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ORIGINAL ARTICLE

The implementation of TORS for head and neck surgery in Thailand

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Abstract

Transoral robotic surgery (TORS) is a novel surgical treatment of head and neck cancers, mainly for limited tumor in oropharynx and supraglottis. Despite the major advantage of favorable postoperative functional outcomes, many obstacles exist during the implementation of TORS, especially in a country where financial resources are modest. We demonstrated our experience of initiating this sophisticated technology at the largest tertiary hospital in Thailand. A retrospective review study was conducted in patients with benign or malignant lesions during 2014–2020 at Siriraj Hospital. Different periods of operation time between initial and subsequent cases were compared to evaluate learning-curve improvement. A total of 36 patients underwent TORS, with median follow-up time of 18 months. The average time of room set-up, anesthesia, and positioning was 37 ± 14, 13 ± 7, and 15 ± 7 min, respectively. Whilst, the average robotic procedure time and total time in room were 44 ± 19 and 118 ± 31 min, consecutively. There was no significant difference in any time interval, except the set-up time between initial and subsequent cases. The worthwhile utilization of TORS could be administered cost-effectively despite the complicated and daunting implementation of TORS. Whilst, meticulous planning and sufficient training prior to the initiation of TORS can favorably shorten the learning curve of operative staffs in the TORS team.

Keywords Transoral robotic surgery · Head and neck cancer

Introduction

Open surgical approaches to the field of head and neck can be associated with morbidities, such as cosmetic deformity, malocclusion, and dysphagia. Deglutition requires the coordination of several structures involving in oral and pharyngeal phases of swallowing. The vast majority of muscle, soft tissue, and nerve injuries by open surgical approaches disturb both anatomical and physiological neuromuscular controls. Since the past few decades, there has been an emerging trend toward using primary radiotherapy and concurrent chemoradiation therapy (CCRT) as a standard modality in head and neck cancer cases. However, the related side effects of CCRT remain significant, in that patients receiving intensity-modulated radiotherapy (IMRT) treatment notably experience toxicities (e.g., mucositis and/or dysphagia) and overall poor quality of life [1, 2].

Recent technological advances have led to a reconsideration of novel surgical resection techniques, with a shift from radical surgery to minimally invasive surgery, such as transoral robotic surgery (TORS) and transoral laser microsurgery (TLM). The TORS technique was first developed in 2005 by Dr. Gregory Weinstein and Dr. Bert O'Malley Jr. at the University of Pennsylvania. Over the years, numerous studies have been performed to authenticate the safety and efficacy of TORS for benign and cancer cure, without potentially disastrous complications [3–5]. Ever since its approval by the US Food and Drug Administration in 2009, TORS has been extensively applied and gained popularity in many types of head and neck surgery.

In Thailand, TORS was first introduced in 2013. There are currently 11 da Vinci robotic systems installed in five major hospitals, including four of the systems at Siriraj Hospital in Bangkok. Following the publications of pharyngeal and laryngeal surgery by mean of the da Vinci system, TORS has become acceptable in many developed countries because of its safety and efficacy [5–7]. However, the initiation of TORS in a developing country involves many obstacles. Most importantly, TORS remains expensive and is not covered by the Thai Universal Health Coverage Fund

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or personal medical insurance. Only a small percentage of Thai patients can afford the surgical technique of TORS. There are not only the excessively high costs of investing in a robotic system, but also the crucially large expenses of disposable equipment in surgical operations. Moreover, this novel technology significantly requires a dedicated and well-trained surgical team. Despite our familiarity with robotic system initiated by Siriraj Urological Robotic Surgical Center, there is still a major challenge to create a robotic surgical team for ENT procedures. In the meantime, our need to share robotic facilities and a timetable with the surgical department, which mostly performs robotic procedures (Fig. 1), have enforced us to adopt this technology, albeit with some difficulties. Whilst, in a bid to facilitate the integration of new surgical equipment and enhance the familiarity of all operative staffs with TORS set-up, multiple procedure simulations must be well practiced prior to the actual implementation of procedural algorithms in the TORS teamwork.

