# 2 Robotic Instrumentation, Personnel, and Operating Room Setup

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## 2.1 Introduction

Robotic-assisted surgery (RAS) is becoming an increasingly important tool for certain diseases treated by the otolaryngologist and head and neck surgeon. As RAS expertise evolves and its use increases, many studies are underway to evaluate RAS as a replacement or alternative to established surgical techniques known to be invasive, potentially disfiguring, and sometimes devastating in terms of functional morbidity. Transoral robotic surgery (TORS) is the prime example of evolution within this surgical field for the management of primary or recurrent benign and malignant lesions of the pharynx and larynx, in particular the oropharynx and supraglottic larynx [1–4]. RAS has been rapidly integrated into the field due to a number factors, including (1) less morbid surgical access, (2) improved visualization, and (3) enhanced surgical precision in confined anatomic spaces [5–8]. It has also been championed for its cosmetic appeal, which allows for the avoidance of a conspicuous incision, such as for transaxillary thyroidectomy/parathyroidectomy or retroauricular neck dissection [9–11]. Moreover, RAS has been described for use in free tissue reconstruction as well as in the surgical management of sleep apnea [12–14]. The focus of this chapter is to provide general guidelines for operating room setup and communication, surgical instrumentation and equipment, and the necessary expertise of surgical personnel.

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## 2.2 Robotic Devices

Two robotic devices are currently FDA approved for use in otolaryngology-head and neck surgery, namely, the *da Vinci* Standard, S®, and Si® Surgical Systems made by Intuitive Surgical Inc. (Sunnyvale, CA) and the Flex® Robotic System made by Medrobotics Corporation (Raynham, MA), which received FDA approval in July 2015. Due to the novelty of and lack of experience with the Flex® System by these authors, the main focus of this chapter will be the *da Vinci* Si® robot though many principles of setup, communication, and personnel remain applicable between systems.

The *da Vinci* Surgical System functions as a traditional master-slave arrangement, consisting of three main components: surgeon console, patient-side cart, and vision system.

The surgeon console ("master") allows the primary surgeon an ergonomically adjustable seat with a binocular, three-dimensional view of the surgical field. The surgeon controls the robotic instruments through bimanual thumb and index or middle finger controls while preserving traditional hand-eye surgical positioning. One important difference between the



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Standard/S® and Si® models is the capability to use a secondary console, thus allowing for participation of a co-surgeon or, more importantly, for direct supervision of a surgical trainee by the primary surgeon while preserving three-dimensional observation and immediate control of the instrumentation.

The patient-side cart (i.e., robotic arms, “slave”) contains the four robotic arms that house the endoscopic camera and three potential instruments. Primarily given space limitations, TORS generally uses only two of these instruments at one time in addition to the camera. Specifics on cameras and instruments are discussed below.

The vision system contains the image processing equipment as well as a high-definition monitor for use by the surgical technician and bedside surgical assistant, which has touch-screen notation capabilities. Also housed within the vision system are the cautery generator and insufflation equipment, if needed.

The Flex® Robotic System employs a flexible endoscopic camera along with two ports for flexible instruments that are controlled in a manner analogous to transnasal endoscopic surgery. The main difference and purported advantage of this system is its flexibility, thereby providing enhanced exposure to deeper areas of the pharynx and larynx that may be more challenging to access with the current *da Vinci* system or with traditional rigid instrumentation [15, 16]. Though this system is promising, it is fledgling by comparison, and additional studies are needed to elucidate its specific use and applicability within the field.

## 2.3 Operating Room Arrangement and Robotic Surgery Personnel

RAS represents a fundamentally different coordination of care among members of the surgical team given distinct instrumentation, a unique technological interface between patient and surgeon, and remote communication/interaction between primary surgeon, surgical assistant and technician, and the anesthesiologist. Arrangement of the components of the surgical system and characteristics of personnel will vary according to the operating room orientation and space, though the following describes some ideal characteristics and arrangement (Fig. 2.1). All personnel should be familiar with the surgical equipment, setup, and basic troubleshooting to facilitate safe and efficient RAS. Hospitals typically require operating room staff and surgical providers involved with these procedures to complete robotic training commensurate with their position and responsibilities.

