# 机器人在头颈外科中的应用——香港中文大学经验

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[摘要] **目的**:机器人手术目前已在头颈部多个区域得到了应用,本文探讨香港中文大学头颈外科机器人手术的经验。**方法**:回顾性分析 2015 年 1 月以来在香港中文大学耳鼻咽喉头颈外科开展的所有机器人头颈外科手术病例资料。**结果**:24 例患者采用达芬奇 S 或达芬奇 Xi 系统进行了手术,21 例患者使用新型柔性机器人达芬奇 SP 系统行了手术。均无二次手术等严重不良事件。已经发表的达芬奇 SP 系统手术的 7 例患者早期结果表明,通过达芬奇 SP 系统可以到达鼻咽、口咽部、下咽部、喉部和咽后淋巴结完成手术,不需中途改变手术方式,没有发生与使用该系统有关的严重不良事件或不良事件。**结论**:通过我们在香港中文大学的经验,我们认为采用达芬奇机器人系统进行经口手术或经耳后入路颈部手术是安全有效的。

[关键词] 机器人;头颈部手术;经口机器人手术

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经口机器人手术(transoral robotic surgery,TORS)始于 2005 年,McLeod 和 Melder 首次报道采用达芬奇机器人系统进行会厌囊肿切除[1]。随后,宾夕法尼亚大学率先开展了 TORS 口咽癌切除术[2-3],并促进美国 FDA 批准达芬奇机器人系统用于切除 $T_{1/2}$ 口咽癌,此后,相关文献报道了利用 TORS 可进行鼻咽部、下咽部及喉部病变手术[4-7]。

除 TORS 外,达芬奇机器人系统可用于多种不同入路的甲状腺切除术,包括腋下入路、耳后入路、腋乳入路和经口腔前庭入路[8-11]。此外,利用机器人系统具备图像放大、三维视觉、运动缩放和震颤过滤等多种功能,其他头颈部手术也可采用腋下或耳后等隐蔽入路完成,避免颈胸部瘢痕。

我们从 2008 年开始运用 TORS 行扁桃体切除术[12]。随后,从 2015 年开始使用达芬奇 S 系统及达芬奇 Xi 系统开展了耳后入路头颈部手术和 TORS。此外,新近我们对新一代柔性机器人达芬奇 SP 系统进行 TORS 的安全性和可行性评价,现将相关经验给予介绍。

## 1 资料与方法

### 1.1 研究设计

回顾性分析 2015 年起香港中文大学耳鼻咽喉头颈外科进行的所有机器人手术的头部和颈部的良性和恶性病变患者资料,包括年龄、性别、病理及手术方式等。数据用 Excel 分析。

### 1.2 手术方法

TORS 舌根手术:患者取仰卧位。八字缝合舌尖后将其向外牵拉暴露舌底,然后使用 Crowe-Davis 或 FK-WO 开口器打开口腔。舌底可采用水胶体敷料覆盖以防止手术过程中受到下牙列的损伤。机器人入位后进行舌根切除。

TORS 扁桃体和咽后淋巴结手术:患者取仰卧位。使用 Crowe-Davis 开口器打开口腔以清楚地暴露出需要处理的扁桃体,或以扁桃体定位下颌骨升支进行咽后淋巴结手术。

耳后入路的颈部手术:耳后切口从耳垂后 5 mm处的折痕向上至外耳道水平的上方,然后向后切到发际线,此时切口可沿着或隐藏在发际线。然后在直视下,向下方和前方分离皮瓣,注意保留耳大神经和颈外静脉。显露颈阔肌后,在颈阔肌深面进行分离直至中线。在进行甲状腺腺叶切除时,可分离胸锁乳突肌的内侧缘后将肩胛舌骨肌提起,显露甲状腺上极后,机器人入位后可按照常规手术步骤进行腺叶切除。

## 2 结果

2015-01—2018-05 期间我们共使用达芬奇机器人系统完成 45 例头颈部手术。24 例患者采用达芬奇 S 或达芬奇 Xi 系统进行手术,9 例患者运用 TORS 进行了根治性扁桃体癌或舌根癌切除术。2 例患者进行了 TORS 双侧舌根切除术治疗 OSAHS。1 例鼻咽癌放疗后咽后部淋巴结复发行 TORS 切除手术。耳后入路甲状腺良性病变手术 2 例,颌下腺良性病变 3 例,颌下区脂肪瘤 1 例。所有患者均无二次手术等严重不良事件。见表 1。

