Robotic Neck Dissection

Neal Rajan Godse, MD[a], Toby Shen Zhu, BS[b], Umamaheswar Duvvuri, MD, PhD[a,c,*]

KEYWORDS

• Neck dissection • Head and neck cancer • Robot-assisted surgery • Robotics

KEY POINTS

- Neck dissection is a key surgical tool in the management of nodal disease in head and neck squamous cell carcinoma.
- Robot-assisted neck dissections have been procedurally well validated and appear to have oncologic and perioperative outcomes similar to open neck dissection.
- Robot-assisted neck dissections have the potential for improved cosmesis compared with open neck dissections, which is increasingly important in the younger, human papilloma virus–related disease cohort.
- Increased operative times and cost are important factors that currently limit the universal adoption of robot-assisted neck dissections.
- Further work and research are required to establish long-term outcomes and to increase experience with this novel surgical approach.

INTRODUCTION

Head and neck squamous cell carcinoma (HNSCC) is a family of malignancies that arise from epithelial tissues of the head and neck. Primary tumors arise in the upper aerodigestive tract, most commonly from carcinogenic exposures (eg, tobacco smoke and alcohol) or in response to infection by the oncogenic human papilloma virus. Local metastasis begins with involvement of the cervical lymphatics and then may proceed to distant metastases. Management of HNSCC involves surgery, chemotherapy, and radiation, depending on patient and tumor characteristics. The surgical neck dissection is a key component of surgical management of HNSCC and involves the systematic removal of cervical lymphatics for diagnostic and therapeutic purposes. Typically, neck dissections are performed with open approaches,

[a] Department of Otolaryngology, University of Pittsburgh, 203 Lothrop Street, Suite 500, Pittsburgh, PA 15213, USA; [b] University of Pittsburgh, School of Medicine, 401 Scaife Hall, 3550 Terrace Street, Pittsburgh, PA 15261, USA; [c] Department of Veterans Affairs, Pittsburgh Health System, University Drive C, Pittsburgh, PA 15240, USA
* Corresponding author. University of Pittsburgh, 203 Lothrop Street, Suite 500, Pittsburgh, PA 15213.
E-mail address: duvvuriu@upmc.edu

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allowing for direct visualization of the key neurovascular structures in the neck. More recently, however, some surgeons have begun exploring the use of surgical robotic platforms to perform minimally invasive neck dissections via incisions that spare the visible, anterior neck. Resultant research has been focused on understanding the pros and cons of these novel approaches.

HISTORY

The neck dissection as an operation has a rich history that begins in the early nineteenth century. Early surgeons, including Warren and Chelius, recognized cancer could spread to the local cervical lymphatics and the poor prognosis it portended and attempted surgical removal of individually affected nodes.[1] In the absence of anesthesia, aseptic technique, and a biological understanding of the disease process, these surgeries often carried significant morbidity and mortality with no survival benefit to the patient.

In the mid to late nineteenth century, Billroth, von Langenbeck, Volkmann, and Kocher described a variety of extirpative surgeries combined with some form of neck dissection.[2] These neck dissections involved removal of surrounding normal structures, not just single-node excisions. Sir Henry Butlin built on these techniques and incorporated Halstedian principles of surgical oncology, ultimately publishing a large series of patients who underwent surgeries for tongue cancer with neck dissections. He used the classic Y-shaped Kocher incision and removed the cervical lymphatics along with the internal jugular vein (IJV), sternocleidomastoid (SCM) muscles, and submandibular gland. Butlin recognized nodal involvement in tongue cancer was common and that lymph nodes could be removed prior to being clinically involved, thus creating the concept of an elective neck dissection. By employing this strategy, Butlin improved 3-year survival of patients with tongue cancer from 29% (n = 44, no elective neck dissection) to 42% (n = 70, elective neck dissection).[2,3]

In 1905, George Crile[4] published an article that described a systematic, radical en bloc neck dissection performed 121 times in 105 patients. Crile[5] went on to publish an expanded series of 132 surgeries in 1906 with 3-year follow-up. The publications included 12 meticulously illustrated figures that demonstrated the key anatomy. In the Crile radical neck dissection, the IJV, SCM, submandibular gland, tail of parotid, and often the spinal accessory nerve (SAN) all were resected routinely as part of the tissue block. In these landmark articles, Crile discussed the inferiority of subradical surgery and advocated for elective neck dissection in the clinically negative neck. The outcomes and techniques that Crile proposed in his original articles were so widely adopted that he now is credited as the father of the neck dissection.

