Journal of Robotic Surgery (2023) 17:613–618
https://doi.org/10.1007/s11701-022-01456-z

ORIGINAL ARTICLE

Practising transoral robotic surgery in a middle-income country: surgical outcomes and early challenges

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Received: 29 January 2022 / Accepted: 7 September 2022 / Published online: 1 October 2022

Abstract

Transoral robotic surgery is a minimally invasive surgical technique that recently debuted in Malaysia. However, there are concerns over its cost, practicality, and feasibility in local settings. Our study aims to evaluate the surgical outcomes of transoral robotic surgery and discuss its learning curves. The clinical records of all patients who underwent transoral robotic surgery in a university hospital were reviewed. 25 patients were identified with a mean age of 43.9 years. The commonest indication was obstructive sleep apnoea (OSA) (76%), followed by base of tongue carcinoma (16%), recurrent tonsilitis and Wharton's duct cyst (4% each). For excision of tongue base in obstructive sleep apnoea without epiglottectomy, the mean operating time was 2.3(±0.9) hours with an average of 2.8(±0.4) days of hospital stay. The success rate for OSA surgery was seen in 78.9% of cases. The mean operating time for transoral excision of tongue base carcinoma was 4.3(±2.5) hours, whereas the mean hospital stay was 9(±3.6) days. All surgical margins were cleared with no recurrence except for one patient. The recurrent tumour was successfully excised via transoral robotic surgery, and he remained disease free after one year. The most frequent post-operative complaints were dysphagia, post-nasal drip, and hypogeusia. Transoral robotic surgery in Malaysia is in the commencement phase, where some pitfalls are expected. Opportunities should be given for more surgeons to acquire this technique so that minimally invasive surgery for head and neck diseases is readily available for patients in middle-income countries.

Keywords Base of tongue · Transoral · Robotic surgery

Introduction

Transoral robotic surgery (TORS) has been widely accepted as a minimally invasive surgery for head and neck diseases, especially in developed countries. It allows surgical access to the difficult-to-reach region of the oropharynx and larynx via the mouth opening. O'Malley et al. were the first to describe TORS in 2005, where they performed supraglottic partial laryngectomy on cadavers and canine models using the Da Vinci Robotic System. Later, they managed to translate the experiment into clinical practice by performing a transoral robotic surgery at the base of the tongue to excise a tumour. It saved the patient from a more invasive mandibulotomy which carried more significant morbidity risks [1, 2]. TORS provides excellent surgical access to the tongue base neoplasms, and the patient can regain post-operative oropharyngeal functions without compromising the oncology margins [3].

TORS can be achieved using either the Da Vinci Robotic Surgical System (DVRSS) or the Flex Robotic System. DVRSS is applicable to multiple specialities while the Flex Robotic System is mainly designed for TORS and colorectal procedures. As DVRSS was invented initially for abdominal and pelvic surgeries, some modifications were made later to suit TORS, the system used in our setting. In Malaysia,

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currently, there are six DVRSS with only two centres offering TORS procedures. Given the relatively new and limited availability, it is a challenge to kickstart the service in this country. We would like to share our experience and challenges in starting TORS in our centre.

Materials and methods

Data source and outcome measures

This is a retrospective study conducted in a single institution. All cases of TORS performed from 1 March 2019 until 29 February 2020 were included. Patients' clinical records and post-operative surgical notes were reviewed. Data such as patients' demographics, indications for surgery, operating time, length of hospital stay, outcomes of surgeries and post-operative complaints were collected and analysed using IBM SPSS Statistics. Descriptive statistics were conducted for patients' demographics. Operating time was described in hours (mean), and total hospital stay was defined in days (mean). Surgical outcomes were determined based on the indications; for obstructive sleep apnoea, the surgical outcome was determined by the success rate in reducing the apnoea–hypopnea index (AHI) of more than 50%. Meanwhile, for tumour cases, the surgical outcome measure was surgical margin clearance and the presence of tumour recurrence. Post-operative complaints were recorded and described in percentage if present.

