Original Article

Evolution of neck dissections performed in conjunction with transoral robotic surgery lateral oropharyngectomy

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Background: Two complications of transoral robotic surgery (TORS) lateral oropharyngectomy performed with neck dissection are hemorrhage and salivary leak. This study investigates the effect of neck dissection timing, and use of vessel ligation and muscle patch techniques, on the incidence of these complications.

Methods: A retrospective case review was conducted on 33 patients who underwent TORS lateral oropharyngectomy and ipsilateral neck dissection for tonsillar SCC in one tertiary medical center. A technique for vessel ligation and prophylactic orocervical repair is described.

Results: Eight patients (24%) underwent neck dissection prior to TORS, 19 patients (58%) had concurrent neck dissection with TORS, and six patients (18%) had a neck dissection following TORS. Of the 33 patients included, one had major haemorrhage and one developed a post-operative leak.

Conclusions: Neck dissection prior to TORS is feasible, enabling selective arterial ligation and digastric flap insertion, but further studies are required to confirm if this significantly reduces the incidence of major secondary haemorrhage and salivary leaks.

Keywords: Oropharynx; oropharyngeal neoplasms; robotic surgical procedures; minimally invasive surgical procedures; neck dissection

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Introduction

Oropharyngeal SCC accounts for 10% of the burden of head and neck squamous cell carcinoma, which is the 6th most common cancer worldwide (1). There is a rising incidence of disease in the oropharynx due to its causative relationship with the human papilloma virus (2). Since it was first described in 2005, transoral robotic surgery (TORS) has emerged as a safe and effective treatment modality for primary site disease (3-5). Surgical management of the neck is usually performed in conjunction with TORS.

TORS allows the surgeon 3D visualization and precise resection capabilities in the oropharynx. However, it is still susceptible to the complications seen in other forms of transoral surgery such as hemorrhage and orocervical communication (6). Haemorrhage after transoral surgery occurs in 3% to 10% of cases and is unpredictable and potentially catastrophic leading to mortality from aspiration and asphyxiation (7-9). Post-operative salivary leaks, while rarely associated with mortality, are a common cause of morbidity in transoral lateral oropharyngectomy when a neck dissection is performed concurrently, with rates of 1% to 15% (10,11).

A contentious proposition during TORS lateral oropharyngectomy and neck dissection is that ligation of the branches of the external carotid artery during neck

dissection reduces the frequency of severe hemorrhage (12). Two studies have evaluated this hypothesis and both have found that there is no significant difference in bleeding rates between patients who undergo prophylactic ligation compared to those who do not undergo prophylactic ligation (13,14).

It has also been hypothesized that the timing of neck dissection could play a role in the prevention, or recognition and management, of post-operative orocervical leaks (15). Some centers suggest staging the neck dissection to give the primary site time to heal and therefore prevent orocervical communication, while other centers promote concurrent neck dissection and use of local, regional or free-tissue flaps as required to repair the observed intraoperative communication (16-19).

In our institution, preference has been for neck dissection to be performed concomitantly with the primary resection. However, to maximize utilization of limited TORS surgical lists there is potential advantage from performing a neck dissection prior to TORS lateral oropharyngectomy. The prophylactic ligation of the branches of the external carotid artery during the neck dissection can be performed to prevent hemorrhage and there is also an opportunity for pre-emptive reinforcement of the area at risk of orocervical communication to prevent leak, with a local muscle flap, further enhanced by the interval time that enables tissues to heal.

The purpose of this study was to evaluate the effect of neck dissection timing, and use of vessels ligation and muscle patch techniques, on secondary haemorrhage and orocervical communication rates in a small series at our institution.

