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TRANSORAL ROBOTIC THYROIDECTOMY (TORT) AND ROBOTIC FACELIFT THYROIDECTOMY (RFT)

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There has been an evolution of various surgical approaches to thyroidectomy since the transcervical approach was adapted over 150 years ago. Both robotic and endoscopic techniques have been developed with access to the thyroid from the axilla, lateral neck, or oral cavity resulting in a hidden or less conspicuous scar [1–3]. These approaches have been developed as the adverse effect of a cervical scar on quality of life has been better understood, particularly in young women [4]. These effects are often compounded in patients with darker skins or those prone to hypertrophic scars or keloids. Central to pursuing any remote-access or "scarless" approach, there needs to be a compromise between minimal tissue disruption with a resultant visible scar (e.g. transcervical approach) and extensive tissue disruption with a remote, hidden scar (e.g. remote access approach). One should keep in mind that the primary advantage of remote access thyroid surgery is to avoid a conspicuous neck scar.

The initial remote access approach to gain widespread utility was the transaxillary robotic approach, as described by Koh [5]. Through an axillary incision with a self-retaining retractor, the robot could be inserted to perform ipsilateral thyroid lobectomy, and with difficulty, total thyroidectomy. The advantages of this technique included safety, reliability, and ease of dissemination. However, this procedure fell out of favor, especially in the West, as complications emerged (e.g. brachial plexus injury) and it was considered too invasive. Transoral and facelift approaches have since largely replaced the transaxillary approach.

Transoral Robotic Thyroidectomy

In expert hands, transoral robotic thyroidectomy (TORT) has demonstrated outcomes approximating those of traditional transcervical thyroidectomy. The transoral route offers several advantages over other remote-access routes[4]. First, the distance between the floor of mouth and vestibule is much closer to the central neck, thus allowing for less tissue disruption during dissection. Moreover, the midline approach allows for access to both thyroid lobes simultaneously without a need for additional access sites. Finally, the mucosal incisions heal to a virtually unnoticeable scar without any external scarring.

Initial studies of the transoral route involved a sublingual, floor of mouth endoscopic port [6,7]. When the robot was introduced for the transoral approach, the sublingual incision was changed to a vestibular incision anterior to the mandible as this allows greater movement of the central camera without restriction by the maxillary or mandibular teeth [8,9]. The sublingual approach and its inherent risks have subsequently been abandoned in clinical practice. The vestibular approach allows all three ports to be placed through the vestibule anterior to the mandible to access the subplatysmal space with violation of the floor of mouth. Initial concern about mental nerve traction injury has led to another modification of the lateral trocars being placed more towards the free edge of the lip [10]. After outcomes were discussed at the *First Transoral Thyroid NOTES Conference* in Bangkok, Thailand in 2016, TORT experienced a renewed vigor and continued forward [4].

Robotic Facelift Thyroidectomy

The first series of robotic thyroidectomies through the facelift approach was reported in 2011 by Terris *et al.* RFT offers similar advantages as TORT over an axillary approach such as proximity to the thyroid gland from the postauricular area, familiarity of the anatomy to the head and neck surgeon, and no risk to the brachial plexus [1]. RFT has been developed as an outpatient procedure generally not requiring drains. While there are reports of total thyroidectomy including central neck dissection with this technique, RFT is typically limited to unilateral thyroid lobectomy.

TORT & RFT: Patient Selection

As experience grows with TORT, inclusion and exclusion criteria continue to evolve [4] *(Table 1)*.

Lesions amenable to TORT or RFT
• Benign nodules <6cm (TORT) or <10cm (RFT) • Well-differentiated thyroid cancer <1cm
Contraindications to TORT or RFT
• Prior neck surgery • Prior neck radiation • Lateral neck disease involvement • Bilateral thyroid involvement (RFT only) • Substernal extension • Extrathyroidal extension • Thyroiditis • American Society of Anesthesiologists Class 3/4
Unique risks
• Mental nerve injury (TORT) • Injury to oral cavity structures: lips, teeth, gingiva, tongue (TORT) • Great auricular nerve injury (RFT) • Neck/chin numbness • Need to convert to open procedure

Table 1: TORT & RFT: Selection criteria, contraindications, and unique risks

At the time of writing, TORT is generally offered to patients with either benign, suspicious, or well-differentiated thyroid cancer with limited disease. Typical lesions chosen for this approach are benign nodules less than 6cm or well-differentiated thyroid cancer less than 1cm. A history of prior neck surgery or radiation, or presence of lateral neck disease are relative contraindications. Finally, patients must be highly motivated to avoid a visible neck scar or have a history of hypertrophic and/or keloid scars. These principles apply to RFT as well except lesions need to be lateralized and amenable to a thyroid lobectomy [1,3]. RFT may also be amenable to larger thyroid nodules as they can be removed through the open incision, in contradistinction to TORT.