21 例患者使用新一代达芬奇 SP 系统进行手术。已发表的 7 例患者早期结果表明采用达芬奇 SP 系统 TORS 可进行鼻咽、口咽、咽喉、喉和咽后淋巴结手术,不需中转其他手术方式,且没有与使用该系统相关的严重不良事件或不良事件[13-14]。

## 3 讨论

达芬奇机器人系统具有 3D 立体视觉、操作灵

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活、运动轨迹缩放等优势，我们的经验表明达芬奇 S 及 Xi 系统可完成 TORS 及耳后入路颈部手术且安全有效，不会造成严重的不良事件及二次手术的风险。最近，我们使用新一代达芬奇 SP 系统的经验也表明其进行 TORS 是安全可行的。

**表 1　使用达芬奇 S 及 Xi 手术的患者临床资料**

| 项目 | 例(%) |
|---|---|
| 性别 | |
| 男 | 15(62.5) |
| 女 | 9(37.5) |
| 年龄/岁 | 51(11～67) |
| 手术方式 | |
| TORS 口咽恶性肿瘤 | 9(37.5) |
| TORS 口咽良性肿瘤 | 8(33.3) |
| TORS 咽后淋巴结切除 | 1(4.2) |
| 耳后入路甲状腺腺叶切除 | 2(8.3) |
| 耳后入路颌下区手术 | 4(16.7) |

TORS 于 2005 年在宾夕法尼亚大学的小型Ⅰ期口咽癌临床试验中率先应用于临床，27 例扁桃体鳞状细胞癌患者的 TORS 结果表明其在安全有效地切除肿瘤的同时能更好地保留吞咽结果[15]。随后，一项与传统开放手术比较的多中心研究表明 TORS 的肿瘤治疗效果和术后功能与传统手术类似甚至更优[3]。基于上述研究 FDA 在 2009 年批准使用达芬奇机器人进行口咽良性病变及早期($T_{1/2}$)恶性病变手术。除此以外，TORS 手术范围目前已经扩大到包括咽旁间隙、鼻咽、喉和下咽[4-6,16]。虽然机器人具有多关节系统等优点，但在 TORS 应用中仍存在一些缺点，包括机器人系统成本昂贵，人员成本较高，相对较大的尺寸和器械臂的体积在有限的空间内使用比较困难，且操作者需要专门的培训和认证要求。

即使升级至达芬奇 Xi 系统，其器械在狭小空间的操作仍受到一定限制，因而临床上需要更灵活的机器人手术系统。达芬奇 SP 系统应运而生，它具有 3 个灵活的手臂及 1 个立体双目摄像头，通过 1 个 2.5 cm 的套管进入手术区域，非常适合进行 TORS。临床前的解剖研究表明运用达芬奇 SP 系统行口咽、鼻咽和下咽部手术是可行的[17-19]。最近，我们开展的第 1 个达芬奇 SP 系统 TORS 临床试验结果表明借助该系统处理咽后间隙、鼻咽、口咽、喉和下咽良性和恶性病变是安全可行的[13-14]。随着包括 Flex® 机器人系统在内的其他柔性机器人系统的推出，TORS 治疗头颈部疾病将进入一个新的时代。

除了 TORS 之外，达芬奇机器人系统已经被用于不同入路的颈部及甲状腺手术，包括耳后入路、经口入路、腋乳入路和腋下入路，均可处理同侧及对侧甲状腺叶[8-11]。由于对耳后入路的解剖结构更为熟悉，我们目前多采用耳后入路进行颈部手术，早期经验表明通过这一入路可以处理颌下区病变、鳃裂囊肿、神经鞘瘤及颈部淋巴结。

总之，我们的经验表明达芬奇机器人系统在执行 TORS 和耳后入路颈部手术中是安全有效的，而新一代柔性机器人系统则可为 TORS 的发展提供新的机遇。

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# Robotic head and neck surgery at the Chinese University of Hong Kong

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**Abstract** **Introduction**: Robotic surgery in the head and neck region has been used to approach many different areas within the head and neck region. Here we describe our experiences of its application at The Chinese University of Hong Kong. **Methods**: This is a retrospective review of all cases operated by the two authors since Jan 2015 at the Department of Otorhinolaryngology, Head and Neck Surgery, The Chinese University of Hong Kong. **Results**: Twenty-four cases were performed with the da Vinci S or da Vinci Xi systems. Twenty-one cases were performed with the novel flexible robotic da Vinci SP system. There were no serious adverse events requiring a return to the operating room. Early results from the da Vinci SP have been previously published in seven patients that demonstrated the ability to reach the nasopharynx, oropharynx, hypopharynx, larynx and also retropharyngeal lymph nodes. There were no conversions to alternative surgical approaches. There were no serious adverse events or adverse events related to the use of this system. **Discussion**: In conclusion, through our experiences at The Chinese University of Hong Kong we have found the da Vinci robotic systems to be useful and safe in performing TORS and addressing pathologies in the neck through the retroauricular approach.