Methods

Patient inclusion

The authors assert that all procedures contributing to this work comply with the ethical standards of the Royal Adelaide Hospital (RAH) Human Research Ethics Committee and with the Helsinki Declaration of 1975, as revised in 2013. A retrospective chart review of the RAH head and neck surgery department cancer database in combination with the hospital operative registry identified all patients who underwent primary TORS for tonsillar SCC with a neck dissection from August 2008 to October 2015. Patients were included if they had pathologically confirmed SCC located in the tonsil treated with TORS coupled with neck dissection. Exclusion criteria included other forms of trans-oral surgery such as transoral laser microsurgery, patients with non-SCC tumours and cancer in other sites of the oropharynx and head and neck. There were 33 patients who met the inclusion criteria. Of these patients there were 8 cases in the group who underwent neck dissection prior to TORS. There were 19 cases in which the neck dissection was performed concomitantly with TORS and 6 cases in which the neck dissection was staged following TORS.

Operative technique

After obtaining informed consent, all patients underwent TORS to resect their oropharyngeal squamous cell carcinoma using the da Vinci surgical robot (Intuitive Surgical Inc., Sunnyvale, CA, USA) via previously established resection techniques (3,20,21). Appropriate ipsilateral or bilateral neck dissections of levels I–V were either performed prior to, concomitantly with, or post-primary resection, as clinically indicated. The exact levels dissected were based primarily on N stage. Generally the affected nodal basin was dissected with a surrounding echelon of normal nodes. Bilateral neck dissections occurred on the rare occasion that the contralateral side was thought to harbor disease either radiologically or pathologically.

Vessel ligation

After completion of the neck dissection the external carotid artery was located and skeletonized. The facial, ascending pharyngeal and lingual arteries were identified and ligated with Weck metal ligation clips (Teleflex Inc., Research Triangle Park, NC, USA) (*Figure 1*).

Prophylactic orocervical repair

After completion of the neck dissection and vessel ligation, attention was directed to the potential for orocervical communication secondary to TORS ablative surgery. The most common site is at the posterior aspect of the submandibular triangle, which lies adjacent to the floor of mouth and the tonsilo-lingual sulcus (*Figure 2*).

On the rare occasion of a demonstrable communication, the mucosa was directly repaired first. An anterior digastric muscle flap was used to reinforce the repair or, as in the majority of cases, pre-emptively reinforce this region.

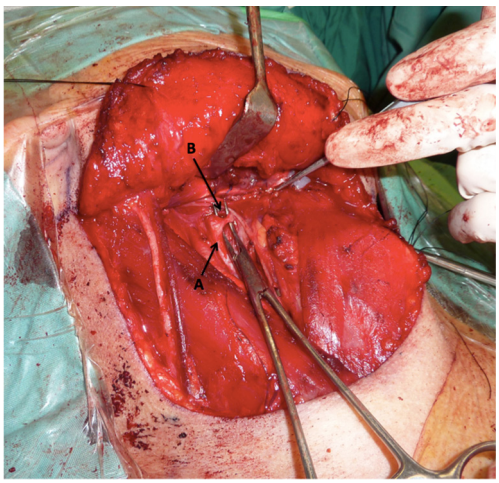

Figure 1 Identification of the branches of the external carotid artery for prophylactic ligation. (A) External carotid artery; (B) lingual artery.

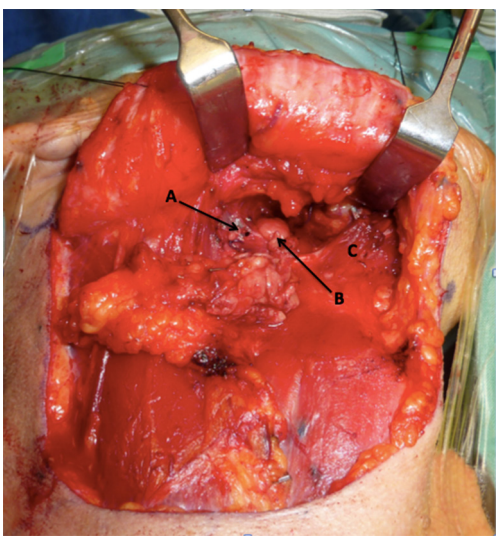

Figure 2 Orocervical communication. (A) Orocervical communication; (B) deep lobe of submandibular gland; (C) anterior belly of digastric muscle.

