Anaesthetic Considerations for Transoral Robotic Surgery (TORS)

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KEY POINTS

- Transoral robotic surgery is most commonly used for oropharyngeal cancer resection, localisation of occult primary head and neck tumours, and treatment of snoring and obstructive sleep apnoea.
- A potentially difficult airway is shared with a robot, and access to the patient is limited intraoperatively.
- A local transoral robotic surgery protocol should be shared between surgical, nursing, and anaesthetic teams. This should include an emergency undocking procedure.
- There is a danger of the robot causing inadvertent injury to the surrounding structures as there is limited direct supervision of robot arms during the procedure.
- The anaesthetic technique must allow for the stimulating nature of the surgery, and opioid-based multimodal analgesia is required for potentially severe postoperative pain.
- Complications include significant haemorrhage, which can lead to asphyxiation and aspiration.

INTRODUCTION

Transoral robotic surgery (TORS) involves the use of a robot to perform minimally invasive surgery on the upper airway through the mouth. The technique was first developed to enable the resection of oropharyngeal tumours,[1] but an expanding range of indications now also includes the surgical treatment of obstructive sleep apnoea (OSA), known as TORSA (transoral robotic surgery for sleep apnoea). This tutorial will provide an overview of the principles behind TORS and the anaesthetic management of these procedures.

BACKGROUND TO TORS

Surgeons operating through the mouth with conventional instruments are limited by line-of-sight working corridors and the confined space available. Robotic technology offers advanced optics and instrumentation that can improve the quality of visualisation, exposure, and dissection in confined spaces. The Da Vinci robot (Intuitive Medical) is most common and has been used for almost all published TORS work. It is a telerobotic system that provides a complete interface between the patient and the surgeon, who sits at a distant console. Two cameras in a single endoscope provide the surgeon with a magnified three-dimensional high-definition view of the surgical field (Figure 1). One robotic arm holds the endoscope, and other robotic arms hold right- and left-handed instruments. Motion scaling and the filtration of natural human hand tremor result in smooth bimanual dexterity within the surgical field. All of these features enable precise excision of tumour tissue.[2]

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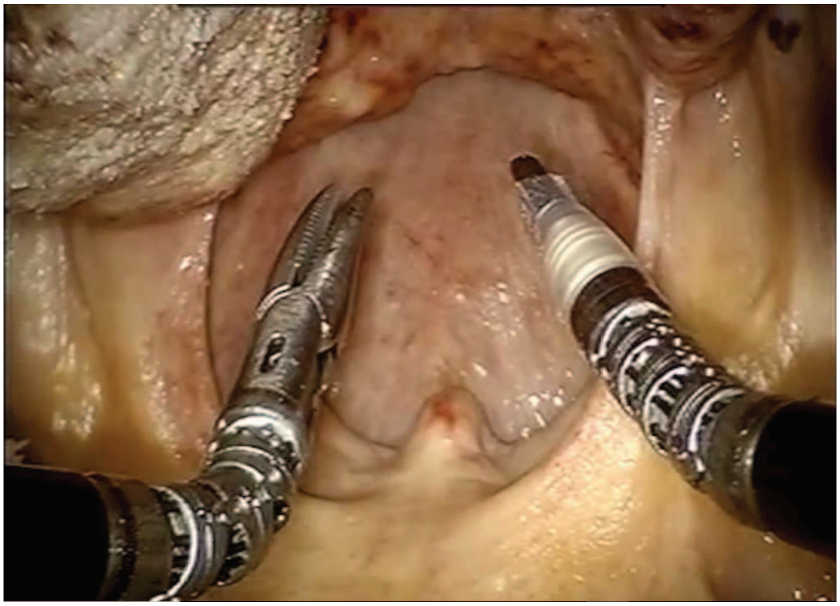

Figure 1. Surgeon's view of oropharynx seen on a screen of the console. Two arms of the robotic system allow multiple degrees of motion.

