Robotics in oral and maxillofacial surgery

How trans-oral robotic surgery can treat cancer in the oropharyngyal space

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Surgical access to diseased tissues in the oropharyngeal space (OPS) is a well-known challenge in oral and maxillofacial and head and neck surgery. Moreover, the incidence of cancer in the OPS is on the rise. This includes the base of tongue (BOT), the pharyngoepiglottic and the glossoepiglottic folds, tonsillar fossa with the anterior and posterior pillars, soft palate and uvula, posterior and lateral pharyngeal walls.[1]

The rise in incidence of tumours in the OPS and specifically oropharyngeal squamous cell carcinoma (OPSCC) may be secondary to an epidemic of human papilloma virus (HPV), which is estimated to be the cause for 40%–70% of all newly diagnosed OPSCC.

This cancer seems to be affecting younger patients without the traditional risk factors of smoking or alcohol use.[2] Resectable tumours in the OPS can usually be accessed from the neck with pharyngotomy or with transmandibular approach.[3,4] The latter includes a lip split mandibulotomy to swing the mandible laterally for direct access in the OPS. However, the reported morbidities associated with the mandibulotomy range from 10% to 60% and include difficulty with speech and swallowing, malocclusion, orocutaneous fistula, temporomandibular joint pain and cosmetic deformity.[2,4,5] Pharyngotomy avoids the risk of the aforementioned complications; however, the access is more limited, with a risk of pharngocutaneous fistula and dysphagia (7–38%).[2,5]

Trans-oral robotic surgery (TORS) is advocated to offer an organ-preserving approach to the OPS that avoids the aforementioned complications. This article aims to review its role in oral and maxillofacial and head and neck surgery.

TORS and oropharyngeal tumours

To this date, there is no randomised controlled trial (RCT) comparing the oncologic outcome of chemoradiotherapy *vs* TORS for OPSCC. However, uncontrolled reports from the current literature suggest comparable oncologic outcomes with TORS, rather than Intensity-Modulated Radiation Therapy (IMRT), and functional outcomes may be superior.[6] Although the non-surgical management (including chemoradiotherapy) is organ-preserv-

ing, this may come with an increased risk of late swallowing dysfunction, which has a quantifiable impact on quality-of-life (QoL) measures.[7]

Since Weinstein *et al* performed the first TORS series for radical tonsillectomy in 2006, this method has increased in popularity. In a series of 27 patients, Weinstein's group achieved clear resection margins in 93% after radical tonsillectomy, with good swallowing and no gastrostomy dependency in majority of patients (96%).[8]

In a more recent case series on TORS for HPV-negative OPSCC, 89.6% of a total of 57 patients were disease-free on an average follow-up of 29 months, with an overall survival of 93.8%. The most common site was BOT for cT1 and cT2 tumours, with N^0 neck on clinical staging. A concurrent ipsilateral neck dissection was performed in all patients.[9]

A larger retrospective study, which included 1,873 patients with HPV-negative and positive OPSCC, revealed an improved 3-year survival in HPV-negative patients (84%) primarily treated with TORS compared with primary radiotherapy (66%) (p=.01).[10]

In the HPV-positive group, no significant benefit in three-year survival between the two cohorts was observed. The survival in the HPV-positive group primarily treated with TORS was 95% *vs* 91% for the radiotherapy group (p=.116).[10] Overall, the loco-regional control has been reported to be higher in non-smokers with HPV-positive OPSCC *vs* smokers with HPV-negative tumours.[11]

In the era of HPV-typing and primary radiotherapy, TORS allows for a de-intensification of the treatment of early-stage oropharyngeal carcinoma and thus avoids the early and late toxicities associated with radiotherapy/chemoradiotherapy.[9] A concomitant neck dissection with a well-hidden scar can be performed using TORS via retroauricular and transaxillary approach.[12,13]

Role of TORS in Cancer of Unknown Primary (CUP)

TORS for salvage surgery of oropharyngeal tumours and reconstruction

The surgical treatment of recurrent or advanced primary oropharyngeal tumours is demanding, regardless of the operative method. Traditionally chemoradiotherapy is the first treatment of choice for advanced or recurrent disease. Salvage surgery may be the only viable treatment for attempts at disease control or potential cure. Adequate access to the tumour, with good visibility, is key to achieve tumour-free resection margins. Normally the open surgical approach to the OPS is performed via transcervical or transmandibular access. However, the open approach for salvage head and neck surgery can be associated with high morbidity rates, poor overall and disease-specific survival, prolonged hospital stays, and decreased quality of life. Impaired swallowing function and speech, leading to tracheostomy and gastrostomy dependency, are part of the concerns for patients due to undergo salvage oropharyngeal surgery. Recent studies proved TORS to be an alternative surgical approach to recurrent tumours of the oropharynx and one that has acceptable oncologic outcomes and better functional outcomes than traditional open surgical approaches.[19,22] The intraoperative blood loss, time for postoperative recovery and hospital stay are less in patients who had robotic assisted salvage surgery.[22] Furthermore, TORS can reportedly help to reduce the incidence of positive resection margins and thereby significantly increase the two-year recurrence-free survival rate.[22,23]

TORS-assisted salvage of oropharynx creates larger defects that may warrant oropharyngeal reconstruction. TORS can be used as an adjunct to conventional reconstruction techniques for the inaccessible parts of the reconstruction. Free-flap reconstruction may be considered in 1 of the following conditions: 1) >50% palatal defect; 2) pharyngo-cervical communication; and/or 3) exposed pharyngeal internal carotid artery.[24] The robotic-assisted flap inset can be performed, especially in the deep portion of the reconstruction under superb vision.[25,26] Since the robotic-assisted reconstruction reduces the length of hospital stay compared with lip split mandibulotomy, it is considered to be a safe, effective and potentially cost-saving alternative.

> *The intraoperative blood loss, time for postoperative recovery and hospital stay are less in patients who had robotic-assisted salvage surgery*

TORS for dissection of para- and retropharyngeal space

Approximately 10% of patients with T1–T2 tonsillar cancer may have clinically positive retropharyngeal lymphnodes on the imaging, including CT or PET CT. Retropharyngeal lymphnode dissection (RPLND) is recommended for loco-regional disease control.[27,28] However, the access to metastatic lymphnodes in retro- and parapharyngeal space is challenging, which is another area for the application of TORS. A limited number of studies report about the feasibility of TORS for RPLND, either for metastatic nodes associated with an oropharyngeal primary or thyroid cancer.[28–31] However, the next generation of robotic systems with a flexible single arm may facilitate the resection of the primary tumour and RPLND.[32]

TORS for Sleep Apnea-Hypopnea Syndrome (OSAHS)

The feasibility of TORS for accessing the BOT and oropharynx has been used in treatment of benign problems such as Sleep Apnea-Hypopnea Syndrome (OSAHS).[33,34] The apnea-hypopnea index in patients with OSAHS can be significantly reduced with low morbidity and a short hospital stay.[35]

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