TORS for patients with sleep-disordered breathing

BY KONSTANTINOS CHAIDAS, NEIL S TOLLEY, AND BHIK KOTECHA

Transoral robotic surgery is now a well-accepted technique in malignant tumours of the tongue base. Here the team from **St Mary's and the Royal National Throat Nose & Ear Hospital in London** describe its use in carefully selected patients with sleep-disordered breathing.

Sleep-disordered breathing (SDB) is used to describe a spectrum of abnormalities ranging from primary snoring to upper airway resistance syndrome and obstructive sleep apnoea (OSA). OSA is an underestimated but serious social health problem affecting at least 2-4% of the adult population. In contrast to primary snoring, OSA is associated with high morbidity and mortality. There is a clear positive correlation between OSA severity and both cardiovascular and neurocognitive events.

The gold standard treatment for moderate or severe OSA is continuous positive airway pressure (CPAP) although compliance rates range from 28% to 80% [1]. For patients not able to tolerate CPAP an alternative treatment is required, of which surgery may be an option. The existing surgical treatment options have demonstrated variable success, particularly when multi-segmental and involving the tongue base and epiglottis [2].

The base of the tongue (BOT) is recognised as a significant site of obstruction in many patients suffering from OSA [3]. The presence of multiple surgical measures aimed at improvement of tongue base obstruction validates the failure of a 'one size fits all' approach to the BOT. A lack of precision and focus often results in inadequate BOT surgery. In addition, difficulty in access and patient physiognomy makes BOT surgery a difficult challenge. Minimally invasive techniques have proven inadequate when treating patients with moderate-severe BOT hypertrophy. Furthermore, traditional open tongue base approaches are associated with significant morbidity and remain unacceptable to patients with OSA [4].

Transoral robotic surgery (TORS) addresses the difficulty with operative exposure of the tongue base. It permits greater dexterity, precision and surgical access to the BOT. The robot system provides improved visualisation with three-dimensional (3D) depth perception and robotic instrumentation, in addition to tremor filtration and motion scaling. On the other hand, potential disadvantages include lack of tactile or haptic sensation and exorbitant capital cost.

The concept of TORS as a treatment of OSA was first introduced in 2010 by Vicini et al. [3] as a transoral robotic modification of Chabolle's open tongue base reduction and hyoid epiglottopexy [4]. It has now been shown to be an effective treatment option for OSA patients [5-7].

TORS indications – St Mary's / RNTNEH protocol

Patient assessment for TORS is paramount in order to improve the possibility of surgical cure and avoid unnecessary operations. Patients eligible for TORS are those who have polysomnographic evidence of moderate-severe OSA with daytime somnolence documented by the Epworth Sleepiness Scale (ESS) and a body mass index (BMI) of less than 35kg/cm^2.

Only patients that have tried and previously failed or refused treatment with CPAP are deemed suitable. Airway endoscopy, both awake and under drug-induced sedation, allows obstruction at the level of the BOT and / or epiglottis to be diagnosed. Drug-induced sedation endoscopy (DISE) provides a dynamic, three-dimensional and real time evaluation of the anatomical sites of upper airway collapse. It has been found to be a reliable and consistent clinical tool for assessing the anatomical site of airway obstruction during sleep.

Patient anatomical features such as neck circumference, mouth opening, mandibular width and length, hyoid-mental length and Mallampati grade are all assessed preoperatively, as they may determine patient suitability for TORS.

TORS set-up and surgical procedure

The TORS set-up has been previously described for BOT neoplasms. The operating surgeon sits at the operating console, which should be situated on the same side of the operating table as the assisting surgeon to allow easier communication within the theatre team. The assistant surgeon is seated at the head of the patient to provide suction, assistance with retraction of tissues and adjustment of robotic arms and instruments. The Da Vinci robot is docked at an angle of 30°-45° relative to the base of the surgical bed.

The patient is positioned supine with a shoulder roll and head ring. Nasotracheal intubation is performed when possible to permit unrestricted and clear access to the tongue base and epiglottis during surgery. St Mary's TORS set-up is shown in Figure 1.

Tongue base reduction

There are different techniques described in the literature when performing BOT reduction. Vicini