Surgical technique

TORS is performed under general anaesthesia, with the patient lying in a supine position. The method of ventilation is preferable via nasotracheal intubation or tracheostomy in tumour cases. The neck is flexed while the head is extended to align the oral cavity, oropharynx and larynx for optimal surgical access. Crowe–Davis mouth gag is inserted into the patient's mouth to maintain the mouth opening. Ideally, to achieve optimal mouth opening with a better operative field, a Flex retractor should be used. This retractor also provides excellent visualisation of the deeper structures due to its axis rotations, which is suitable for endolaryngeal cases such as partial epiglottectomy and laryngeal work. As DVRSS was not specifically invented for TORS, some modifications were made to suit the procedure. We utilise a smaller 5 mm, 0° rigid endoscope with two working robotic arms instead (Fig. 1). At least one trained assistant is required to dock the robot before the operation (Fig. 2). While operating, the assistant must be at the patient's side to assist with fogging, retraction of tissues, and ensuring no injury to lips and buccal mucosa from the collision of instruments. The surgeon viewed the operative field and controlled the robotic arms via a console remotely, as shown in Figure. 3. The robotic arms can precisely dissect and coagulate the tissues depending on the type of surgery. However, in a case of uncontrolled bleeding, the surgeon should be ready to convert the procedure into open surgery.

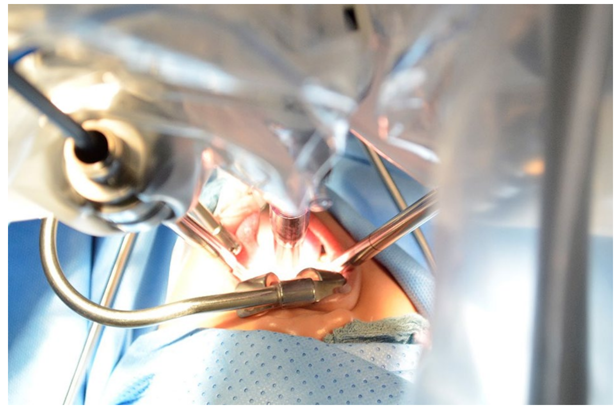

Fig. 1 Two robotic arms with a single camera port are the minimal requirement for TORS. Meanwhile, a Crowe-Davis mouth gag keeps the mouth open during surgery

Results

A total of 25 patients were identified, where the majority were males (56%) and of Malay ethnicity (76%). The mean age is 43.9 (±16.6) years old, ranging from 27 to 79 years old. The most frequent indication of TORS in our centre is obstructive sleep apnoea (76%). Others include the base of tongue tumours, recurrent tonsillitis and Wharton's duct cyst, as shown in Table 1.

Excision of tongue base with or without epiglottectomy for OSA is the commonest intervention in our series, N=12 (48%). The mean operating time was 2.3(±0.9) hours with an average of 2.8(±0.4) days of hospital stay for excision of tongue base without epiglottectomy, and 2.7(±1.1) hours with an average of 3.0(±0.) days of hospital stay with epiglottectomy. The success rate of OSA surgery was defined as more than a 50% reduction from the pre-operative AHI. This was seen in 15 out of 19 patients (78.9%). Meanwhile, the other four remaining patients refused post-operative polysomnography due to financial constraints. Generally, they reported good post-operative clinical outcomes.

In the primary base of tongue carcinoma cases, the tumour was at stages I, III, and IV, respectively. These patients underwent TORS base of tongue tumour excision, combined with bilateral neck dissection, elective tracheostomy and dental clearance. The mean operating time was 4.3(±2.5) hours, and the mean hospital stay was 9(±3.6) days. All surgical margins were cleared, and they

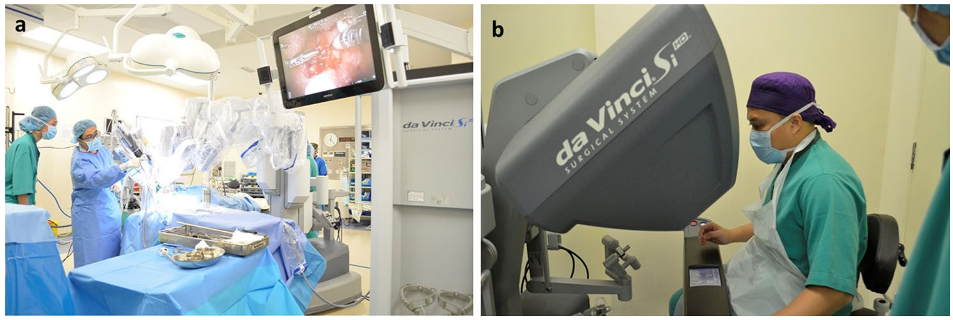

Fig. 2 **a** A trained assistant is required to dock the robot before surgery and assist during surgery. **b** The surgeon is operating from a remote console