The muscle was mobilized anteriorly from its mandibular attachment and pedicled on the hyoid. The muscle was then sutured to the posterior edge of the mylohyoid muscle, periosteum of the mandible and to the posterior belly of the digastric muscle (*Figure 3*). Any primary mucosal repair, as well as the inset flap, was then reinforced with the fibrin sealant Tisseel (Baxter; Deerfield, IL, USA).

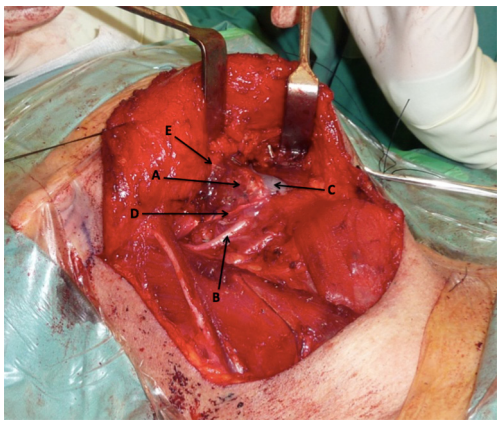

Figure 3 Anterior belly of digastric muscle flap. (A) Digastric muscle; (B) hypoglossal nerve; (C) posterior edge of mylohyoid with Tisseel (Baxter; Deerfield, IL, USA); (D) anterior belly of digastric muscle sutured to posterior digastric muscle tendon; (E) mandibular periosteum.

Data collection and analysis

An electronic spreadsheet was created to tabulate patient demographics, tumour location and staging, and timing of primary surgery and neck dissection. Data regarding the use of vessel ligation and fistula repair techniques and occurrence of hemorrhage and fistulae were entered into this spreadsheet. Data was retrieved from operative notes, pathology reports, hospital inpatient progress notes and outpatient department documentation.

Cases of post-TORS haemorrhage were classified according to a system for post-operative haemorrhage described by Pollei *et al.* (14). The tabulated data was analyzed with a specific focus on correlating hemorrhage and fistula rates with prophylactic surgical measures and timing of neck dissection.

Results

Patient demographics

Thirty-three consecutive patients who underwent TORS for tonsillar SCC coupled with neck dissection by the senior contributing authors were included in this retrospective analysis. In total 8 patients (24%) underwent neck dissection prior to TORS with a mean interval between operations of 8 days (*Table 1*). Nineteen patients (58%) had concurrent neck dissection with TORS, and 6 patients (18%) had

their neck dissection following TORS with a mean interval between operations of 10 days.

The mean age of patients was 55 and 67% of patients were male and 33% female. The pathology confirmed T staging of the 33 patients as follows: 7 T1 (21%), 19 T2 (58%), 3 T3 (9%) and 4 T4a (12%). The N staging of the 33 patients was as follows: 7 N0 (21%), 1 N1 (3%), 3 N2 (9%), 5 N2a (15%), 16 N2b (48%), 0 N2c, and 1 N3 (3%). No patients had distant metastases. Two patients had stage II disease (6%), 4 patients had stage III disease (12%), and 27 patients had stage IV disease (81%).

Incidence of hemorrhage (Table 2)

Of the 33 patients included in this study, 14 patients (42%) had documentation in their operative record of vessel ligation. Nineteen patients (58%) did not have documented vessel ligation. There was one case of major haemorrhage in this study, which required return to theatre, and this patient did not have branches of his external carotid artery ligated initially. None of the 14 patients who had vessel ligation experienced major postoperative haemorrhage.

Of the 14 patients who were documented to have had vessel ligation, 6 of these patients underwent neck dissection with vessel ligation prior to TORS, 6 patients had neck dissection and vessel ligation concurrently with TORS and 2 patients had neck dissection after TORS. One of the patients who was scheduled to undergo staged neck dissection following TORS had a mild tonsillar bleed on the first post-operative day of TORS, prior to his staged neck dissection, that resolved spontaneously and did not require return to theatre.