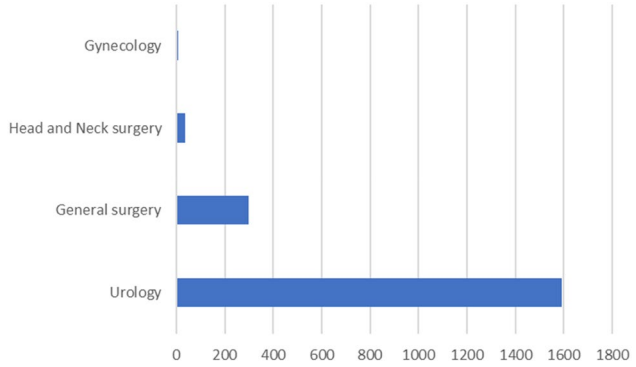

Fig. 1 Robotic surgery performed by different specialties and total number of patients at Siriraj Hospital during 2014–2020

Whereas, it is critical for TORS to be acquired as an alternative modality in cancer treatment by members of the tumor board, including medical and radio-oncologists. Fortunately, we have received support and funding from the Faculty of Medicine at Siriraj Hospital, which enables the strengthening of our TORS implementation. In this study, we present the development of TORS implementation in Thailand, with mainly focusing on our experiences and patients' outcomes at Siriraj Hospital.

Materials and methods

Design and protocol

A retrospective review study was conducted in patients with benign or malignant lesions during 2014–2020 at Siriraj Hospital. The study received ethical approval from the Faculty of Medicine Siriraj Hospital, Mahidol University. All patients provided their written informed consent. Those eligible for TORS, with primary or recurrent oropharyngeal or supraglottic cancer at stages T1, T2, and selected T3, were included in the study. The time measurement between initial and subsequent cases was compared to evaluate the learning-curve improvement.

The room set-up time is defined as the time needed to prepare the surgical instruments, along with the waiting time for

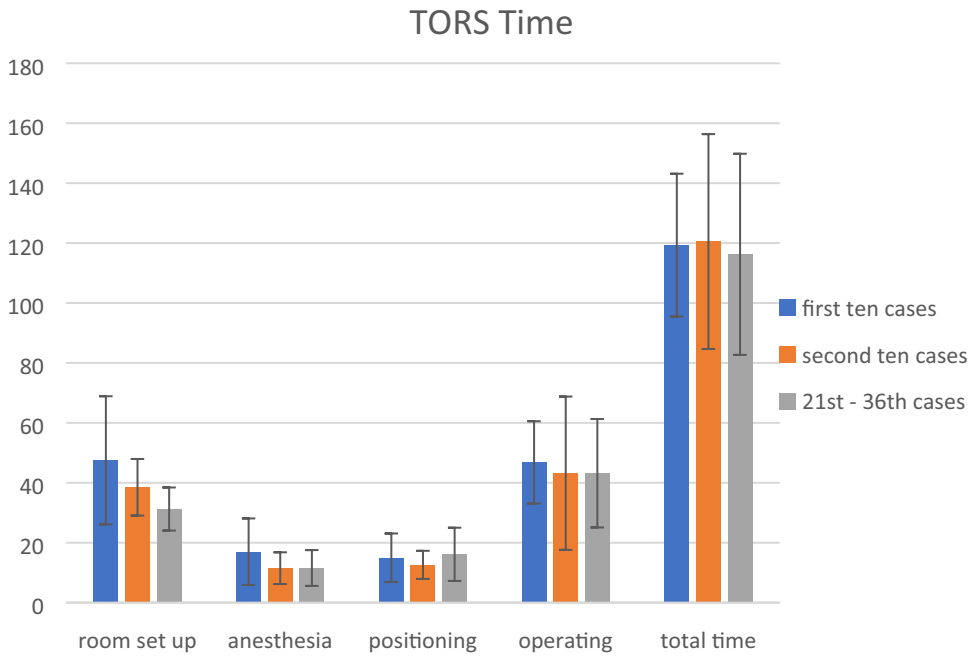

Fig. 2 Comparison of mean ± SD time measurements of the first 10 cases, second 10 cases, and last 16 cases of TORS

a patient's entry. The anesthesia time is defined as the time between each patient's entry into the operation room and the anesthesia turnover to the surgeons, which includes anesthesia positioning, induction, and intubation. The positioning time is defined as the time from the anesthesia turnover to the start of robotic procedure, which consists of patient's positioning, direct laryngoscopy, and docking of robotic arms. The robotic procedure time is defined as the total time between the start of robotic procedure and the removal of robotic arms from the patient. The average total time in room is defined as the involving of any other surgical procedures, such as neck dissection, concurrently performed in four cases.