TORT & RFT: Preoperative Assessment

Preoperative imaging studies include a CT neck with contrast and a thyroid and neck ultrasound. All patients should have the nodules biopsied via ultrasound-guided fine needle aspiration to accurately guide treatment planning. Informed consent is especially important for this procedure as the da Vinci robot is not approved by the Food and Drug Administration (FDA) for this approach. This needs to be carefully reviewed with the patient, including several unique risks of TORT including temporary or permanent mental nerve injury and lip/teeth/ gingiva/tongue damage along with usual thyroidectomy risks. An additional unique risk of RFT is greater auricular nerve injury causing numbness of the ear and upper neck[3]. All patients should be counselled about the possibility of having to convert the procedure to a standard transcervical approach if necessary.

TORT & RFT: Instrumentation

For detailed information and photos on room setup, exposure, and instrumentation for TORS, please refer to separate article "*Transoral Robotic Surgery (TORS): Setup and Basics*".

With TORT, standard laparoscopic instruments are initially used to develop subplatysmal flaps down to the sternum. This includes a 30-degree rigid scope, suction electrocautery, Maryland dissector, and hook cautery. With RFT, a modified Chung or Thompson retractor, a Singer hook, and a

Greenberg retractor are used to retract the skin flaps and muscles [3].

TORT & RFT: Setup and Intubation

- Position the patient supine
- Pad all pressure points
- Protect the eyes, including goggle protection
- Neuromonitoring is critical during the procedure
- Use a GlideScope (Verathon Inc, Bothell, USA) for intubation so that both the anaesthesia and surgical teams can confirm proper positioning of the EMG electrodes with the 6-0 or 7-0 nerve monitoring endotracheal tube (Medtronic, Inc.)

TORT: Surgical Dissection

- Prep and draped the patient in a sterile fashion *(Figure 1)*
- The lower lip is exposed
- Mark a 2cm incision in the midline approximately 1cm above the frenulum of the lower lip *(Figure 2)*
- Use electrocautery to dissect down to the midline of the mandible
- Identify the periosteum
- Inject 1:500,000 epinephrine into the neck using a fat injection syringe to hydro-dissect the subplatysmal plane
- Atraumatically develop the submental and subplatysmal spaces in the midline using a blunt-tipped dilator
- Make lateral stab incisions close to the free edge of the lip and inject 1:500,000 epinephrine
- Pass the robotic ports through the three incisions and advance them to the inferior aspect of the mandible

Figure 1: TORS draping

Figure 2: Inverted-U midline vestibular incision

- Use a 12mm bariatric cannula centrally for the camera, and 5mm ports laterally for the dissecting instruments *(Figures 3 and 4)*
- Insufflate the neck at 5-7mmHg by attaching insufflation tubing to one of the cannulas *(Figure 5)*
- Develop a subplatysmal working space using standard laparoscopic instrumenttation
- Pass a 30-degree rigid scope via the central cannula that is manipulated by an assistant

Figure 3: Trocar placement. Reproduced with permission Kim et al [11]

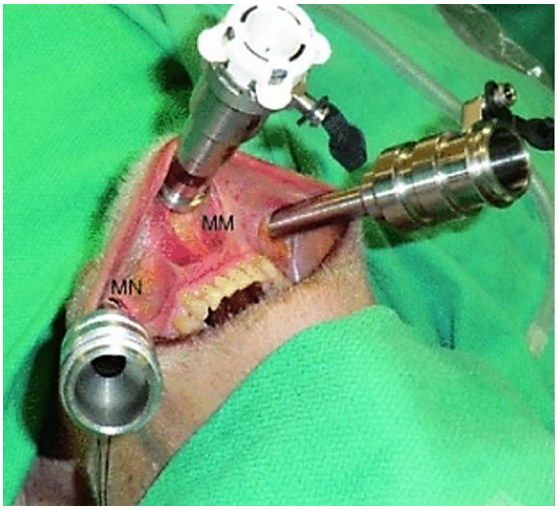

Figure 4: Tri-port placement for TORT. The lateral ports are positioned posterior to the mental nerve (MN). The camera port is placed in the midline between the fasciculus of the mentalis muscle (MM)

