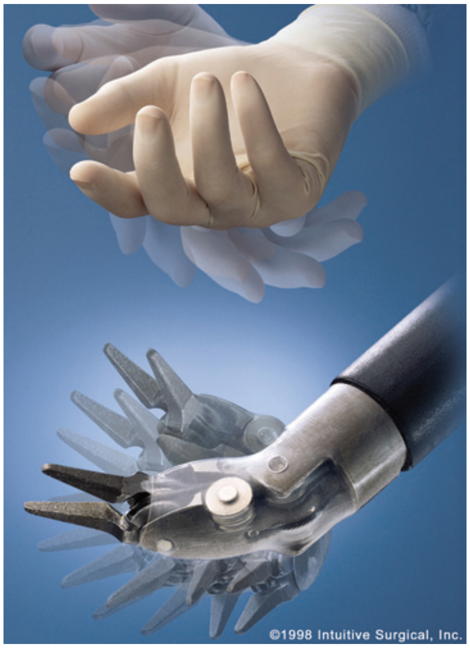

Figure 9.3 The robotic instruments are capable of "wristed motion," which entails 7 degrees-of-freedom at the tips of the instruments, including flexion, extension, pronation, supination, radial and ulnar deviation, and grasping. This movement mimics those of the human hand and wrist. (©2016 Intuitive Surgical, Inc. Used with permission.)

Figure 9.4 A 12 mm and 8.5 mm endoscope. The endoscope contains two cameras and a light source. The separate cameras convey an image to each eye, accounting for the 3-dimensional image in the surgeon console. There are also 30° and 70° up and down scopes to increase viewing versatility. (©2016 Intuitive Surgical, Inc. Used with permission.)

from visual information which is interpreted by the surgeon based on previous experience. Although a theoretical concern, in the author's training, this required only a brief cognitive adjustment period to overcome.

ROBOTIC OPERATING TEAM

Because of the highly complex nature of the machine and its underlying technology, a skilled team must be present to operate it. Sitting down at the console and using the arms is the easiest part of robotic surgery. Setting the machine up for specific procedures and understanding how to troubleshoot a machine that is not performing optimally requires much more experience. It is critical to work with a skilled scrub assistant who is trained in instrument use and exchange, calibration and cleaning of the endoscope and camera, port management, and vision tower control, particularly in the beginning. In addition, working with another physician who can remain at the bedside and manage conflicts among arms and provide other additional information to the operating surgeon that may be outside her/his field of view is extremely helpful, again particularly early on. Having a good team in robotic surgery is analogous to a pit crew in racing. If you have a good team, you can make adjustments and transitions quickly and seamlessly. If your team is unsure about the technology, its use will be a burden in both time and effort. Ultimately, it is the surgeon's responsibility to understand the robot better than everyone else in the room.

Although only recently introduced to plastic surgery, the superb precision and high resolution, 3-D optics make the surgical robot a valuable and versatile plastic surgical tool.[1,2] In this chapter, three general applications of robotics in plastic surgery are discussed:

1. *Trans-oral robotic reconstructive surgery* for head and neck reconstruction, permitting complex oropharyngeal reconstruction without dividing the lip or mandible
2. *Robotic muscle harvest*, permitting an "incisionless" harvest of both the latissimus dorsi and rectus abdominis muscles
3. *Robotic microvascular anastomoses*, extending the capabilities of the human hand in challenging microsurgical scenarios.

TRANSORAL ROBOTIC SURGERY (TORS)

TORS was developed to resect tumors in the oropharynx, avoiding the morbidity of mandibular swing procedures and high-dose chemoradiation therapy.[3–6] It has since been adopted at multiple other centers, and was FDA approved in 2009. Initially, the standard following TORS resections was that oropharyngeal defects were left to heal by secondary intention.[7,8] This approach is reliable for smaller tumors, but is suboptimal when a significant anatomic defect is created, vital structures are exposed, or a surgical fistula is created. To mitigate reconstructive access to a severely constrained physical space, transoral inset of a free flap or local flap using robotic assistance has been shown to be both feasible and effective (Fig. 9.5).[9,10] By taking this approach, the plastic surgeon can provide the reconstructive support for the head and neck surgeon to remove larger and more complex tumors robotically that would be very difficult to reconstruct through traditional methods.[11,12]

INDICATIONS

Any oropharyngeal resection in which reconstruction is necessary and direct visualization through the mouth or pharyngotomy is inadequate for inset.