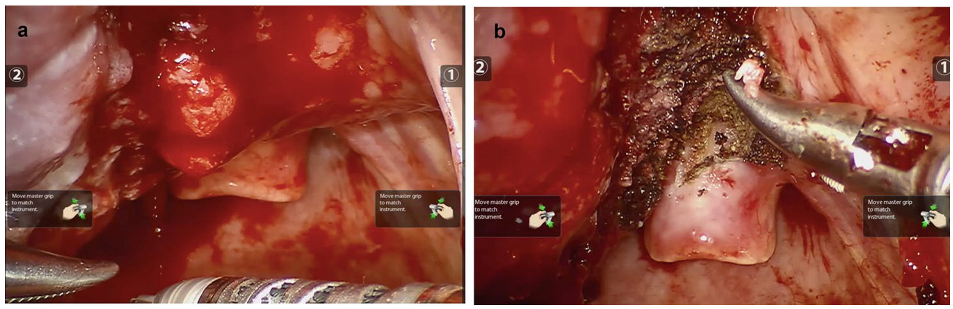

Fig. 3 Surgeon's operative view from the DVRSS console. **a** Pre-excision of tongue base tumour. **b** Post excision of tongue base tumour where haemostasis was achieved using the robotic arms

Table 1 Patient demographics and indications of TORS.

Demographics	Study sample N=25	Percentage (%)
Age		
20–39	16	64
40–59	4	16
60–79	5	20
Gender		
Male	14	56
Female	11	44
Ethnicity		
Malay	19	76
Chinese	1	4
Iban	1	4
Indonesia	1	4
Bangladesh	1	4
Somalia	2	8
Indications		
Obstructive sleep apnoea (OSA)	19	76
Base of tongue carcinoma	4	16
Recurrent tonsillitis	1	4
Wharton's duct cyst	1	4

received adjuvant radiotherapy post-operatively. The stage IV patient developed a recurrence at 11-month follow-up and was successfully excised via TORS with a negative margin. This patient remained disease free at one-year follow-up. The adenotonsillectomy was combined with endoscopic turbinoplasty in a single setting. Meanwhile, Wharton's duct cyst excision was performed alone via TORS. Both procedures showed excellent post-operative results, as shown in Table 2.

Dysphagia, post-nasal drip and hypogeusia are the commonest post-operative complaints (36%, respectively) which mainly occurred in OSA surgery patients. The symptoms were transient and resolved after 9–23 days (mean=11.8 days). The complete list of post-operative complaints is shown in Table 3. No post-operative complaints were documented for adenotonsillectomy and Wharton's duct cyst patients.

Discussion

This is the first literature that describes the outcomes of TORS in Malaysia, a middle-income country with multiracial demographics. The mean age is similar to the grand mean concluded in a meta-analysis of OSA cases (49.39 years), possibly as the bulk of our case series is predominantly sleep surgeries [4]. Surgical intervention in OSA is common among the Asian population as they tend to have more severe OSA when adjusted for age, sex and body mass index [5]. In contrast to a survey done in the United States, more than 80% of TORS indications were for the base of tongue carcinoma [6]. Patients' selection in TORS for carcinoma cases is limited as most head and neck cancers in Malaysia presented at an advanced stage [7, 8].

In our region, the base of tongue and epiglottis were rarely operated on for OSA patients. We mainly relied on continuous positive airway pressure treatment, which was

Table 2 Type of TORS, operating time, hospital stay duration and surgical outcomes.