Surgical procedures and operative techniques

All surgical indications of a malignant tumor were approved by the Tumor Board of Siriraj Cancer Center with complete endoscopic and imaging evaluation. The initial endoscopy was done to verify tumor accessibility and resectability for TORS. Superficial and localized carcinomas which abided at the base of the tongue, soft palate, tonsils, pharyngeal wall, epiglottis, aryepiglottic fold, and false vocal cord were indicated for surgical resection. Tumors with T4, unresectable neck disease, neoplastic related trismus, and multiple distant metastases were contraindications for TORS. In our study, the surgical procedures were mainly performed by the da Vinci Si robotic system. The 0°- or 30°-angled (8.5 mm) endoscope was applied, along with 5-mm Endowrist instruments (Maryland forceps and Bovie electrocautery spatula). The placement of tracheostomy and feeding tube was decided by the surgeon, depending on the risk of postoperative bleeding and airway obstruction. Each patient obtained comprehensive information regarding the surgical procedures.

Adjuvant therapy

Indications for adjuvant radiotherapy and chemotherapy were based on the usual criteria: pT > 2; a positive margin on the surgical sample; perineural or lymphovascular invasion; more than one involved lymph node; and extranodal spreading. The adjuvant therapy was comprised of the postoperative radiation therapy using intensity-modulated radiation therapy (IMRT). Concomitant weekly cisplatin was offered to suitable cases of extracapsular extension or a positive surgical margin.

Results

Patients and procedures

A total of 36 patients who underwent TORS during 2014–2020 were reviewed (Table 1), with median follow-up time of 18 months [IQR: 9–36]. The median age was 62 years [IQR: 57–70]. Twenty of the patients were diagnosed with oropharyngeal cancer, followed by eight supraglottic cancer and eight benign lesions in the oropharynx and supraglottic. The average time of room set-up, anesthesia, positioning, robotic procedure, and total time in room was 37 ± 14, 13 ± 7, 15 ± 7, 44 ± 19, and 118 ± 31 min, consecutively (Fig. 2). There was no significant difference (p values > 0.05) in any time period measurement between initial and subsequent cases, except room set-up time (p value < 0.05). Also, no intraoperative complications were observed in any of these cases. Blood loss in those who underwent TOR was 30 ± 10 ml. No patients received blood transfusion during the operation.

Postoperative outcome

The median hospital stay was 4 days [IQR: 3–8]. A preoperative tracheostomy prior to definitive surgery was performed in four cases (11%), all of which involved supraglottic cancer. The median decannulation time was 3 months [IQR: 3–10]. No immediate postoperative airway was compromised. Three patients underwent enteral feeding via a nasogastric tube, which was removed after a median period of 10 months [IQR: 7–10]. Full oral feeding was possible in all patients after a median of 7 days [IQR: 3–10]. Two patients with supraglottic cancer (5%) demonstrated initial laryngeal aspiration, with later improved without intervention required. Postoperative hemorrhaging at the surgical site occurred in two patients (5.5%) on days 7 and 9. Cauterization without TORS was successfully administered in both of them. Whilst, the later with T3 tonsillar carcinoma required an emergent tracheostomy for airway protection. The tube was downsized and then removed at 2 months after radiotherapy. None of the benign patients experienced treatment complications.

Discussion

Despite being classified as a minimally invasive procedure, the standard protocol requires that robotic surgeons need to be registered. To ensure a smooth transition to this advanced technology, our comprehensive training of nurses and surgeons has been supported by the Department of Otorhinolaryngology at Yonsei University College in South Korea. Whereas, the certified TORS surgeons have to perform their operations with an adequate number of patients. During the first year of our TORS implementation, ten procedures were performed, mostly on oropharyngeal tumors, both benign and malignant. Once all of the team members were familiar with the operating system, we moved on to more advanced procedures,