One patient out of the 33 (3%) included in this study had major haemorrhage, which required return to theatre. This was a 46-year-old male with a T2N2aM0 right tonsillar SCC. He had an ipsilateral level I–V neck dissection concurrently with the TORS resection of his tonsillar primary. He did not have the branches of his external carotid artery ligated during neck dissection. He was un-irradiated with no bleeding diathesis. On the fifth post-operative day he had a major haemorrhage from his right tonsillar bed and an urgent return to theatre was required. Topical measures were initially ineffective in haemostasis, so the neck was re-entered and selective arterial ligation performed. This resulted in haemostatic control. He recovered well from this episode with no sequelae or further secondary bleeds.

Incidence of orocervical communication (Table 3)

During each neck dissection, level Ib was assessed for the intra-operative presence of an orocervical communication. In six cases prophylactic reinforcement of these areas at risk of orocervical communication was performed. There were four cases of prophylactic repair of the potential area of orocervical communication in the neck dissection preceding TORS group, and one case each in the concurrent and post-TORS neck dissection groups.

Table 1 Timing of neck dissection in TORS lateral oropharyngectomy (n=33)

Timing of ND	Cases [%]	Mean interval between operations (days)
Pre-TORS	8 [24]	8
With TORS	19 [58]	–
Post-TORS	6 [18]	10

TORS, transoral robotic surgery; ND, neck dissection.

Table 2 TORS lateral oropharyngectomy vessel ligation in neck dissection data

Bleeding data	No vessel ligation documented	Vessels ligated pre-TORS	Vessels ligated with TORS	Vessels ligated post-TORS
Patients	19	6	6	2
Post-operative bleeds	1	0	0	1
Mean post-operative day of bleeding	5	–	–	1
Bleeds requiring operative intervention	1	–	–	0
Rate of bleeding	5%	0%	0%	50%

TORS, transoral robotic surgery.

Table 3 TORS lateral oropharyngectomy orocervical communication repair in neck dissection

Intraoperative findings and repair procedure	Neck dissection preceding TORS	Neck dissection concurrent with TORS	Staged neck dissection following TORS
Intra-operative communication + repair (post-op leaks)	0 (0)	3 (0)	2 (0)
Pre-emptive muscle patch (post-op leaks)	4 (0)	1 (0)	1 (0)
No intra-operative communication, no pre-emptive muscle patch (post-op leaks)	4 (0)	15 [1]	3 (0)

TORS, transoral robotic surgery.

In all six of these instances there was no post-operative leak. Of the 8 patients who had neck dissection prior to TORS, there were no cases of post-operative orocervical communication and salivary leak. The 4 patients who did not have prophylactic orocervical communication repairs also did not develop a post-operative leak.

Of the 19 patients who underwent TORS and neck dissection concurrently, 3 patients had documented evidence of orocervical communication identified intraoperatively. In the group of patients who underwent TORS followed by neck dissection, 2 of 6 had documented evidence of orocervical communication identified intraoperatively. In both groups of patients, in all cases where intraoperative communication was observed and documented, repairs were performed and none of these patients went on to have a post-operative leak.

There was only one patient in the study who developed a post-operative leak. This was a 48-year-old man with a T1N2bM0 right tonsillar SCC who underwent a concurrent neck dissection and TORS. Interestingly this man was not identified as having an orocervical communication intraoperatively and no prophylactic repair was performed. The discovery of a leak was made in the immediate postoperative period when the wound site was observed to inflate and deflate with respiration. He was treated conservatively with low-pressure wall suction, appropriate dressing, intravenous antibiotics and delay of oral diet with exclusive nasoenteric feeds for alimentary support. A subsequent barium study performed 12 days postoperatively showed no evidence of extraluminal contrast material to suggest a leak, at which time all of the above interventions were ceased. The leak did not reoccur thereafter.