The neck dissection continued to evolve in the twentieth century. Osvaldo Suarez proposed the functional neck dissection based on the anatomic understanding that the cervical lymphatics were contained within fascial sheathes that may allow other key structures in the neck to be spared.[6,7] Bocca observed the Suarez neck dissection and, along with Pignataro, went on to publish a series of 843 patients in the English literature who underwent the functional neck dissection as well as long-term outcomes.[8] In the late twentieth century, patterns of cervical metastases were identified, allowing surgeons to perform level-specific neck dissections based on the location of the primary tumor.[9] Thus the modern era of the neck dissection came about in which a customized neck dissection (eg, risk-stratified primary site–specific neck dissections, elective neck dissections for the clinically negative neck, and selective neck dissections that spare the SCM, IJV, SAN, and so forth) could be used based on the clinical scenario to maximize oncologic control and minimize surgical morbidity and mortality.

It is in this environment, rich in history, innovation, and discovery, that the concept of a robot-assisted neck dissection is introduced.

DISCUSSION

Robot-assisted surgery has become adopted in a variety of surgical fields due to the minimally invasive nature and ability to access difficult anatomy, visualize small structures in superb detail, and reduce physiologic tremor. Transoral robotic surgery commonly is used in otolaryngology for cancers of the oropharynx and supraglottis due to issues with access and visualization with more traditional approaches. As the use of robotic platforms in otolaryngology has increased, the potential for other applications in the head and neck have been proposed. Early work focused on robot-assisted transaxillary approaches for thyroidectomy with the potential advantage of no visible cervical incision.[10] As these surgeries were shown to be feasible and became widely practiced, particularly in Asia, the possibility of a robot-assisted neck dissection in cases of HNSCC was explored.[11] Potential benefits included improved cosmesis and reduced postoperative lymphedema. In the current state, robot-assisted neck dissections typically are performed using the da Vinci Surgical System (Intuitive, Sunnyvale, California) via a modified face lift/postauricular incision due to ease of access to the lymphatic packet of the neck while minimizing centrally located, visible incisions.

In this procedure, an incision is made first directly under the lobule of the ear and then carried postauricularly to approximately the middle of the ear and then inferiorly to the hairline. Subplatysmal flaps are raised medially to the anterior border of the SCM muscle. The great auricular nerve can be used to judge the depth of the subplatysmal flap laterally in the neck (**Fig. 1**). After the initial dissection, a Chung retractor is used to suspend the subplatysmal flap superiorly. The da Vinci surgical robot then is docked in the surgical field (**Fig. 2**). A 5-mm Maryland dissector and 5-mm Harmonic scalpel are used for deeper dissection. The structures within the deep cervical fascia are dissected, taking care to identify and preserve the SAN, IJV, and hypoglossal nerve (**Fig. 3**), while removing the lymphatic packet (**Fig. 4**). With the specimen removed, the wound bed is examined for hemostasis, the robot is removed, and the wound is closed over a suction drain (**Fig. 5**).

Oncologic control is of utmost importance for any proposed surgical intervention in HNSCC—as such, assessing the oncologic outcomes of robotic neck dissection versus open neck dissection is critical. Sukato and colleagues[12] looked at 11 published studies on robotic neck dissections and found that the total lateral lymph node yield, pathologic nodal yield, and 6-month locoregional recurrence rates were not statistically significant between open and robotic approaches. Because robotic neck dissection is a relatively new procedure, long-term control and survival rates have yet to be determined. Furthermore, they found that rates of common perioperative complications (eg, hematoma, chyle leaks, Horner syndrome, marginal mandibular nerve weakness, seroma, and wound infection) and length of stay in the hospital were similar between open and robotic approaches. Although more work needs to be done to establish long-term outcomes, it appears that the oncologic and perioperative outcomes of robotic neck dissection are comparable to those of open neck dissections.

The major advantage of a robotic operation is its minimally invasive approach. In a traditional open surgery, an incision is made in the anterior neck for adequate exposure of the entirety of the lymphatic packet but leaves a visible scar. By contrast, the modified facelift incision used for a robotic neck dissection is well disguised in

Fig. 1. Initial approach. A modified facelift incision is created and subplatysmal flaps are raised using open techniques. The great auricular nerve (*) is used to guide the depth of the flap laterally. Gross nodal disease is encountered in the level II lymphatics (^).

the postauricular tissue and in the hairline. As human papilloma virus–related disease reveals itself in a younger patient population, cosmesis increasingly is becoming a major concern. Although subjective, studies done by Sukato and colleagues[12] and Albergotti and colleagues[13] reported increased cosmesis (as determined by the surgeon) and patient satisfaction after robotic surgery.