Table 1 First 36 cases of TORS at Siriraj Hospital

Case #	Gender	Age	Location of primary	Staging	Pathological report	Positioning time (min)	Robotic procedure time (min)	Tracheostomy required/days	Days with tube feeding	Days in hospital	Complications
1	M	63	BOT	T1N0M0	SCCA	12	58	*n*	2	3	–
2	M	76	BOT	rT1	SCCA	10	50	*n*	5	7	–
3	F	61	BOT	N/A	Low grade mucoepidermoid CA	20	50	*n*	2	3	–
4	M	60	Tonsil	T1N0M0	SCCA	35	40	*n*	1	2	–
5	M	56	Tonsil	rT1	SCCA	10	25	*n*	3	4	–
6	F	60	Vallecular	N/A	Benign	5	35	*n*	0	4	–
7	M	57	Epiglottis	rT1	SCCA	13	62	*n*	3	4	–
8	M	76	BOT	N/A	Lymphoma	15	70	*n*	2	4	–
9	M	74	BOT	N/A	Lingual tonsillar hypertrophy	15	40	*n*	3	4	–
10	M	61	Tonsil	T2N2bM0*	SCCA	15	38	*n*	7	10	–
11	M	65	BOT	T1N0M0	SCCA	15	75	*n*	3	5	–
12	M	66	Supraglottis	T2N0M0	SCCA	10	30	y/3	3	4	–
13	M	62	Tonsil	rT1	SCCA	6	19	*n*	2	3	–
14	M	62	Supraglottis	T2N0M0	SCCA	20	50	y/3	5	8	–
15	M	76	Tonsil	rT1	SCCA	10	45	*n*	3	4	–
16	M	71	BOT	N/A	Lingual tonsillar hypertrophy	10	83	*n*	1	2	–
17	M	60	BOT	rT1	SCCA	10	25	*n*	2	3	–
18	F	40	BOT	N/A	Lingual thyroid	20	25	*n*	2	3	–
19	F	65	BOT	N/A	Hemangioma	15	10	*n*	2	3	–
20	M	70	Supraglottis	T2N2M0	SCCA	10	70	*n*	4	5	–
21	F	70	BOT	N/A	Lingual tonsillar hypertrophy	15	30	*n*	3	4	–
22	M	62	Supraglottis	T2N2M0	SCCA	15	30	*n*	5	6	Postoperative bleeding
23	M	59	Tonsil	T2N2M0*	SCCA	15	45	*n*	7	8	–
24	M	57	Supraglottis	T2N0M0	SCCA	25	95	*n*	5	6	–
25	M	63	BOT	T1N3M0	SCCA	5	35	*n*	2	3	–
26	F	25	Vallecular	N/A	Benign	15	45	*n*	3	5	–
27	M	46	Supraglottis	T3N2M0	SCCA	45	35	y/12	12	4	–
28	F	63	BOT	N/A	Lingual tonsillar hypertrophy	10	15	*n*	3	4	–
29	F	61	BOT	N/A	Verrucous CA	15	33	*n*	2	3	–
30	M	79	Vallecular	N/A	Lymphoma	15	33	*n*	2	3	–
31	M	42	BOT	T1N0M0	SCCA	13	55	*n*	2	3	–
32	M	73	Tonsil	T1N3M0*	SCCA	10	45	*n*	3	4	–

Table 1 (continued)

Case #	Gender	Age	Location of primary	Staging	Pathological report	Positioning time (min)	Robotic procedure time (min)	Tracheostomy required/days	Days with tube feeding	Days in hospital	Complications
33	M	66	Tonsil	T2N0M0	SCCA	15	35	*n*	3	4	–
34	M	57	Supraglottis	T2N3M0	SCCA	15	50	y/3	5	15	–
35	M	60	Tonsil	T3N2M0*	SCCA	20	65	y/65	50	30	Postoperative bleeding
36	M	45	BOT	T1N0M0	SCCA	10	45	*n*	2	3	

M male, *F* female, *BOT* base of tongue, *SCCA* squamous cell carcinoma, *CA* carcinoma, *n* no, *y* yes, * concurrent neck dissection with ECA ligation

such as supraglottic laryngectomies and those involving a higher tumor volume of oropharyngeal carcinoma. Thus, our result was an initial report from a single institution on the feasibility, safety, and surgical outcomes, including post-operative adverse events of TORS in Thai head and neck cancer patients. It was the first report on a clinical study of TORS in Thailand.

In our study, a conversion to external approach was not necessary in any of TORS procedures, while a multi-institutional study revealed that 1.1% of those who underwent TORS inadvertently converted to an open surgical procedure [8]. All patients were preoperatively verified for trismus and brachygnathia. Potential limitations related to tumor exposure were assessed to avoid a surgical cancelation, following the comparatively high costs of robotic set-up.

In the present study, no significant difference in the anesthesia, positioning, robotic procedure, and total time in room for the TORS procedure was noted when compared with the first 10 cases, second 10 cases, and last 16 cases. However, the significant shortening of room set-up time was observed in our study, which could be explained by the familiarity and experience gaining of nurses in the preoperative procedure. Our results were compatible with those of another study, in comparisons of the time by the two means of calculation. Richmond, 2011 [9] compared the first 10 cases with the last ten, and then subsequently re-calculated by comparing the first 15 cases to the last five ones. Despite a non-significant difference between the two groups, there was a trend toward a shorter operation time and the total time in the operation room once the staffs gained adequate experiences [9]. A prospective study of 168 cases yielded a particular improvement, with an increasing number of cases [10]. Nonetheless, the lack of significant improvement in the operating and docking time in our study suggested that an adequate training and a well-planned surgical operation before initiation of a new procedure could significantly minimize the learning curve of medical personnel.