Discussion

There is currently no universally accepted guidelines or gold standard for timing of neck dissection in patients undergoing TORS lateral oropharyngectomy for the treatment of tonsil carcinoma. Concomitant primary resection and neck dissection would allow for selective arterial ligation and identification and repair of a level 1b orocervical communication, or prophylactic repair of this area, to prevent postoperative salivary fistulas. The patient needs only one general anaesthetic and there is an overall reduction in the total treatment package time and potential risk of tumour progression that could occur with delay in initiation of definitive treatment (22). Unfortunately, this is not always feasible, due to limited access to TORS operative lists and the increasing number of patients presenting with HPV-related tonsil cancers. Maximization of the TORS list for primary resections can occur by staging the neck dissections on these patients, either before or after the TORS primary resection. Performing the neck dissection before the primary resection facilitates pre-resection selective arterial ligation and prophylactic repair of level 1b (where orocervical communications occur), although strong evidence to show a resultant reduction in secondary haemorrhage and salivary fistula rates remains to be elucidated.

The Royal Adelaide Hospital began TORS protocol for the treatment of tonsillar SCC in August 2008. In this time the type and timing of the neck dissection has evolved as a result of a better understanding of the postoperative journey. There are now two major modifications to a standard neck dissection that we would routinely advocate. These are selective arterial ligation of the facial, lingual and ascending pharyngeal arteries, and local muscle flap reinforcement of level 1b (even in the absence of an identified orocervical communication). In this retrospective study there were no secondary bleeds or salivary leaks in the patients in which the neck dissections (and modifications) were conducted either on the same day or the week prior. To facilitate the improved morbidity that comes from these

modifications the neck dissection needs to be performed either concomitantly or prior to the primary resection. This study, although limited by small numbers, confirmed the feasibility and safety of such a protocol.

The literature is scarce regarding prophylactic external carotid system vessel ligation during neck dissection and incidence of post-TORS lateral oropharyngectomy hemorrhage. To assess post oropharyngectomy haemorrhage rates and associated risk factors Pollei *et al.* conducted a retrospective chart review of 906 patients who underwent any type of transoral surgery for oropharyngeal carcinoma (14). Transcervical external carotid system vessel ligation was performed with the primary resection in 15.6% of patients. There was no overall difference in bleeding rate or severity of bleeding in patients who underwent ligation versus those who did not. There was a trend toward reduced post-oropharyngectomy bleeding severity with vessel ligation and so this group of authors recommended ligation for patients at higher risk of haemorrhage such as those with high T-stage tumours, primary tonsil tumours and patients undergoing revision surgery. Mandal *et al.* undertook a retrospective review of 224 consecutive patients who underwent TORS for any indication at a single institution and found 22 patients (9.82%) who had varying degrees of post-operative bleeding (13). The results of this demonstrated that prophylactic transcervical arterial ligation did not significantly decrease overall post-operative bleeding rates, however, like the previous study, there was a trend toward decreased haemorrhage severity.

Repanos *et al.* undertook a systematic review to assess how timing of neck dissection following transoral laser microsurgery in various head and neck subsites impacts upon patient outcomes, including its impact on post-operative haemorrhage rates. Fifteen studies in this review directly made mention of bleeding after primary resection, giving a rate of 5.3%, however there was a significant paucity of information on how timing of the neck dissection and use of external carotid system vessel ligation correlated with rate of post-operative haemorrhage (23). Crawford *et al.* contend in a review that ligating vessels in a pre-staged neck dissection may theoretically make the operative field less bloody during a delayed primary site ablation although clear evidence for this does not exist (12). Unfortunately, given the retrospective nature of the present study, this was not measured and analyzed.

Several authors have reported the role of primary closure of ablative defects after TORS pharyngectomy and concomitant neck dissection to decrease fistula rates (16-19). Genden *et al.* performed musculomucosal advancement flap pharyngoplasties in 25 patients (with a concomitant velopharyngoplasty in 6 of these patients) in a prospective non-randomised clinical trial (19). Also included in the study were 6 patients who underwent radial forearm free-flap reconstruction. No patients in this study developed neck infection or salivary fistula. Nam *et al.* described their method of closure of orocervical communication in 13 patients who underwent TORS for tonsillar SCC and where orocervical communication resulted during concomitant neck dissection (17). In all cases, their method of primary closure of the defect and reinforcement with muscle coverage was achievable with no cases of post-operative pharyngocutaneous fistula formation.

