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ROBOTICS IN ENT HEAD AND NECK SURGERY

Authors

Venkatakarthikeyan C (1), Swati Nair (2), Gowri Shankar (3)

Consultant ENT Head and Neck Surgery, Clinical Lead, Robotic Head and Neck Surgery (1),
Associate Surgeon, Department of ENT Head and Neck Surgery (2), Consultant ENT Head and Neck Surgery (3)
Apollo Main and Children's Hospital, Chennai

Abstract

Robot assisted surgery in the specialty of ENT Head and Neck Surgery can be classified into Transoral Robotic Surgery (TORS) for lesions in the oropharynx, larynx, hypopharynx and Remote access surgery through a hidden Retro Auricular Hairline Incision (RAHI) for removal of neck masses without leaving a scar in the visible portion of the neck. TORS has the advantages of excellent three-dimensional visualization, magnification in all directions, accessibility to the otherwise blind areas in the upper aero digestive tract. TORS offers significant benefits and lower morbidity rates as compared to the conventional surgical procedures and other adjunctive treatments like chemoradiation in selected patients. The indications of robotic surgery are expanding with the introduction of the retroauricular approach for various neck lesions which includes thyroidectomy, removal of tumors from parathyroid glands, parapharyngeal space, submandibular gland, branchial cleft cyst and neck dissection for metastatic cervical lymphadenopathy. This approach will become popular with young patients who want better cosmesis.

With the latest innovative developments in the technology and design of surgical robots, robotic surgery will continue to occupy an increasingly important role in the specialty of ENT-Head and neck surgery. In the future, we will see the widespread application of robotics not only for TORS or Retroauricular approach neck surgeries but also in Otology, Skull base and Paediatric Otolaryngology.

Keywords: Robot assisted surgery, Transoral Robotic Surgery (TORS), Remote access surgery.

Introduction

Robot assisted surgery in the specialty of ENT head and neck is a relatively novel approach which has led to a paradigm shift in the management of head and neck tumors.

It can be classified into Transoral Robotic Surgery (TORS) for lesions in the oropharynx, larynx, hypopharynx and Remote access surgery through a hidden Retro Auricular Hairline Incision (RAHI) for removal of neck masses without leaving a scar in the visible portion of the neck.

The Da Vinci Surgical System is a robotic system made by Intuitive Surgicals (Sunnyvale, California), and was approved by the Food and Drug Administration (FDA) in 2009. It is designed to facilitate surgery using a minimally invasive approach, and is controlled by a surgeon from a

console. The Da Vinci Surgical System has several key components:

· Magnified vision system that gives surgeons a three-dimensional high-definition view inside the patient's body

· Ergonomically designed console where the surgeon sits while operating

· Patient-side cart with Endo Wrist instruments that bend and rotate far greater than the human hand (7 degrees of movement with 540 degrees of arm rotation)

· It is powered by robotic technology that translates surgeon's hand movements into smaller precise movements in the endowrist instruments to perform the surgical procedure.

TORS (Figure 1):

Figure 1: TORS with oral cavity as the access point for the robotic instruments

Trans Oral robotic surgery was introduced in the clinical setting in ENT– head and neck surgery by Bert O'Malley and Gregory Weinstein at the University of Pennsylvania in 2006.1

TORS is a Natural Orifice Transluminal Endoscopic Surgery (NOTES) and the oral cavity is used as an access point to provide access to the pharynx, parapharyngeal space and larynx without the morbidity of conventional open surgeries and associated disruption of the pharyngeal musculature/laryngeal skeleton. It also overcomesthe limitations (line of sight issues, difficulty in en-bloc resection) associated with other transoral approaches, namelytransoral laser microsurgery (TLM).

Currently TORS is being performed in various centers across the world for the surgical treatment of tumors of the Head & Neck involving the oropharynx, supraglottis and hypopharynx. Conventionally, the management of these tumors requires extensive surgical resection through open approaches, which can result in varying degrees of aesthetic and functional sequelae resulting in severe physical morbidity and psychosocial repercussions. The conventional open surgical approaches have higher morbidity as they require larger external incisions and at times, disfiguring mandibulotomy or lip split approaches to gain access to deeper areas like the base of tongue, supraglottis or parapharyngeal space. This leads to longer hospital stays, delayed post-operative recovery, increased risk of complications and poor cosmesis.

Studies have shown that TORS dramatically improves the way the head and neck cancer patients are treated, by allowing complete resection of the disease, while preserving speech and swallowing. It is a minimally invasive procedure where both the endoscope and the instruments are introduced through the oral cavity with advantages of excellent three-dimensional visualization and magnification in all directions, wide range of motion and accessibility to the otherwise "blind areas".