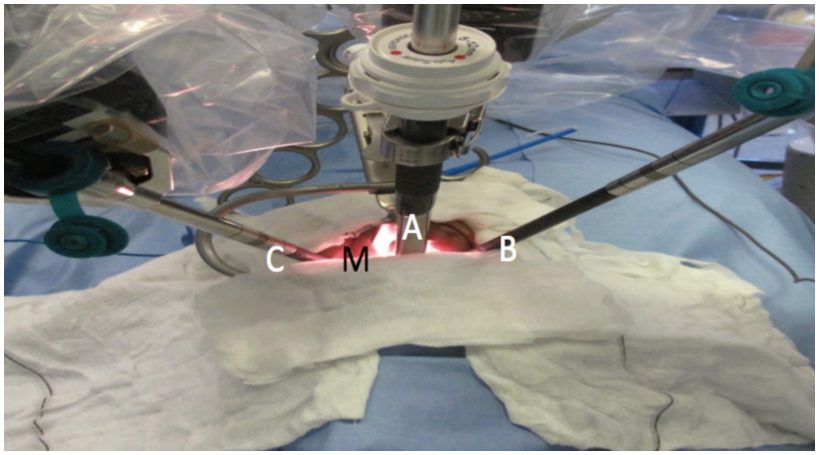


Figure 1: TORS set-up using the standard da Vinci system.
A = 30° up 8 or 12mm dual channel endoscope; B = 273µm thulium laser;
C = 5mm long tip Maryland dissector; M = patient's mouth.

performs an inverted pyramid technique [3], whereas Friedman prefers a triangular resection method [5]. The incision starts in the midline and extends from the foramen caecum and circumvallate papillae to the vallecula, permitting sparing of a 1cm mucosal bridge between the base of the epiglottis and the tongue interface (Figure 2). At St Mary's, resection is carried out by means of 273µm thulium laser fibre ablation (2013 nm, 15W). The limits of resection are from the midline extending posterior to the circumvallate papillae for a distance of 2cm towards the vallecula. The resection then continues for 1cm either side of the midline to a depth of 1cm (Figure 2). The lateral limits of the resection are at these limits in order to avoid damage to the lingual artery.

Epiglottoplasty

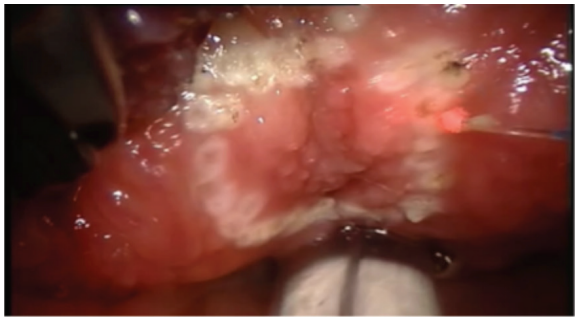
The epiglottis is grasped with the Maryland dissector and a wedge-shaped part of the upper one-third of the epiglottis is resected using the thulium laser fibre (Figure 2). The plane of resection is above the pharyngoepiglottic folds to minimise the chance of aspiration and to avoid bleeding from branches of the superior laryngeal vessels.

Intra- and postoperative management

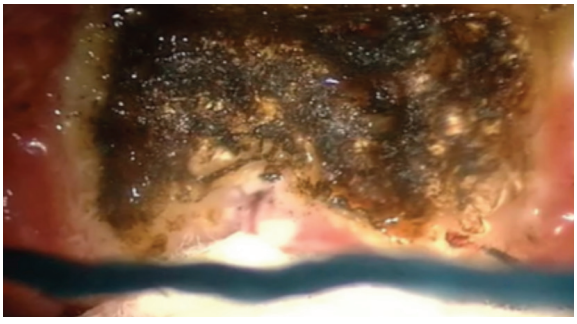
Mean set up time is 19.5±10.5 min and mean operative time for BOT reduction is 26.5±9.2 min and for epiglottoplasty is 10.4±4.9 min [6]. The average amount of removed tissue from the BOT is 10.3±4.1ml. Blood loss is minimal and patients receive perioperative and postoperative steroids to minimise lingual edema, nausea and pain. In addition, antibiotics and analgesics are given postoperatively (Table 1). Soft oral diet is allowed a few hours after surgery for most patients, although some centres use a nasogastric tube for all patients in the immediate postoperative period. The average hospital length of stay is 3.5±3.2 days with a wide range (1-19 days), reflecting the different hospital policies in different centres. In our unit, the first two patients stayed hospitalised for 48 hours as a matter of precaution but the remaining cohort (19/21 patients, 90.5%) were all discharged within 24 hours. The disposable costs for TORS are estimated to be approximately £1000 a case.

Outcomes and complications

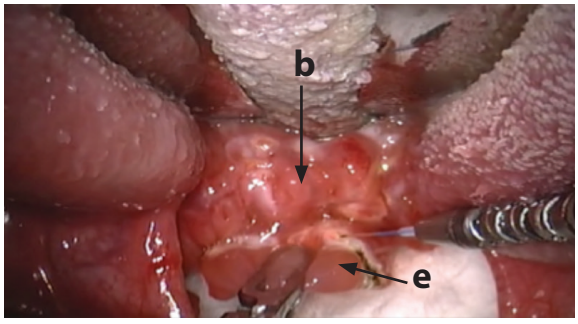
TORS is an effective treatment option for surgery to the BOT and epiglottis. Success rate ranges from 45% to 90%, with success defined as a decrease in postoperative apnoea-hypopnoea index (AHI) of greater than 50% and a postoperative AHI of less than 20 episodes per hour [5-9]. A large multicentre study demonstrated a mean