Surgical case selection is important. It must be feasible to achieve adequate surgical access and completely excise the tumour. Limited mouth opening, more common in females, may prevent satisfactory exposure. The most commonly performed procedures are tonsil and base-of-tongue resections for T1- and T2-stage oropharyngeal cancers along with lingual tonsillectomy or mucosectomy to remove the lining of the base of the tongue in the hunt for an occult primary squamous cell cancer of the neck. Prior to TORS, the treatment of patients with oropharyngeal cancers often entailed classic mandibulotomy, tracheostomy, and free flap or other reconstructions or, alternatively, chemoradiotherapy. These interventions all have very significant morbidities. In selected cases, TORS now provides the option of a completely transoral approach, thus maintaining the integrity of the muscular framework of the laryngopharynx, which is important for swallowing function. Most tissue defects caused by transoral surgery are allowed to close successfully via secondary intention over several weeks. A minority of defects require some form of reconstruction, such as skin grafts, local mucosal flaps, or local/regional pedicle flaps.

With the primary surgical approach, the use adjunctive radio- and chemotherapy may be reduced or eliminated altogether.[3] It should be noted that the evidence base behind TORS is still limited to case series from a comparatively small number of centres that have been pioneering its use. Whilst trials are ongoing, there is no high-quality evidence from randomised controlled trials that compare oncological outcomes after TORS with those of radiotherapy and chemotherapy.[4] However, systematic reviews suggest that TORS has improved functional outcomes, with better quality-of-life outcomes around swallowing and oral feeding than alternative nonsurgical treatments.[5] In addition to its use for proven oropharyngeal cancer, TORS can be used to perform base-of-tongue mucosectomy for identification of unknown primary tumours after conventional diagnostic tests have failed.[6]

Prior to a TORS oropharyngeal cancer resection, patients will typically undergo a diagnostic and therapeutic pathway that will include nasendoscopy, computed tomography (CT)/magnetic resonance imaging tests, and panendoscopy to visualise the surgical field and obtain a histopathological diagnosis. Frequently, patients will need to undergo a limited neck dissection, and the timing of this in relation to the TORS resection varies depending upon institution. In some centres, such as our own, patients have their neck dissection a couple of weeks before their TORS procedure. At the time of the neck dissection, several branches (lingual, ascending pharyngeal, and facial) of the external carotid artery are ligated to help reduce the chance of catastrophic bleeding during the TORS oropharyngeal cancer resection procedure.

OPERATING ROOM AND ROBOT SETUP

The requirement to dock the Da Vinci robot over the patient's mouth mandates a particular operating room setup (Figure 2), which appears consistent across TORS centres.[7] Both the setup and operating time decrease rapidly with increasing experience of the operating team.[8] It is essential to have a clear plan for the operating room and anaesthetic setup as a local guideline.

After induction of anaesthesia, the operating table is rotated into place so that the patient's feet are positioned by the anaesthetic machine. As appropriate for the site of the surgery and the patient's anatomy, a surgical retractor such as a Boyle-

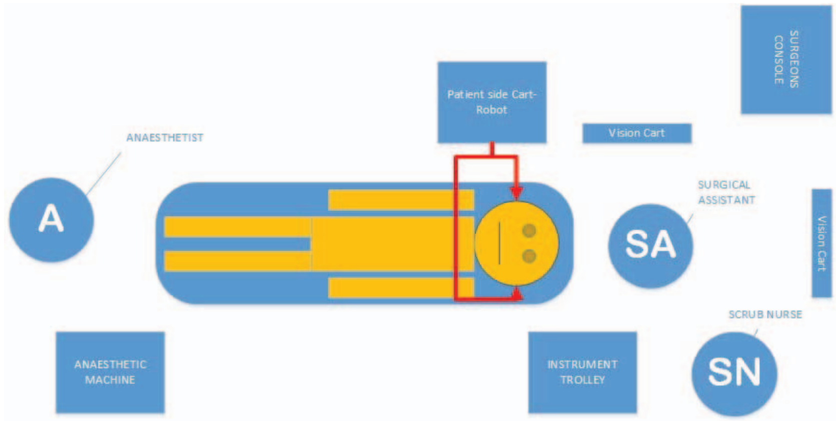

Figure 2. Example of an operating theatre setup.

Davis or Feyh-Kastenbauer type will be inserted. The robot is driven into position and the robotic arms positioned over the patient's chest. The camera-endoscope (midline) and right and left instruments are inserted into trocar holders and advanced into the mouth. They are subsequently controlled by the surgeon from a console elsewhere in the room (Figure 3).