TORS offers significant benefits and lower morbidity rates as compared to the conventional surgical procedures, which include faster recovery, avoids disfiguring mandibulotomy,

minimal visible scarring, reduced risk of wound infection, reduced blood-loss/postoperative pain, shorter hospital stay, improved speech/ voice conservation, and reduces the need for adjuvant chemoradiation for early stage cancers/ tracheostomy/ gastrostomy, thereby improving the quality of life.A simple example can be, if a patient with an early cancer of the tonsil/tongue base gets treated by TORS, there is a possibility of avoiding 6 weeks of radiotherapy with concurrent chemotherapy and its associated side effects.TORS also helps in the deintensification of the adjuvant therapy for intermediate to advanced cancers either by avoiding chemotherapy or de-escalation of dose of radiotherapy. Currently various multicentric RCT studies are being conducted to assess the role of TORS in oropharyngeal cancers and the possibility of deintensification of the treatment2,3,4

The newer indications of TORS include robotic tongue base reduction in patients with obstructive sleep apnea (OSA)for improving the airway as an additional technique apart from the nasal and palatal surgeries. This is especially helpful in patients not compatible with continuous airway positive pressure (CPAP) or patients who have failed conventional non-robotic multilevel surgery. There is now an increasing body of evidence to support its safety and efficacy as a treatment for moderate-to-severe OSA.5

TORS is also very useful in the evaluation and management of Carcinoma of Unknown Primary (CUP). When the primary tumour cannot be identified despite clinical examination, radiological imaging, FDG PET-CT, and panendoscopy with biopsies, TORS tongue base mucosectomywith tonsillectomy can detect the primary in upto 78% of the cases6. This paves the pathway for more targeted approach rather than wide field radiation treatment with or without chemotherapy in CUP.

Remote access robotic neck surgery (Figure 2):

Figure 2: Retro Auricular Hairline Incision (RAHI)

The incisions used in conventional surgeries, though they provide an optimal view and exposure may result in cosmetic problems with a visible scar in the anterior neck. To solve this issue especially in young patients, various remote access techniques have been described.

The first transaxillary robotic thyroidectomy was performed by WoongYoun Chung in South Korea in 20097 followed by the first robotic parathyroidectomy by Neil Tolley at St Mary's Hospital, Imperial College London in 2011.8 Though the transaxillary robotic surgery evolved rapidly in South East Asia for thyroidectomies and a variety of other head and neck procedures, it could not find its place as a popular technique in the West. The factors responsible for the limited uptake include cultural perception of having a neck scar, the profile of patients(larger nodules, large body habitus unsuitable for remote access surgery), longer operative time with low remuneration for the surgeons, the impact of FDA recall in 2011 and complications like brachial neuropraxia.

Based on the initial reports of Terris on robotic facelift thyroidectomy9, Yoon Woo Koh10 popularized the Robot-assisted neck surgeries via

Retro Auricular(RA)Approach (Figure 3)where the instruments mounted on the robotic arms are introduced through a workspace created via retroauricular hairline incision which is hidden behind the pinna and the hairline (Figure 4). This facilitates endoscopic neck surgeries under higher magnification and better cosmesis without a scar in the visible portion of the neck. This is an ideal treatment for young and socially active members of the society who need treatment for the tumours of the thyroid, parathyroid glands, parapharyngeal space tumors, submandibular gland removal, benign neck swellings like the branchial cleft cyst and neck dissection for metastatic cervical lymphadenopathy.

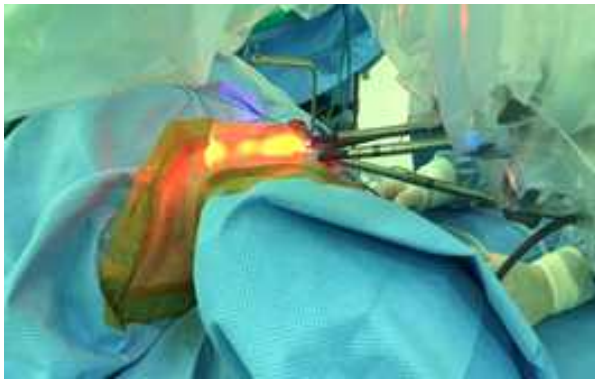

Figure 3 and 4: Workspace created via RAHI for the robotic instruments

The modified facelift (MFL) incision when performing conventional parotidectomy forms the basis for RA incision. The only difference between the MFL and RA incision is the presence of the preauricular limb. Most of the time, the robotic procedure can be performed with the RA incision. If there is a necessity for extended access or parotidectomy, the MFL incision can be performed. Remote access RA robotic surgery offersnot only better cosmesis but also facilitates complete removal of the lesion with surgical and oncological outcome compared to conventional open surgery. Since the incision is placed far from the location of the lesion, the possibility of wound complications like fibrotic band formation, dehiscence in the trifurcation, lymphedema, post radiation wound healing problems will not occur in the RA approach. In contrast to the remote access transaxillary approach, the dissection in RA approach is less and very much similar to conventional open surgeries.