When the neck dissection occurs prior to the primary resection no orocervical communication will be apparent, as the oropharynx remains *in situ*, and therefore communication into the mouth is not possible due to the interposition of this tissue. We would however still advocate reinforcing the potential leak area with a local muscle flap, given the timing interval between the neck dissection and TORS procedure. This occurs no more than a week apart to reduce the overall treatment package time. This is unlikely sufficient time for the oropharyngeal defect to fully mucosalize and protect from any potential orocervical communication.

While our study focused on the incidence of pharyngocervical communication in patients where level I was routinely dissected, it is worth noting that there is no consensus in the literature regarding the best management of level I during neck dissection for oropharyngeal primaries (24). Some authors consider level II to IV dissection to be sufficient (25) whereas other authors recommend the removal of level I in clinically positive necks with tonsillar primaries (26,27). It has been our practice to remove level I regardless of nodal status in tonsillar primaries given the small but universally reported risk of <10% of level 1 metastasis from the tonsil (25-28). This practice is supported in the literature by other authors (29,30).

There is also no consensus in the literature regarding the best timing of neck dissection in the management of primary oropharyngeal SCC (23). Moore *et al.* conducted a retrospective chart review of 148 patients who underwent TORS and concurrent neck dissection for oropharyngeal neoplasia and identified 29% as having an orocervical communication intraoperatively, all of which were managed

according to the authors' described algorithm for treatment of pharyngocervical communication (31). Of these, 4% developed a subcutaneous pharyngeal fluid accumulation requiring post-operative management. These authors concluded that concurrent neck dissection at the time of TORS resection is safe and feasible and that while orocervical communication is common intraoperatively, persistent fistula formation is uncommon and preventable with prompt recognition and intervention. Möckelmann *et al.* performed a prospective case series comparing 21 patients who underwent TORS and concurrent neck dissection with 20 patients who underwent neck dissection staged after their TORS resection (15). These authors reported no significant difference in complication rates between the two groups and recommended that staged neck dissection following primary resection is safe if there are theatre constraints that do not allow for concurrent resection. We would however advocate staging the neck dissection before the TORS resection.

Limitations of our study are its retrospective nature and the small number of patients included in this series, which diminishes its statistical power. Risk factors for post-operative haemorrhage and orocervical fistula have not been controlled for. Practical and economic factors associated with timing of neck dissection were not evaluated and questions surrounding the oncological and mortality outcomes relating to timing of resection of the primary site or the cervical lymph nodes remain unanswered.

In conclusion it would seem ideal that neck dissection and its modifications occur concurrently with the TORS resection, however where TORS operative time is limited then this can occur prior to the resection in a way that is safe and feasible. It does not compromise patient care and allows maximization of robotic theatre utilization. Pre-staged neck dissection prior to TORS provides the opportunity to ligate the branches of the external carotid artery and reinforce the areas at risk of orocervical communication as outlined in this paper. While the numbers in this series are small, this study adds to the scarce data in the literature on the effect of vessel ligation and orocervical communication repair techniques on post-operative haemorrhage and post-operative leak rates respectively. Further large-scale prospective clinical trials are necessary to define the precise value of these techniques and until such studies are complete, an expert consensus among highly experienced transoral head and neck surgeons may be helpful to guide standardization of such approaches.

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Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/ajo.2018.01.09). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The authors assert that all procedures contributing to this work comply with the ethical standards of the Royal Adelaide Hospital (RAH) Human Research Ethics Committee and with the Helsinki Declaration of 1975, as revised in 2013. Written informed consent was obtained from the patient for publication of this manuscript and any accompanying images.

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