When the robot, camera, and instruments are in position, access to the head, neck, and chest of the patient is very restricted. An emergency undocking procedure needs to be followed if immediate access is required. Such situations might include airway problems, surgical haemorrhage requiring conversion to an 'open' procedure, and cardiac arrest. It is recommended that institutions have a local emergency undocking protocol that should be rehearsed so that the team are clear of their individual roles.[9]

ANAESTHESIA FOR TORS

Airway Management

Patients undergoing TORS resections are at risk for having a difficult airway. Tumours of the oropharynx, previous surgical scarring (including from neck dissection), and previous radiotherapy may interfere with face mask ventilation and intubation. In addition to performing a standard bedside airway assessment and consulting previous anaesthetic charts, the anaesthetist should review nasendoscopy and CT scan findings with the surgeon preoperatively. Awake intubation may be indicated.

Figure 3. Robot and surgeons during the procedure. The master surgeon sits at the distant console and operates in a true 3-dimensional endoscopic vision of the surgical field. The assisting surgeon sits at the head end of the patient, inserting interchangeable instruments such as electrocautery, forceps, and suction into 2 instrument arms.

In our centre as preferred, we use a contralateral to tumour nasal RAE endotracheal tube. This allows optimal access for the robot with minimal obstruction to the surgical field. The use of nasal vasoconstrictors prior to nasal intubation minimises nasal mucosa injury and bleeding. They can be self-administered by the patient as a nasal spray premedication, followed by vasoconstrictor/local anaesthetic spray on induction. Access to the airway is extremely restricted once the robot is docked, so the endotracheal tube must be well secured as accidental dislodgement intraoperatively could be disastrous. Some centres suture the tube to the face if an oral tube is used.[8] Placing padding between the endotracheal tube and the forehead will prevent pressure damage.

Maintenance of Anaesthesia

Anaesthesia can be maintained with a volatile anaesthetic or a propofol infusion. Whatever the choice of hypnotic agent, TORS can be very stimulating, and several strategies have been described to minimise the sympathetic response.[10,11] A good option is to use a target-controlled infusion of remifentanil with additional fentanyl. In other centres, the use of other opioids, such as sufentanil, has been established. Many centres use an infusion of anaesthetic adjuncts such as ketamine or lignocaine. Resistant hypertension is unusual in patients whose blood pressure is well controlled preoperatively but can be managed with beta- ± alpha-blockers or nitrates.[11] Invasive arterial monitoring is indicated in patients with significant cardiovascular disease who will not tolerate extremes of heart rate or blood pressure.

Practical Points

- The arms are difficult to access intraoperatively, and intravenous line extensions are helpful.
- There is the potential for the robot arms to contact the face, and the eyes should be protected with tape and eye goggles.
- Good muscle relaxation is required for optimal surgical exposure and to prevent coughing as this might cause tearing of the tissue by the robot. A peripheral nerve stimulator should be used to monitor neuromuscular function.
- Intravenous antibiotics (according to the local policy) and steroids should be administered prior to incision and are continued for 72 hours postoperatively. In a recent study, a course of postoperative dexamethasone allowed a more rapid improvement in diet consistency and a reduced hospital length of stay.[12]
- As for any patient having prolonged surgery, the usual steps should be taken to maintain normothermia and prevent pressure-point injury and deep vein thrombosis.
- As with other transoral procedures, there is a risk of airway fire when using cautery if there is a gas leak from the endotracheal tube cuff. The inspired oxygen concentration should be kept below 0.3 to reduce this risk.
- At the end of the surgery, the surgeon may request a Valsalva manoeuvre to confirm adequate haemostasis. The patient should not be hypotensive during this test to avoid a false-negative result. The airway should be inspected for oedema. The expectation would be that most patients are extubated in the theatre immediately postoperatively. A minority, who have difficult airways, extensive oedema, or other comorbidities, may require a period of postoperative intubation or a tracheostomy.
- Because of the traumatic nature of the TORS procedure to the oropharyngeal structures (pharyngeal muscles, innervating nerves, and vasculature), patients are at increased risk of aspiration postoperatively. A nasogastric tube is placed in all our patients, and it is particularly important if an orocervical communication occurred during the procedure. As reinsertion is likely to be problematic, the nasogastric tube may be sutured to the nasal septum.

POSTOPERATIVE MANAGEMENT

Postoperative Analgesia

One challenge in postoperative care is pain control. Of note, there are 2 sites of potentially significant postoperative discomfort away from the surgical site. The first is the tongue, which may be retracted during the procedure. The tongue is also the most common site for unintended injury caused by retraction or shearing movements of robot arms. The nasal septum may also be painful if a nasal gastric tube has been sutured to it.