The 3rd generation of Da Vinci surgical robot Xi is very useful for the retroauricular approach as the 4th endowrist arm with the prograsp forceps can be used for holding the tissues while the other two endowrist arms (monopolar scissors and bipolar Maryland forceps) can do the dissection and delivery of the neck tumours.

Current Scenario:

As compared to the West and South-East Asia, very few centers in Indiaare performing robotic ENT Head and Neck Surgery. The main reason for the limited uptake of robotic technology is the cost of capital equipment. The Da Vinci robot costs approximately 14 crore INR with an approximately yearly maintenance fee of 90 lakhs INR. Cost savings can only be achieved when the robot is routinely used by different specialtiesand with shorter operating time, lesser complications, shorter hospital stays and low readmission rates.

As compared to the conventional open approaches, robotic surgery in ENT incurs the additional cost of approximately 1,00,000 INR more. This additional cost is a real challenge for the patients to opt for robotic surgery. Though this a stumbling block, outreach awareness programs to the doctors and public, stressing the benefits of the robotic surgery will help in solving this problem. The scenario is likely to change with patents which are due to expire soon and newer robotic systems being introduced to the market. This will facilitate competition and bring down the cost.

The robotic technology satisfies the two primary goals of healthcare- improved care and reduced costs. TORS becomes cost-effective in large volume centers when performed by experienced surgeons as compared to other modalities due to decreased hospital stay, reducing the need for adjuvant therapy, decreased rates of gastrostomy and tracheostomy. Not only does it reduce the need for adjuvant therapy reducing the costs, it also avoids the long-term toxic effects of chemoradiation. The recovery time is also considerably reduced, because of which the patient can get back to his/ her job earlier, and regularize their income sooner. Another advantage for young patients with head and neck cancers is that, we can reserve the chemoradiation for recurrent and second primary cancers.

Complications resulting from robotic surgery are rare but can still occur (infection, bleeding, need for revision surgery, recurrence of disease and complications of general anesthesia). The rate of complications is far lesser as compared to the conventional surgeries when performed by experienced surgeons.

Future Directions:

Novel surgical robots are being introduced into the market which will be more beneficial for the ENT Head and Neck Specialty considering the narrow access both in transoral and retroauricular approaches

Flex® Robotic System (Medrobotics® Inc., Raynham, MA) is the first surgical robot to be specifically designed for TORS,11which has got the US-FDA clearance in 2015. It has operator controlled computer-assisted flexible endoscope with articulated segments to facilitate easy transoral robotic surgery. Its flexibility extends the possibility of its use in operating in the nasopharynx, hypopharynx, cervical oesophagusandfor glottic surgery.

Da Vinci SP Surgical System is a newer 4th generation robot which has three, multi-jointed, wristed instruments and a fully wristed 3D HD camera. The instruments and the camera all emerge through a single cannula. They can be properly triangulated around the target anatomy to avoid external instrument collisions that can occur in narrow surgical workspaces. This will be very useful for TORS, retroauricular approaches andtransoralthyroidectomies.

Innovative technologies can be integrated with robotic system to enhancesurgical precision and improve patient safety. Augmented Reality (AR) can provide the surgeon with real-time navigational cues and localization of key anatomical structures.

With an ever-increasing incidence of head and neck cancers in our country, transoralrobotic surgery will benefit lot of patients in the years to come.The indications of robotic surgery are expanding with the introduction of the retroauricular approach for various neck lesions.As the technological advancements in the

health sector are happening around the world at a faster pace, robotic surgery will continue to occupy an increasingly important rolein the specialty of ENT-Head and neck surgery. Innovation of the technology and improvisation of the technique in the future will lead to widespread application of robotics in Otology, Skull base and Paediatric Head and Neck Surgery.

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Corresponding author:

Dr. Venkatakarthikeyan C,

Consultant ENT Head and Neck Surgery, Clinical Lead, Robotic Head and Neck Surgery

Apollo Main and Children's Hospital, Chennai. Email: ace.apolloent@gmail.com