From our experiences, there are three major obstacles in adoption of TORs, including:

(i) Learning curve: Despite the fact that robotic surgery promises a shorter learning curve when compared with minimally invasive surgery platform [11], unlike other laparoscopic robotic-assisted surgical techniques, TORS set-up has a different protocol. To overcome this problem, our robotic surgical staffs have integrated new surgical equipment in the systematic and stepwise curriculum, starting with the observation and assisting robotic operation, followed by the robotic console training under supervision of the experienced robotic teams. All of the trainings have been supported by the Department of Otorhinolaryngology at Yonsei University College in

South Korea. These systematic trainings are related to cooperative operational sequences, better robotic surgical skills, and minimal learning-associated morbidity [12–14].

(ii) Operational limitations: Due to a dimension of devices, the specific operation room with sufficient space has to be scheduled for robotic surgery. In our institute, TORS needs to share the timetable with other surgical departments, mostly of the occupied robotic device in-situ operation theater. Besides, the operating room reservation and funding process may take more than 3 weeks, possibly causing the illegibility of our TORS eligible cases due to disease progression. Moreover, no 5-mm instrumentation of TORS is applied in other departments. Thus, the procurement of TORS instrumentation tools requires an advanced and well-planning process.

(iii) The cost of robotic system: In our hospital, the operational cost of robotic surgery is a one-time charge regardless of duration of service. Since TORS actually requires less operative time than other robotic-assisted procedures, the expense calculation based on duration of employment is thus more optimized. Furthermore, the contemporary da Vinci robotic platform remains beyond the financing capability of Thai Universal Health Coverage Fund or personal medical insurance. Fortunately, with support and funding from the Faculty of Medicine, Siriraj Hospital, we could perform TORS in optimal selected cases.

Major bleeding is one of the most common complications after TORS. In our study, there were two cases (5.5%) of hemorrhage after TORS. The first was a T1 base of tongue carcinoma, with postoperative bleeding on the 7th day. The second cases was a T3 tonsillar carcinoma, which bled on the 9th day, postoperatively. The methods of hemostasis in both cases during the initial TORS procedure comprised of hemoclip, bipolar, and monopolar cautery. In the latter case, ipsilateral lingual artery was controlled during a concurrent neck dissection. Bleeding complication was especially monitored under general anesthesia in our two patients, while the modes of bleeding control were suture ligation and bipolar cautery, without robotic assistance. A meta-analysis of post-TORS hemorrhage yielded the overall incidence of 5.78% [15]. However, the prophylactic ligation of external carotid artery (ECA) or its branches did not significantly impact the incidence of postoperative bleeding, but may reduce the severity of hemorrhage [16]. Bleeding in a controlled ECA was observed from the contralateral ECA distribution, particularly in a previously radiated patient [17].

The tracheostomy-dependency rate of TORS is reported at 0–3.5%, as compared with 0.1–4.5% in radiation therapy [18]. Despite a preferable non-tracheostomy treatment, the tracheostomy should be done in all possible cases of compromising perioperative airway. Our two patients underwent the tracheostomy prior to TORS in anticipation of airway edema during the perioperative time. Nonetheless, both of them were decannulated within a few days. Meanwhile, tracheostomy was performed in the other patient due to post-surgical hemorrhage on the 9th day postoperatively, with the downsized, left prophylactically tube for 3 months and finally removed after adjuvant radiotherapy. Hence, the clinical judgment regarding a prophylactic tracheostomy for a large-volume tumor needs to be justified for both TORS and conventional therapy.

Conclusion

The implementation of TORS could be complicated and daunting, especially where sharing of robots and operation rooms is indispensable. Whereas, the cost-effective administration of TORS machines with meticulous planning and sufficient training prior to the TORS initiation can favorably shorten the learning curve of operative staffs in the TORS team.

Compliance with ethical standards

Conflict of interest Warut Pongsapich, Cheerasook Chongkolwatana, Hataikarn Chuetnok, and Narin Ratanaprasert declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all patients for being included in the study.

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