Opioid-based multimodal analgesia is a key strategy with intravenous fentanyl via patient-controlled analgesia (PCA) or infusions commonly used for the first 24 to 72 hours.[10,11] Regular paracetamol and gabapentinoid are used to reduce strong opioid requirements as per the World Health Organisation analgesic ladder. In our centre (where no TORSA is performed), fentanyl PCA is started in the recovery area, and additionally, a fentanyl transdermal patch is applied. Although TORS brings an advantage of rapid recovery of swallowing in most patients, the transdermal route is used as it offers the possibility of delivering consistent plasma levels of strong opioids. It is especially important for those individuals who are not able to swallow for a significant period postprocedure. The patch is applied immediately postoperatively as it does not deliver minimally effective blood concentrations of fentanyl until after 12 hours, and the time to maximum concentration is approximately 36 hours.[13] The use of this opioid combination alongside other sedative analgesics requires cooperation between the surgical team, ward staff, and the pain team. The patient must be closely monitored for sedation and respiratory depression. On discharge, patients on fentanyl patches must not have any other opiates prescribed, and there are strict exclusion criteria for their use out of hospital.

These would include patients with respiratory system conditions such as OSA, severe chronic obstructive pulmonary disease, or those at high risk of developing respiratory depression, such as the elderly. At surgical follow-up, the standard policy would be to remove the patch.

Management of TORS Complications

TORS is associated with a 3% to 8% risk of postoperative bleeding, which can be either minor or major in nature and most commonly occurs around the 10th postoperative day.[2,14] Most bleeding is minor venous bleeding and self-limiting in nature. Major bleeding may be due to erosion into arteries that were clipped intraoperatively or due to vasodilatation of vessels that were in spasm intraoperatively and therefore not controlled. Patients frequently have altered swallow and impaired airway protection mechanisms, and morbidity and mortality from haemorrhage tend to be due to aspiration and asphyxiation as opposed to exsanguination.[2] In case of bleeding, patients should place their head in a dependant mouth position to prevent aspiration. A hydrogen peroxide gargle may stem small bleeds. External pressure should be applied to the neck ipsilateral to the pharyngeal defect.[2] All significant bleeds should be taken back to the theatre.

Although a risk of primary bleeding in recovery seems similar to that after tonsillectomy, patients initially go to recovery on a transfer trolley, so that they may be returned to the operating theatre immediately if required.

Neck abscess can occur if an intraoperative orocervical communication occurs and is not repaired. The risk of orocervical communication is highest in patients having a concomitant neck dissection, although resultant pharyngocutaneous fistula formation is comparatively rare (4%).[15]

Oral Intake

Symptoms of dysphagia, dysgeusia, nasopharyngeal reflux, or velopharyngeal insufficiency frequently occur after TORS.[2] In our centre, reintroduction of oral intake is done strictly with the supervision of a speech and language therapist. The initial assessment takes place at variable postoperative times, from 48 hours after mucosectomies/lingual tonsillectomies to 5 to 7 days after tongue-base resections.

The aim is for a hospital stay of 5 days. In some cases, this will be prolonged, usually because of failed swallowing ability.

THE FUTURE FOR TORS

Drawbacks of TORS include the high cost versus benefits of the procedure and high cost of training of staff and maintenance of the robotic system. The benefits of TORS include a precise tumour excision within a healthy tissue margin and therefore lower risk for subsequent surgery. Decreased blood loss, reduced wound infection, and prompt recovery of swallowing improve in-hospital stay postprocedure, and TORS has been proven to be cost-effective. The study also showed that patients who received TORS had a lower rate of gastrostomy and tracheostomy when compared with other surgical procedures.[3] The analysis of clinical and cost outcomes of TORS for lateral oropharyngectomy and tongue-base resection cases showed clinical and cost benefits. The successful use of TORS in the surgical treatment of oropharyngeal tumours has attracted interest for use in other robotic surgeries in the head and neck that are not currently using the transoral approach, including thyroid surgery, skull-base surgery, paediatric airway surgery, and free flap reconstruction. Multicentre studies are required in all areas of TORS surgery to prove its safety and efficacy. As TORS expands or is introduced, it is important that local guidelines are produced that support high standards of perioperative care.

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