Interventions	Number of patients N=25	Mean operating time in hours (SD)	Mean hospital stay in days (SD)	Outcomes
TORS tongue base excision for OSA	6	2.3 (± 0.9)	2.8 (±0.4)	AHI reduction more than 50% in all patients
TORS tongue base excision for OSA + epiglottectomy	6	2.7 (± 1.1)	3 (±0.6)	AHI reduction more than 50% in 5/6 patients
TORS tongue base excision for OSA + adenotonsillectomy + septoturbinoplasty	4	3.75 (± 0.29)	2.75 (±0.96)	AHI reduction more than 50% in 1/4 patients
TORS tongue base excision for OSA + tonsillectomy + UPPP	2	2.7 (± 1.1)	2.5 (±0.7)	AHI reduction more than 50% in all patients
TORS tongue base excision for OSA + septoturbinoplasty	1	4	2	AHI reduction more than 50%
TORS tongue base excision for tumour + neck dissection + tracheostomy	3	4.3 (± 2.5)	9 (±3.6)	One patient with recurrence at 11 months post-op
TORS tongue base excision for tumour	1	1.5	3	No recurrence on one-year follow-up
TORS adenotonsillectomy + turbinoplasty	1	4.5	3	No complications
TORS excision of Wharton's duct cyst	1	2	3	No recurrence after one year

Table 3 TORS post-operative complaints.

Post-op complaints	N (%)
Dysphagia	9 (36)
Post-nasal drip	9 (36)
Hypogeusia	9 (36)
Tongue paraesthesia	2 (8)
Globus pharyngeus	2 (8)
Aspiration	2 (8)
Nasal regurgitation	1 (4)

hardly complied with by patients. With the availability of TORS, we can excise the tongue base adequately and partially excise the epiglottis for retroflexed cases to overcome this issue. Drug-induced sleep endoscopy was used to diagnose OSA patients with base of tongue hypertrophy with or without retroflexed epiglottis. For patients who also have low-lying palate with enlarged palatine tonsils, TORS base of tongue excision was initially performed as a second stage procedure following modified uvulopalatopharyngoplasty (UPPP) with tonsillectomy. Later, these procedures were combined in a single setting, and it has been applied in many works of literature worldwide. A meta-analysis study demonstrated that the surgical success of TORS in sleep surgery was 48% [4]. However, in a more recent meta-analysis and systematic review, surgical success was reported at more than 70%, and this outcome was similar to our series, 78.9% [3, 4].

TORS also provided an advantage to our three elderly patients (69–79 years old) with a base of tongue carcinoma, where we successfully excised the tumour without needing a mandibulotomy. Therefore, it reduced morbidity and preserved important functions without compromising the surgical margins in this high-risk group of patients. The two patients with advanced tumour (stages III and IV) underwent neck dissection after the robotic procedure, which explained the long operative time in these cases. Although the excision margin was negative for malignancy, we still commenced with adjuvant radiotherapy as the tumours were of a high stage with the presence of positive cervical lymphadenopathy. TORS has the least likely post-operative positive margin and need for chemoradiation adjuvant than nonrobotic surgery in early-stage oropharyngeal squamous cell carcinoma (OPSCC). However, the overall survival rate is the same [5]. TORS allows tumour excision of the recurrent base of tongue carcinoma cases, and the patient remained disease free for at least one year. Paleri et al. concluded TORS is a valid management option for recurrent or residual OPSCC. The oncologic outcomes are similar to open surgery, or transoral laser microsurgery provided careful patient selection [9].

The diversity in the type of intervention led to a wide range of intraoperative duration and hindered the real operative time. The robot docking time is not documented in this study; however, it is estimated at about 41.6 minutes [4]. The surgeon needs to overcome the learning curve of losing the tactile sensation while operating via the console. As the surgeon learns to control muscle tension while handling the console, a good tissue plane can be achieved with less bleeding encountered, contributing to a shorter operative time later. We started with low-risk cases such as adenotonsillectomy and Wharton duct cyst excision to acquaint with tissue manipulation and dissection plane. Later, we progressed to tumour excision under the supervision of a head and neck oncology surgeon.