ROBOTIC MUSCLE HARVEST

Free and pedicled muscle flaps have been in use by plastic surgeons for a variety of applications since the First World

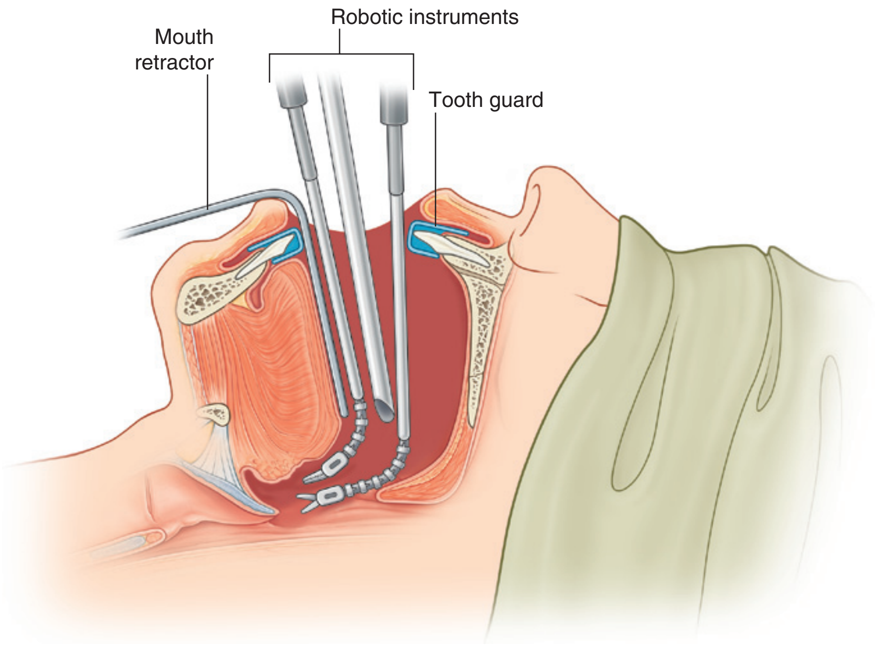

Figure 9.5 The set-up for transoral robotic surgery. A mouth retractor is used to set the interdental opening. Teeth are protected with a tooth guard and eyes with goggles or pads. The robotic patient side cart is placed next to the patient, typically at 30° to the foot of the surgical bed. The three robotic arms are aligned around a point converging at the back of the oropharynx: two arms contain instruments and one contains the endoscope.

War, and remain workhorses in scalp, extremity, head and neck, and breast reconstruction. Harvest of these flaps usually requires incisions that allow access to muscle origin, insertion, and pedicle. Incisions can range from 20 cm to 40 cm in length and can result in significant donor site morbidity.[13,14] The robotic interface has supplied the necessary exposure, picture clarity and precision to accomplish both muscle and pedicle dissection, with minimal external incisions and donor site morbidity.

Harvest of the latissimus dorsi muscle can be performed with no new incisions beyond those needed for a mastectomy. Dissection of the pedicle and anterior border of the muscle can be performed through either the sentinel lymph node biopsy incision or mastectomy incision alone, with two additional ports that can be used for drain exit sites.[15,16] When a free flap is needed, a short axillary incision will suffice. Insufflation provides the optical window for dissection (Fig. 9.6, Video 9.1).

Harvest of the rectus abdominis muscle is done intraperitoneally, using three ports through the contralateral abdominal wall, lateral to the linea semilunaris (Fig. 9.7).[17] The entire muscle and pedicle can be easily dissected for use in the pelvis, or extracted using a laparoscopic retrieval bag for a free flap. There is no violation of the anterior rectus sheath (Video 9.2).[18]

Figure 9.6 The robot docking for the robotic latissimus dorsi harvest. The patient is in the left lateral decubitus position. The patient side cart is oriented to face the patient's back, while the robotic arms are delivered over the patient and nearly parallel with the floor. Ports are placed anterior to the anterior border of the muscle. The central arm is for the camera and should be flexed 90° at the elbow. Arm 2 contains the Cadiere grasper and arm 1 contains the monopolar scissors. There are no incisions that are not already required for either the mastectomy, sentinel lymph node, or drains.

INDICATIONS

1. Harvest of the latissimus dorsi when a skin island is not necessary or desirable:
   a. Free flap for scalp or extremity coverage
   b. Pedicled flap for breast reconstruction in:
      i. Delayed immediate breast reconstruction when re-expansion is acceptable but long-term durability of skin coverage is questionable[19]
      ii. Immediate implant-based breast reconstruction in NAC sparing mastectomies as a superior alternative to lower pole coverage
      iii. Oncoplastic reconstruction of the upper outer quadrant in partial breast reconstruction