannulas and pressure is maintained at 5–7 mmHg.

Standard laparoscopic instrumentation is used to develop the subplatysmal working space. A 30 degree down rigid scope is passed centrally and held by an assistant. The surgeon uses a suction electrocautery, Maryland dissector, and hook cautery to elevate the platysma from the level of the mandible to the sternum inferiorly and laterally to the sternocleidomastoid muscles. Subsequently, an 8-mm bariatric trocar can be inserted through an incision made along the patient's right axillar fold into the subplatysmal working space for counter-traction during the operation and for later drain insertion if desired (technique of HYK).

Then the da Vinci robot is docked at the left side of the OR table at 30 degrees (similar to transoral robotic surgery for oropharyngeal cancer) or between the legs if the patient is placed in the lithotomy position. First, the median raphe of the strap muscles is identified and divided. The thyroid dissection is performed with the da Vinci Si robot with a 30-degree scope, Maryland dissector and Harmonic scalpel. The thyroid isthmus is divided and the trachea serves as a landmark for identification of the recurrent laryngeal nerve (RLN). A capsular dissection begins around the thyroid itself and the superior pole is taken down with the Harmonic scalpel. The nerve stimulator probe is used to stimulate the RLN and to test neurophysiologic integrity during and after the procedure. The parathyroid glands are readily appreciated if they are in the capsular plane. A parathyroid adenoma may also be removed in a similar fashion.

The thyroid is delivered off of the trachea. The contralateral lobectomy can be completed at the same time if necessary without any additional incisions. The robot is undocked and the specimen is retrieved with laparoscopic instrumentation via the central incision using an endocatch bag so as not to contaminate the endoscopic access. Hemostasis is achieved and the wound is irrigated. The strap muscles are re-approximated with a self-locking absorbable suture. The oral vestibule incisions are closed with layered absorbable sutures. A compression dressing is placed across the neck and chin after the patient has been extubated.

Surgical outcomes

A total of 17 patients are reported here; 5 patients underwent TORT surgery at Johns Hopkins Hospital, and 12 patients at the Korea University Medical Center. All patients were female. The average age was 42 years and the range of age was from 17 to 65 years.

Lobectomy was performed in 16 cases and central lymph node dissection was performed in 13 cases. In all cases, we used intraoperative neuro-monitoring system and confirmed that all RLNs were preserved. A drain was inserted into the thyroidectomy bed after surgery in 12 cases. The mean operative time was 254 minutes (310 min Hopkins *vs.* 230 min at Korea University). In a single patient with a large substernal goiter not appreciated on pre-operative sonography, open conversion was required.

Final pathology included 11 papillary thyroid carcinomas and 5 benign neoplams. The mean volume of the thyroid specimen was 23 cc (31 cc Hopkins *vs.* 20 cc Korea University). The average nodule size was 1.2 cm (2.5 cm Hopkins *vs.* 0.9 cm Korea University).

Postoperative complications included hypesthesia of the lower lip in three patients and lip weakness was observed in one patient. In one patient, a small tear occurred at the lateral lip commissure which healed uneventfully. Bruising over the zygomatic regions occurred in one patient. One patient experienced a perforation of the chin skin.

Future directions and conclusions

TORT can be performed safely in select patients by an experienced surgeon and might be a potential alternative remote-access robotic approach as it does not require flap dissection beyond that of the anterior neck. TORT is scarless (except a small subcentimeter incision in the axillar area if a drain is used) and provides equal access to both central necks as opposed to other remote-access approaches.

Although the surgical outcomes of TORT must be evaluated with a larger number of patients and longer follow-up from multiple institutions, TORT is a promising robotic approach with optimal cosmetic outcomes.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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