- Use a suction electrocautery, Maryland dissector, and hook cautery to develop a

Figure 5: View of flexed neck with insufflated subplatysmal working space with no external retractors. Reproduced with permission Richmon et al [8]

subplatysmal flap from the mandible down to the sternum inferiorly and laterally to the sternocleidomastoid muscles (SCM)
- An optional step includes insertion of an 8mm bariatric trocar through an incision in the right axillary fold into the subplatysmal working space to assist via countertraction during surgery or for later drain insertion
- The laparoscopic instruments are then removed
- Dock the da Vinci robot (Intuitive Surgical, Inc, Sunnyvale, CA) next to the OR table at 30 degrees or between the patient's legs
- Use the da Vinci Si robot with a 30-degree scope, Maryland dissector, and Harmonic scalpel for the thyroid dissection
- Identify and divide the median raphe between the strap muscles
- Once the thyroid is seen, divided the isthmus; this brings the trachea into view which is a landmark for identifica-

tion of the recurrent laryngeal nerve (RLN) *(Figure 6)*
- Dissect the thyroid in a capsular plane
- Use the Harmonic scalpel to take down the superior pole vasculature *(Figure 7)*
- Use the nerve stimulator probe throughout the procedure to stimulate the RLN to test its neurophysiologic integrity *(Figure 8)*
- The parathyroid glands should be identified and are readily appreciated if they are in the capsular plane. A parathyroid adenoma can be approached in a similar fashion
- Dissect the thyroid off the RLN and deliver it off the trachea

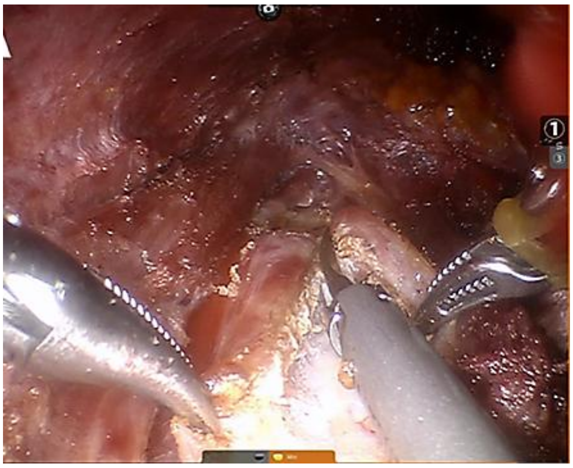

Figure 6: TORT: Dividing the isthmus and exposing the trachea

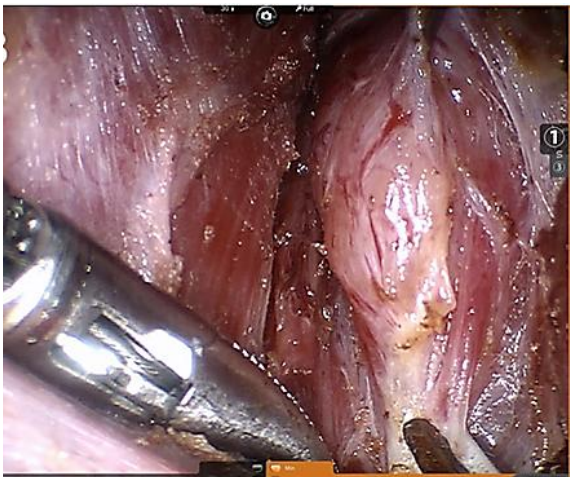

Figure 7: TORT: Ligating the superior thyroid vessels off the left thyroid gland

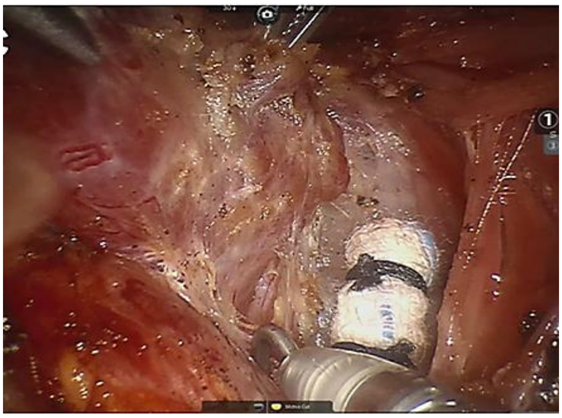

Figure 8: TORT: Identification of right recurrent laryngeal nerve. Figure 6-8 reproduced with permission Kim et al. [11]