Another advantage is the distance between the incision and the operative bed, especially as this relates to adjuvant radiation therapy. In patients considered high

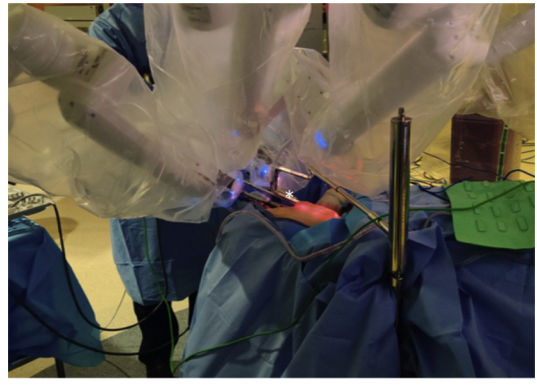

Fig. 2. Robotic setup. The head is turned toward the right and the robot arms (Maryland dissector and Harmonic scalpel) are inserted directly into the left neck. A Chung retractor is used to suspend the subplatysmal flap (*).

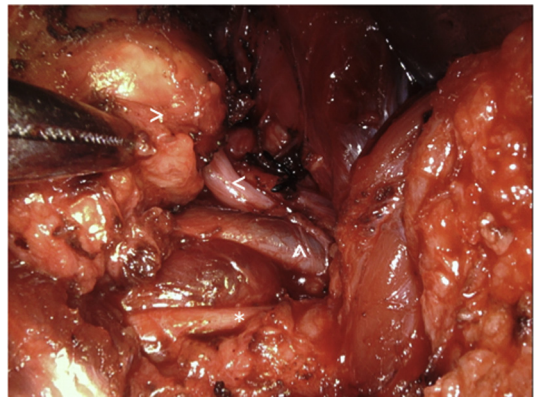

Fig. 3. Intraoperative image of left neck from a superior view with the robotic system. The accessory nerve (*), IJV (^), and hypoglossal nerve (<) have been dissected and preserved while raising the lymphatic packet (>).

risk for locoregional recurrence (eg, locally advanced T3/T4 disease, positive resection margins, extranodal extension, 2 or more pathologically positive lymph nodes, perineural invasion, and lymphovascular space invasion), adjuvant chemotherapy and radiation therapy often are used to improve oncologic control. Numerous complications can occur from radiating a relatively new operative site, including wound infection, incisional dehiscence and breakdown,[14] pharyngocutaneous fistula, and carotid rupture. The risk of developing these complications often necessitates a delay between the conclusion of surgery and the initiation of radiation to allow for postoperative wound healing to occur. With an incision that is positioned away from the operative bed and out of the field of irradiation, there potentially is a reduced risk of these wound healing complications.

Although robot-assisted neck dissections have advantages, there also are pertinent disadvantages that would discourage its use. One key issue in robotic surgery is the prolonged operation time. Although operational times for each surgery vary drastically

Fig. 4. Resected lymphatic packet with gross nodal disease.

Fig. 5. Final wound closure. The incision is closed over a suction drain hidden in the postauricular tissue and hair line.

depending on degree of disease and experience of the surgeon with robotic procedures, on average robotic neck dissections can take an hour longer (189 minutes vs 254 minutes[12]) or twice as long (110 minutes vs 234 minutes[13,15]) compared with traditional open neck dissections. This prolonged operative time is attributed to preparation of the robot and the learning curve associated with use of a novel technology. Increased operative and anesthesia times also could increase the rates of perioperative complications. Over time, however, the operational time for robotic neck dissections is expected to decrease with experience but may not ever reach or be faster than open neck dissections due to the inherent delays with using an additional technology.

Another important consideration is cost—current robotic systems are highly advanced and expensive systems and, as such, robotic surgeries are more expensive than traditional approaches. Factors that affect cost include the direct cost of the equipment, maintenance costs, and costs associated with increased times in the operating room. The details of cost analysis, including hospital costs, insurance costs, and costs charged to the patient, are beyond the scope of this article but must be considered at an institutional and systems level when studying how feasible it is to routinely adopt robotic surgeries.