With the surgical bed in a central location, the anesthesiologist and anesthesia cart are at the foot of the patient. Similar to other surgical procedures involving the upper aerodigestive tract, the anesthesiologist plays a pivotal role and communication about anticipated challenges and/or relevant pathology. The anesthetic team should be facile with transnasal intubation and use of laser-safe endotracheal tubes, if needed. The patient-side cart can be positioned on the right or left side of the patient with the leg of the cart forming an approximate 30-degree angle with the surgical bed. Opposite the patient-side cart are the surgical technician, instrument table(s), and vision system. The circulating nurse should have easy access to surgical technician, instruments, and vision system. The surgical assistant sits at the head of the bed, should have an ergonomic view of the vision system monitor, and should be positioned to facilitate communication with the primary surgeon and transfer of instruments with the surgical technician. The primary role of the bedside surgical assistant is to ensure optimum surgical visibility through suctioning of smoke and/or blood, providing additional soft tissue retraction, and occasionally through application of external hyoid pressure. This assistant should be facile with the placement of vascular clips and also must have endoscopic skills as they are working from a monitor rather than by direct visualization. Lastly, the surgeon console should be located near the surgical assistant if operating room orientation/space allows since this provides immediate access to the patient by the primary surgeon and facilitates two-way communication (though a microphone on the surgeon console connects to a speaker on the patient-side cart for surgeon to assistant verbal communication).