- If necessary, a contralateral lobectomy can be performed with the same setup as can a central neck dissection
- Undock the robot to allow for specimen retrieval with the laparoscopic instrumentation via the central incision
- Use an endocatch bag to remove the thyroid to avoid seeding or to contaminate the endoscopic access
- Ensure haemostasis and copiously irrigate the wound
- Reapproximate the strap muscles in the midline using a self-locking absorbable suture
- Close the oral vestibular incisions in multiple layers with absorbable sutures *(Figure 9)*
- Apply a compression dressing to the neck and chin after extubation

RFT: Surgical Dissection

- Position the patient so he/she is closer to the edge of the bed on the side of the lesion
- Shave the occipital hairline 1cm posterolaterally
- Mark a facelift incision extending from the posterior aspect of the ear lobule, along the postauricular crease, and curved along the hairline to conceal the incision once the hair regrows *(Figure 10)*

Figures 9: Healed vestibular incision at 2 months postoperative and no anterior neck scar

Figure 10: Facelift incision is marked extending from the posterior aspect of the lobule, along the postauricular crease, and curved along the hairline. Finger points to thyroid nodule

- Mark the incision as far posteriorly and inferiorly as necessary depending on the size of the lesion and exposure needed
- Inject the incision with 1% lidocaine with 1:100,000 epinephrine
- Prep and drape the neck in a sterile fashion
- Use a scalpel to make the incision parallel to the hair follicles
- Develop subplatysmal flaps in a standard fashion
- Take care to identify the greater auricular nerve and to preserve its integrity
- Identify the SCM and unwrap its fascia
- Find the external jugular vein and ideally preserve it; however, it may be ligated to improve exposure if needed
- Place the OR table in a reverse Trendelenburg position and tilt it away from the surgeon to facilitate inferomedial dissection along the anteromedial border of the SCM
- Continue this dissection until the clavicle is reached
- Identify the muscular triangle bordered by SCM, omohyoid, and sternohyoid
- Retract the omohyoid, sternohyoid and sternothyroid ventrally towards the skin flaps to create a deeper dissection pocket
- Elevate these muscles off the thyroid lobe
- Identify the superior thyroid pedicle
- Place retractors to keep the strap muscles retracted ventrally which include placing the modified Chung retractor (Marina Medical, Sunrise, USA) on the contralateral side of the OR table and attaching a Singer hook (Medtronic, Jacksonville FL) to a Greenberg retractor (Codman & Shurtleff, Inc., Raynham, USA) which is then secured to the ipsilateral OR table. The modified Chung retractor pulls the strap muscles ventrally while the Greenberg retractor pulls the SCM laterally and dorsally *(Figure 11)*

Figure 11: The Thompson Retractor system retracting the strap muscles ventrally (top retractor in photograph) and the SCM laterodorsally

- A Thompson retractor can also provide necessary exposure *(Figure 11)*
- Position the robotic console with a 30° angle on the opposite side of the OR table
- If fine adjustments are needed, the OR table can be moved rather than moving the robot
- Place a 30° camera in the middle robotic port facing downward, and then advanced along the retractor into the surgical field
- Place the camera as ventral as possible against the retractor and completely extended to avoid competing with the other robotic arms
- The working arms consist of a Maryland grasper and a Harmonic Scalpel
- Commence the robotic part of the procedure
- Divide the superior thyroid pedicle with the Harmonic device
- Retract the superior thyroid pole inferiorly and ventrally
- This exposes the inferior constrictor muscle
- Dissect the inferior constrictor down to its lower border while avoiding the superior laryngeal nerve
- Identify the superior parathyroid gland at this point and dissect it off the thyroid gland
- Identify, and if needed stimulate the RLN as it courses under the inferior constrictor and can be stimulated
- Divide the ligament of Berry
- Divide the thyroid isthmus
- Ligate the middle thyroid vein with the Harmonic Scalpel
- Identify the inferior parathyroid gland and again dissect it away from the thyroid preserving its blood supply
- Transect the inferior thyroid vessels with the Harmonic Scalpel
- Release the thyroid lobe from the trachea
- Remove the specimen
- Ensure haemostasis and irrigate the wound
- Remove the robotic arms
- Place a closed suction drain and secure it to the neck
- Close the wound in multiple layers using absorbable sutures followed by epidermal glue *(Figure 12)*