In an oropharyngeal cancer survey, TORS decreases hospital admission by 1.5 days compared to other techniques [10]. However, in our series, tumour excision resulted in the longest mean of hospital stay (9±3.6 days). This is attributed mainly to elderly post-operative care with tracheostomy, nasogastric tube feeding and swallowing rehabilitation. In fact, many of our patients live far away as TORS services are scarce and some are from remote areas with difficult access to healthcare services. In particular, one of the cancer patients came from Borneo (west side of the country) and another from Somalia, and these patients stayed for longer periods to ensure they had recovered well prior to their flight home. It is vital to ensure our patients are really fit prior to discharge following TORS. Though the complication rate of TORS is reported at 10.1% [6], most of our post-operative complaints were transient. Transient dysphagia is the commonest post-operative complaint studied by Macariello et al., and a similar result is found in our study [11]. We observed transient post-nasal drip and hypogeusia were equally common, 36%, respectively. Other post-operative complaints such as nasal regurgitation and candidiasis were not documented in previous studies [3, 4, 6, 10, 11]. There were no major complications such as post-operative bleeding or aspiration encountered in our series. Three of our oropharyngeal cancer patients who needed pre-operative tracheostomy were able to be decannulated uneventfully prior to discharge. Perioperative care of OSA patients is also pertinent following sleep surgery including TORS. All patients were put on nasopharyngeal airway post-operatively and monitored in the post-anaesthesia care unit (PACU) with 1:2 nursing care and continuous oxygen saturation monitoring. The nasopharyngeal airway was removed before they were transferred to the general ward.

Starting the TORS service in our centre was not an easy task as we were the pioneer, and it was a relatively new surgical method to be offered to our citizens. Other challenges include expensive running costs, lack of trained staff, lack of exposure in the first starting cases, and lack of awareness of this service among the medical fraternity in the country. These challenges were overcome as we performed more cases, and the staff and surgeon were more familiar with utilising the DVRSS. This was shown in the operating hours when the operating time becomes shorter with increasing cases. Operating time includes draping, driving and docking by staff nurse and cutting time by surgeon. Park et al. claimed that robotic thyroidectomy operative time gradually decreased and reached a plateau after 20 surgeries for new surgeons [12]. Over the period, with the increasing number of patients operated on, the awareness among the medical fraternity also increased; hence more cases were referred.

The cost-effectiveness of robotic surgery remains a major concern among surgeons, especially in developing countries where health funding is scarce. The initial cost to purchase and maintain the robot is more expensive than traditional approaches, as demonstrated in a cost comparison study for partial and total laryngectomies [13]. However, other economic advantages need to be addressed, as concluded by Jeremy et al., whereby TORS reduces the length of hospitalisation and hospital-related cost significantly compared to other surgical techniques for oropharyngeal neoplasm [10]. TORS is more cost-effective than chemoradiotherapy in early T-staging oropharyngeal squamous cell carcinoma, provided a careful patient selection was made [14]. Meanwhile, Weinstein et al. suggested that increasing the caseload will maximise the profitability of the robotic system in a hospital with multiple specialities [15]. There is growing research and demand on the development of telesurgery incorporated with robotic surgery, improving surgical training and sharing expertise worldwide [16]. Therefore, manufacturers are competing to create affordable robotic systems, and thus the cost limitation can be eliminated in the future. In addition, an economic study on the cost-effectiveness of robotic surgery particularly in low to middle-income countries would be invaluable to determine its future practice.

Conclusion

Transoral robotic surgery has various indications, and it offers patients a minimally invasive surgery as an option to previously difficult-to-reach lesions. Our case series highlights the early practice in starting TORS and the associated learning curve as well as the usefulness of this service in improving patient outcomes. It also provides a minimally invasive technique suitable for elderly patients with co-morbidities in achieving adequate surgical margins, particularly for tumour cases. More surgeons should be trained in this field so that robotic surgery is readily available for patients regardless of their locality. Although there were challenges in starting and providing this service in this part of the world, we believe that the learning curve should be overcome to provide this beneficial service to our citizens.

Author contributions All authors contributed to the study conception and design. Data collections were performed by Ahmad Kusyairi Khalid and research assistants. The data analysis and the first draft of the manuscript were written by Khairil Afif Mahmud. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

Ethics approval This is a retrospective study and approval was obtained from relevant authorities.

Consent to participate Informed consent was obtained from all individual participants included in the study.

Consent to publish No identifiable images of the participants were included in this manuscript.

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