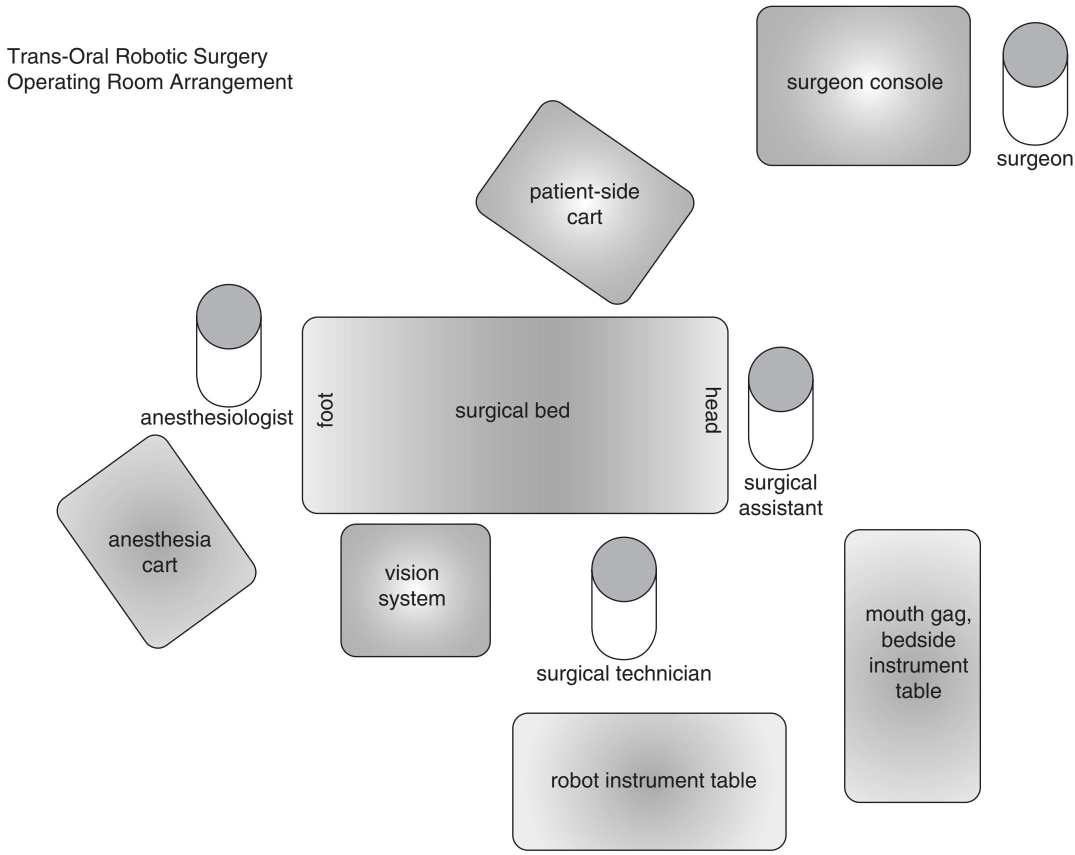


**Fig. 2.1** Diagram of TORS operating room arrangement

## 2.4 Patient Positioning and Exposure

The patient is positioned supine and the bed is rotated 180° from the anesthesia cart. Surgical beds not equipped with the ability to slide in relation to their base should be reversed to allow space for the legs of the patient-side cart as well as those of the surgical assistant. Nasotracheal intubation through the contralateral nostril in relation to the surgical site minimizes interference of the endotracheal tube with the procedure. Induction and intubation may be completed after bed rotation for improved efficiency, though this must be carefully considered in the context of patient safety, in collaboration with the anesthesiologist. Wire-reinforced endotracheal tubes can help guard against compression with oral intubation though must be used cautiously since collapse of these tubes results in luminal narrowing that can only be ameliorated through tube replacement. The endotracheal tube should be secured with tape or via circumdental or nasoseptal suturing. The eyes should be protected with plastic shields or with tape and moist gauze as part of standard laser precautions. Careful wrapping of the patient's head with surgical towels and foam padding can further secure the endotracheal tube and protect the patient's eyes and face. If an open neck procedure is planned, the ventilator circuitry should be routed in such a way as to avoid need for subsequent additional positioning or setup.

For RAS of the upper aerodigestive tract, direct laryngoscopy may be performed after intubation to characterize anatomy of interest as well as specifics of exposure. A synthetic tooth guard should be placed to protect the upper dentition, or a moist gauze in the case of an edentulous patient. To assist with manipulation of the base of tongue during placement of the mouth gag and to maximize exposure, a nonabsorbable suture (commonly 2-0 silk) is placed through-and-through the central anterior tongue and tied with an air knot to prevent strangulation. More than one pass of the suture may be completed to minimize the chance of "cheese-wiring" the anterior tongue with traction. For superior lesions and depending on placement of the endotracheal tube, a red rubber catheter may be placed through the nose and out the mouth for soft palate retraction. With regard to additional patient positioning to maximize exposure, a shoulder roll or flexion of the head of bed may be beneficial.

Several different retractors have been developed for exposure of the oropharynx, supraglottis, hypopharynx, and glottic larynx (see Chap. 6 in this book). The Crowe-Davis and Dingman mouth gags provide suitable access to the upper oropharynx including the tonsils and soft palate. The Crowe-Davis is perhaps the oldest and simplest of these devices, commonly being used in non-robotic tonsillectomy. The Dingman mouth gag is similar though it includes the ability to laterally retract the patient's lips. For lesions in the base of tongue and beyond the FK (Feyh-Kastenbauer), retractor employs longer tongue blades of different lengths and shapes and allows for additional degrees of manipulation of the extension and angulation of the blade (Fig. 2.2). The Flex® retractor is a more recently developed system that combines several advantages of each to achieve great versatility. A surgical headlight is helpful during placement of the retractor. Suspension of the retractor should ideally be accomplished through a support directly attached to the surgical bed as opposed to the patient's chest or a Mayo stand. This, combined with lowering the surgical bed, minimizes the chance of collision or interference between the retraction apparatus and the patient-side cart.