Figure 12: RFT incision closure at case conclusion

Postoperative Care

For both TORT and RFT, standard postoperative thyroidectomy care is initiated. Gentle compression dressings are usually placed for 24-48 hours to obliterate the dead space under the skin flaps. Patients may experience more neck soreness for 1-2 weeks than is typically encountered in standard transcervical thyroid surgery.

Outcomes

While this chapter focuses on two robotic thyroid approaches, it is important to realize that these techniques are only performed at a few select, high-volume institutions with access to a surgical robot, and with surgeons who dedicate a significant part of their practice to mastering these advanced techniques.

TORT has largely been replaced by transoral endoscopic thyroidectomy vestibular approach (TOETVA), the same procedure but performed entirely with endoscopic instruments. TOETVA is likely the most widely disseminated remote access thyroid approach utilised today across the world by general, endocrine, and head and neck surgeons. While the instrumentation may be different, the procedure remains largely identical. TORT and TOETVA have similar outcomes including comparable rates of hypoparathyroidism and recurrent laryngeal nerve injury [12]. There were no conversions to open cases. The only difference was a slightly shorter mean operative time for TORT (228 minutes) versus TOETVA (308 minutes). A metanalysis comparing TOETVA to open transcervical thyroidectomy showed no significant differences in surgical outcomes [13].

A large series by Duke *et al.* reported on 102 RFT procedures (98.9% female) with an average age of 42 years[14]. Of those, 91.2% were done for benign disease with an average nodule size of 1.9cm. The average operating time was 162 minutes with no permanent complications. Transient complications included RLN weakness (3.9%) and haematoma (2.9%) with no cases of hypocalcemia. Both TORT and RFT provide a "scarless" approach to the thyroid that and can be performed safely, efficiently, and with similar outcomes to traditional transcervical thyroidectomy in an experienced remote-access surgeon's hands.

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Additional Open Access Resources

Transoral Robotic Surgery (TORS) - Setup and Basics: https://vula.uct.ac.za/access/content/group/ba5fb1bd-be95-48e5-81be-586fbaeba29d/Transoral%20Robotic%20Surgery%20_TORS_%20-%20Setup%20and%20Basics.pdf

Transoral Robotic Oropharyngectomy (TORS) surgical technique for cancers of the tonsil and base of tongue: https://vula.uct.ac.za/access/content/group/ba5fb1bd-be95-48e5-81be-586fbaeba29d/Transoral%20Robotic%20Oropharyngectomy%20_TORS_%20surgical%20technique%20for%20cancers%20of%20the%20tonsil%20and%20base%20of%20tongue.pdf

Transoral Robotic Surgical (TORS) approaches to Parapharyngeal Space, Hypopharynx and Larynx https://vula.uct.ac.za/access/content/group/ba5fb1bd-be95-48e5-81be-586fbaeba29d/Transoral%20Robotic%20Surgical%20_TORS_%20%20approaches%20to%20Parapharyngeal%20Space%2C%20Hypopharynx%20and%20Larynx.pdf

AfHNS Clinical Practice Guidelines for Thyroid Cancer in Developing Countries and Limited Resource Settings: https://developingworldheadandneckcancerguidelines.com/__trashed/

Thyroidectomy: https://vula.uct.ac.za/access/content/group/ba5fb1bd-be95-48e5-81be-586fbaeba29d/Thyroidectomy.pdf

Thyroidectomy under local and regional anaesthesia:
https://vula.uct.ac.za/access/content/group/ba5fb1bd-be95-48e5-81be-586fbaeba29d/Thyroidectomy%20under%20local%20and%20regional%20anaesthesia.pdf

Parathyroidectomy:
https://vula.uct.ac.za/access/content/group/ba5fb1bd-be95-48e5-81be-586fbaeba29d/Parathyroidectomy.pdf

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