**Key words** robot; head and neck surgery; transoral robotic surgery

## Introduction

Transoral robotic surgery (TORS) was the first described utilizing the da Vinci robotic system in head and neck surgery by McLeod and Melder in 2005 with the marsupialization of a vallecular cyst[1]. Subsequently, coinciding with the increasing incidence of human papilloma virus associated oropharyngeal carcinoma, there was the development of TORS oropharyngeal resections that was pioneered at University of Pennsylvania[2-3], resulting in the approval by the FDA for using the da Vinci Si in resecting T1/2 oropharyngeal carcinomas. Following this there have been descriptions utilizing TORS for the resection of the nasopharynx, hypopharynx and larynx[4-7].

Beyond the TORS approach, the system has also been applied through multiple different surgical approaches to resections of the thyroid gland, including the transaxillary, retroauricular, BABA and transoral transvestibular approaches[8-11]. Importantly, the transaxillary and retroaruicular approaches also provide the access to address other head and neck pathologies including the need for neck dissections through a remote site. These all demonstrate the versatility that the robotic system with image magnification, 3D vision, motion scaling and tremor filtration offers when operating in the head and neck reigon.

At our department in The Chinese University of Hong Kong, we first started performing TORS in 2008 with a tonsillectomy[12]. After a hiatus, we started using the da Vinci S to perform TORS and surgery through the retroauricular incision since 2015. Furthermore, we performed the first safety and feasi-

bility of a next generation flexible robot, the da Vinci SP, recently. Here we describe these experiences.

**Methods**

*Study design*

This is a retrospective review of all robotic cases performed by the Department of Otorhinolaryngology, Head and Neck Surgery at The Chinese University of Hong Kong since 2015. Data including age, gender, pathology and procedure were collected. The data was analyzed with Excel.

*Study population*

Both benign and malignant lesions of the head and neck were included.

**Surgical technique**

*TORS tongue base*

For transoral robotic surgery the patient was placed in the supine position. For approaching the tongue base a figure of eight suture is placed through the tongue for anterior retraction. Duoderm is also placed over the lower dentition to protect the tongue from injury by the lower dentition during retraction. Then a Crowe-Davis mouthgag or FK-WO retractor were used for retraction. The robot was then docked to perform the resections.

*TORS tonsillectomy and retropharyngeal lymph node*

For tonsillectomy or retropharyngeal lymph node dissection the patient was placed in the supine position. Then a Crowe-Davis mouthgag was placed to clearly expose the tonsil that needed to be addressed or the mandibular ramus to approach medially for resection of the retropharyngeal lymph node.

*Retroauricular approach to the neck*

The retroauricular incision was drawn from the posterior aspect of the ear lobe 5 mm from the crease and superiorly to the level of the superior aspect of the external auditory canal, and then a horizontal limb was drawn posteriorly to the hairline and then carried inferiorly along or slightly within the hairline. Then under direct vision the skin flap was raised inferiorly and anteriorly with a needle tip cautery preserving the great auricular nerve and external jugular vein. Once the platysma was seen, the dissection was carried in a subplatysmal plane as far as the midline. For hemithyroidectomy the omohyoid was lifted anteriorly, once identified medial to the sternocleidomastoid muscle. The superior pole of the thyroid gland was identified and preceded in a usual fashion.

**Results**

Since Jan 2015 we have performed a total of Forty-five cases utilizing the da Vinci robotic system. Twenty-four cases were performed with the da Vinci S or da Vinci Xi systems. Twenty-one cases were performed with the novel flexible robotic da Vinci SP system. Table 1 demonstrates a summary of the procedures performed with the da Vinci S and Xi systems. TORS with radical tonsillectomy and tongue base resections for malignancies were performed in nine patients. TORS bilateral tongue base resections for obstructive sleep apnoea (OSA) was performed in two patients. One patient had TORS resection of a retropharyngeal lymph node following radiotherapy for nasopharyngeal carcinoma. The retroauricular approach was used to treat benign thyroid nodules of the thyroid in two patients, benign nodules of the submandibular gland in three cases and a submandibular lipoma in one patient. There were no serious adverse events requiring a return to the operating room.