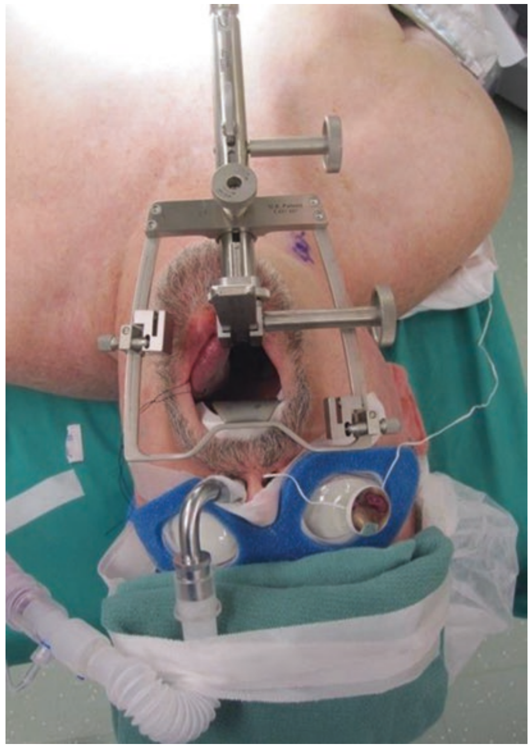

**Fig. 2.2** Obtaining initial operative exposure of right oropharynx using the Feyh-Kastenbauer (FK) retractor. Note contralateral nasotracheal intubation and ventilator circuitry, silk tongue suture, tooth guard, eye protection, and head wrap

## 2.5 Robotic and Surgical Assistant Instrumentation

Once the mouth gag is engaged, the surgical team should take note of the time as portions of the tongue are now ischemic from retraction. Using the *da Vinci* system, the 12 mm endoscopic camera is used for TORS, specifically the 0-degree camera for the soft palate and palatine tonsils and the 30-degree camera for the lower pharynx and larynx. The camera is placed in the central position at a depth that allows adequate visualization but ensures maneuverability of the laterally placed instruments. The *da Vinci* Surgical Systems employ EndoWrist® instruments that feature seven degrees of freedom and 90 degrees of articulation as well as motion scaling and tremor reduction. The two most commonly used instruments in TORS are the 5 mm permanent (monopolar) cautery spatula and the 5 mm Maryland dissector (Fig. 2.2). The authors have found the 8 mm Cadiere forceps to be particularly effective for gentle grasping and retracting, with minimal tissue injury, and utilize this instrument for nearly all TORS (Fig. 2.2). The cautery should be placed ipsilateral to the area of dissection, while the dissector should be contralateral to improve retraction and avoid crossing of the instrument arms (Fig. 2.3). Taken together, the instruments should make a V or triangular formation with respect to the central camera, and the two instrument tips should converge on the area of interest (Fig. 2.4). Additionally, aftermarket flexible CO2 lasers are available and may be particularly useful for resections involving the supraglottis and hypopharynx (Fig. 2.5) [17–19]. Regardless of which instruments are chosen, great care must be taken during their initial placement so as to avoid trauma to the oral cavity, dentition, and pharynx. Proper placement maximizes arm mobility thereby avoiding collisions, making use of the full use of the robot's mechanical and dexterous advantage, and helping to ensure a more efficient, safer surgery. Once in place, robotic arms should be assessed for adequate maneuverability and responsiveness prior to mucosal incision.

After placement of the camera and instrumentation, the surgical assistant should sit at the head of the bed, ideally in a chair with height adjustability. Using a metal or plastic Yankauer suction and Hurd retractor, the assistant helps to optimize exposure. Metal Yankauer suction has the advantage of a narrower diameter than the plastic version though one must make sure the suction tip is securely screwed in place to avoid separation and the resultant foreign body situation. Nevertheless, the curvature of these suctions can be beneficial in providing additional retraction in the base of tongue or vallecula while concurrently evacuating smoke, blood, or secretions. Laparoscopic peanuts and the paddle dissector end of the Hurd