There are advantages and disadvantages to both open and robotic neck dissections in the treatment of HNSCC and there are different indications for the use of either technique. A proposed algorithm of how to choose between robotic and open neck dissection is presented in **Fig. 6**. The authors believe the most important indication for performing a robotic neck dissection is if cosmesis is a primary concern, such as in the case of a younger patient or potentially in a patient with extensive wound healing

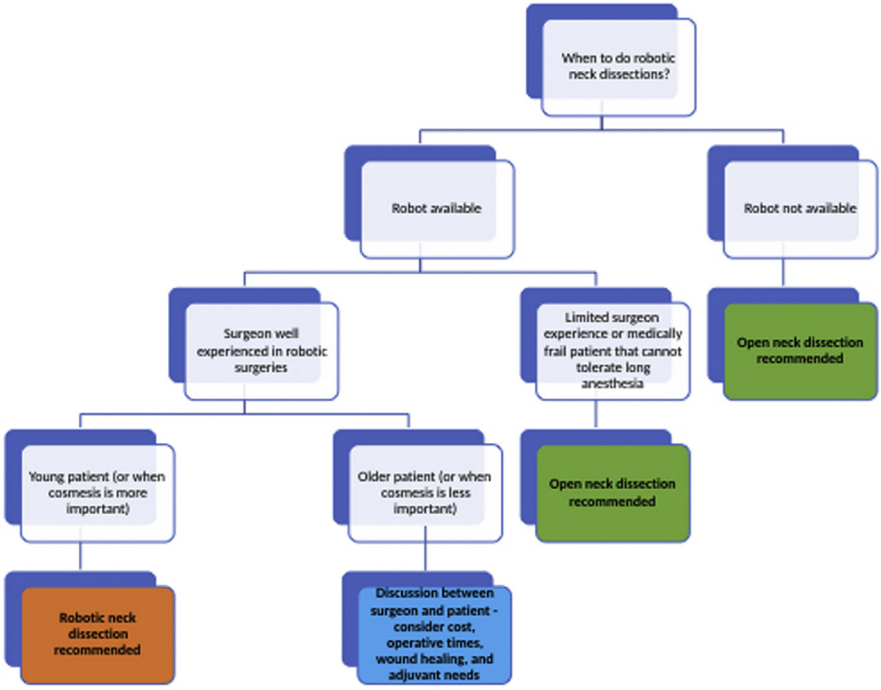

Fig. 6. Proposed algorithm of when to employ robotic neck dissection. Key considerations are surgeon experience, equipment availability, cosmetic needs, wound healing issues, medical comorbidities, and patient preference.

issues that require adjuvant radiation. Open surgery is indicated as the gold standard procedure and is indicated particularly when cost or experience eliminate the possibility of robotic surgery. As always, a careful discussion must be had on a patient-by-patient basis to evaluate whether a robotic neck dissection is the appropriate surgical therapy in a given scenario.

SUMMARY

From the days of Crile's radical neck dissections to the modern, minimally invasive robotic surgeries, there have been drastic advancements in the treatment of HNSCC. Early radical neck dissections removed many important structures in the patient's neck; elective and functional neck dissections refined the process and spared patients significant postoperative morbidity; and, finally, site-specific risk stratified selective neck dissections further refined the process while maintaining oncologic outcomes. Each new discovery improved some aspect of patient care but took time to become disseminated and adopted by the community of head and neck surgeons. In the modern age, robotic and minimally invasive surgery have been popularized among clinicians, and patient demand for improved cosmesis has increased. It still is imperative, however, to systematically examine the advantages and disadvantages of adopting robotic and minimally invasive techniques in the management of nodal disease of the neck in order to deliver evidence-based recommendations to patients.

Current literature suggests that perioperative outcomes and oncologic control are comparable between robotic and the gold standard open neck dissection, although long-term survival outcomes still need further research. The main advantage of robotic surgery is its minimally invasive approach, offering improved cosmesis by avoiding scarring of the anterior neck. There also may be important implications of having an incision distant from the operative bed when it comes to wound healing and the need for adjuvant radiation. Robotic neck dissections are associated, however, with a longer operative time, due to the physical setup of the robot and learning curve associated with the new technique, and increased costs. Both of these are expected to decrease with experience and technological advancements. Careful considerations of surgical experience, cost, patient disease status, and patient values are imperative in the decision to use robotic cervical lymphadenectomy over the traditional open procedure.

CLINICS CARE POINTS

- Robot-assisted neck dissections offer the possibility of minimally invasive approaches to the cervical lymphatics with potentially improved cosmesis
- When equipment and experience are available, robot-assisted neck dissection should be offered to young patients with cosmetic concerns and potentially in patients with wound healing issues.
- Robot-assisted neck dissection should not be used in situations when equipment, support personnel, or surgeon experience is lacking; in these scenarios, the open neck dissection should be employed.
- More research and experience are required to assess long-term oncologic outcomes and to assess whether cost and operative times decrease.

DISCLOSURE

The authors have nothing to disclose.

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