Early results from the da Vinci SP have been previously published in seven patients that demonstrate the ability to reach the nasopharynx, oropharynx, hypopharynx, larynx and also retropharyngeal lymph nodes[13-14]. There were no conversions to alternative surgical approaches. There were no serious adverse events or adverse events related to the use of this system.

**Discussion**

Through the application of the da Vinci robotic systems at The Chinese University of Hong Kong we have applied the robot in both TORS and retroauricular approaches in different systems. With the advantages of offered of 3D immersion visualization, maneuverability, motion scaling and magnification, the da Vinci robotic system is an important tool in offering safe and efficient surgery for TORS and retroaurciular approaches given our experiences with no serious adverse events requiring a return to the operating room. More recently, we have also had the opportunity to demonstrate the safety and feasibility of a novel flexible robot in performing TORS in the head and neck region.

**Table 1 Description of the demographics and procedures performed with the da Vinci S and Xi systems**

| Variables | $n$(%) |
|---|---|
| Gender | |
| Male | 15(62.5) |
| Female | 9(37.5) |
| Age | |
| Median | 51(11－67) |
| Procedures | |
| TORS oropharynx malignant | 9(37.5) |
| TORS oropharynx benign | 8(33.3) |
| TORS retropharyngeal lymph node excision | 1(4.2) |
| Retroauricular approach to hemithyroid | 2(8.3) |
| Retroauricular approach to the submandibular space | 4(16.7) |

TORS was initially pioneered for use clinically in the oropharynx by a small phase Ⅰ clinical trial at the University of Pennsylvania enrolling twenty-seven patients with tonsil squamous cell carcinoma (SCC)[15]. The study demonstrated favorable outcomes including swallow results, which further supported the safety of TORS for removal of select oropharyngeal SCC. Subsequently a multicenter investigation of TORS demonstrated equivalent or superior oncologic and functional outcomes, when compared to open and other transoral surgical approaches[3]. In 2009, based this data, the FDA approved the use of the da Vinci robot (Intuitive Surgical Inc., Sunnyvale, CA) for TORS for benign and malignant T1 and T2 lesions. In addition to its use in the oropharynx, the repertoire of procedures where TORS with the da Vinci system has been used with great enthusiasm has expanded to include the parapharyngeal space, nasopharynx, larynx and hypopharynx[4-6,16]. However, despite the previously mentioned advantages of using the multi arm system, there are certain disadvantages of TORS including the exorbitant cost of the robotic system, logistics of sharing the robot among multiple surgical specialties, the relatively large size and bulk of the instrument arms for use in a confined space, and the need for specialized training and credentialing requirements.

Given the constraints of the rigid relatively large instruments in the da Vinci systems up to the recent Xi system, the flexible robotic surgical system--da Vinci SP surgical system, with three flexible instruments, stereoscopic binocular camera in a single 2.5 cm cannula offers a device well suited for TORS. This has been shown in pre-clinical cadaver studies to be feasible in surgery of the oropharynx, nasopharynx and hypopharynx[17-19]. More recently the da Vinci SP system was used in the first clinical trial for TORS at our institution where the early safety and feasibility results clearly demonstrate that the system is safe to use in accessing the retropharyngeal space, nasopharynx, oropharynx, larynx and hypopharynx to treat benign and malignant lesions[13-14]. With other flexible robotic systems including the Flex® robotic system now available, advances in the treatment of head and neck lesions with TORS will undoubtedly advance at a rapid pace.

Finally, beyond TORS, the da Vinci robotic system has been used to address pathologies in the neck through a variety of surgical approaches. Approaches to the thyroid are numerous, including a retroauricular approach, transoral approach, BABA approach and transaxillary approach all being described to address the ipsilateral and contralateral thyroid glands[8-11]. Our own preference has been to use the retroauricular approach, given our familiarity with the anatomy in this region. Utilizing this approach we can also address different pathologies in the neck including, submandibular pathologies, branchial cleft cysts, schwannomas and neck dissections.

In conclusion, through our experiences at The Chinese University of Hong Kong we have found the da Vinci robotic systems to be useful and safe in performing TORS and addressing pathologies in the neck through the retroauricular approach. Recent developments in flexible robotic systems offer an exciting tool for further developing TORS.