**Fig. 2.3** *da Vinci* EndoWrist® instruments, Maryland dissector (*left*) and Cadiere forceps (*right*) (©2016 Intuitive Surgical, Inc. Used with permission)

**Fig. 2.4** Example of *da Vinci* robotic arm orientation and vision cart placement. Note central camera, ipsilateral monopolar cautery, and contralateral forceps placement

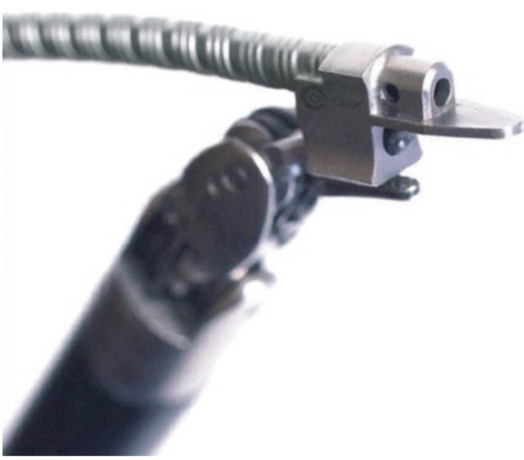

**Fig. 2.5** C02 laser using BeamPath® robotic fiber and FlexGuide™ fiber conduit (OmniGuide Surgical, Lexington, MA) (©2016 OmniGuide Surgical, Inc. Used with permission)

retractor may also be of assistance in retraction. Care must be taken using non-insulated, metal instruments as these have the possibility to conduct monopolar current to other areas in the patient's oral cavity such as the lips. Use of a plastic double cheek retractor may be used in combination with specific mouth gags to guard against this possibility.

In addition to retraction, the surgical assistant must also be able to assist with hemostasis. This may require the placement of vascular clips prophylactically on prominent branches of the lingual and ascending pharyngeal arteries, or in response to inadvertent vessel transection. The 22 cm Karl Storz endoscopic clip applier is very useful given its length and low profile though some advocate for use of the automatic laparoscopic clip appliers. Also available in the surgical field should be a suction electrocautery and an extended length bipolar cautery. In the unfortunate scenario where blood obscures the lens of the robotic camera, a deft surgical assistant, equipped with a headlight, Yankauer suction or suction cautery, tonsil sponges, and even topical hemostatic matrix (such as Floseal® or Surgiflo®) can be indispensable for obtaining hemostasis until reestablishment of visualization. Lastly, regardless of whether an open procedure in the neck such as vessel ligation or neck dissection is planned, all open surgical and tracheostomy instrumentation should be immediately available.

The above scenarios provide a detailed description of the instrumentation and setup for TORS. Additional procedures such as transaxillary thyroidectomy or retroauricular neck dissection utilize an incision in a remote location with development of a soft tissue plane under direct visualization followed by placement of a self-retaining retractor to maintain the working space [11, 20–22]. Common retracting systems include the Chung and Kuppersmith retractors. Varying degrees of dissection may be completed under direct visualization prior to placement of robotic arms. A small additional incision (such as the anterior chest, peri-areolar area, or contralateral axilla) may be used to accommodate another surgical arm for retraction. In contrast to development of a broad soft tissue plane for access, CO2 insufflation has also been described for visualization in the central or lateral neck in a manner similar to the non-robotic, endoscopic approach [23]. Lastly, these procedures commonly employ extended harmonic advanced energy devices such as the 23 cm Harmonic ACE®+ shears or synthetic vascular clips such as the Hem-o-lock® system for vessel ligation.

**Conclusion**

Robotic surgery draws on traditional transoral and open surgical principles but represents a fundamentally different surgical approach that necessitates thoughtful operating room arrangement, algorithms for troubleshooting equipment and instrumentation, and effective communication among all members of the surgical team. These should be modified by each surgical team through their acquisition of robotic experience. With the continued pace of technological evolution in surgery, further refinements to TORS should be anticipated.

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