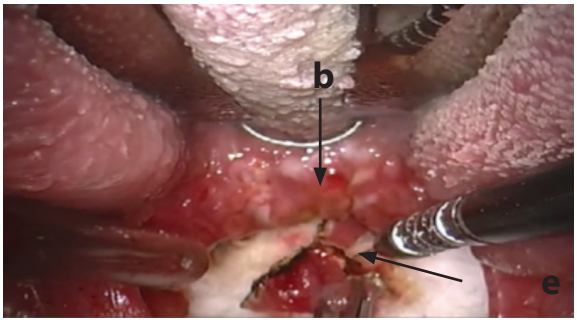
I. TBR: marking area for laser ablation



II. TBR following ablation



III. Partial epiglottic resection



IV. Completed epiglottoplasty

Figure 2: Tongue base reduction and epiglottoplasty (e = epiglottis, b = base ot tongue).

TABLE 1: POSTOPERATIVE MEDICATION PROTOCOL FOR TORS PATIENTS AT ST MARY'S HOSPITAL.

Drug	Dose	Frequency	Duration
Dexamethasone	2mg	3 times/day	5 days
Co-amoxiclav	625mg	3 times/day	5 days
Paracetamol	1gr	4 times/day	7-14 days
Ibuprofen	400mg	3 times/day	7-14 days
Codeine	30mg	As required	As required
Benzydamine hydrochloride	15ml (gargle)	4-6 times/day	14 days

success rate of 66.9%, and 53.8% of patients had an AHI of less than 15 episodes per hour and did not require CPAP after surgery [6]. Statistically significant improvement was also seen in ESS score, lowest oxygen saturation, and overall patient satisfaction and quality of life score.

No major complications relating to tongue mobility, hypoglossal nerve injury, lingual artery injury or speech have been noted so far. Likewise, no aspiration symptoms have been reported after epiglottoplasty. The most common operative complications are transient dysgeusia (14%), bleeding (5%) which was self-limiting in most cases, and temporary tongue numbness caused by pressure from the tongue blade attached to the mouth gag (100%, typically resolved within 1-4 weeks) [6]. Other potential complications include transient dysphagia (5%) and transient pharyngeal oedema (0.4%).

Summary

Most patients with OSA benefit from the use of the gold standard therapy of CPAP. However, because of the morbidity and mortality associated with moderate and severe OSA, noncompliant patients should be considered and assessed as to whether surgery might offer an alternative treatment. The literature would support that TORS may have a role in selected patients. Although the application of TORS for OSA is still in its infancy, the results so far are promising. TORS allows the surgeon to address BOT obstruction with excellent visualisation and an easier approach that is well tolerated by the patient.

Patient selection has a pivotal role as TORS certainly does not proclaim to offer a 'one-size fits all' surgical solution for OSA. DISE evaluates the pattern of collapse in each patient before selecting and planning patients for surgery. Previous studies have shown that at least 25% of patients with moderate-severe OSA have significant BOT and supraglottic obstruction that is suitable for TORS.

TORS for OSA may be a stand-alone procedure addressing obstruction at the level of BOT and / or epiglottis or can be carried out as part of multilevel surgery that may include either palatal and / or nasal surgery. Furthermore, recent studies demonstrate that TORS can be feasibly performed without the need for tracheostomy [5].

In conclusion, patients who undergo TORS with or without concomitant procedures had a significant improvement in objective and subjective OSA parameters and symptoms. TORS should be considered as an additional option for treating OSA related obstruction at both BOT and epiglottic levels. It has been associated with good efficacy and low complication rates. Currently, there are limited data to support its long-term efficacy and further studies are needed to elucidate its position in the surgical management of OSA patients.

References

1. Haniffa M, Lasserson TJ, Smith I. Interventions to improve compliance with continuous positive airway pressure for obstructive sleep apnoea. *Cochrane Review Cochrane Database Syst Rev* 2004:CD003531. The Cochrane Library. Chichester, UK; John Wiley & Sons, Ltd; 2004.
2. Elshaug AG, Moss JR, Southcott AM, Hiller JE. Redefining success in airway surgery for obstructive sleep apnoea: a meta analysis and synthesis of the evidence. *Sleep* 2007;**30(4)**:461-7.
3. Vicini C, Dallan I, Canzi P, et al. Transoral robotic tongue base resection in obstructive sleep apnoea-hypopnoea syndrome: a preliminary report. *ORL J Otorhinolaryngol Relat Spec* 2010;**72(1)**:22-7.
4. Chabolle F, Wagner I, Blumen MB, et al. Tongue base reduction with hyoepiglottoplasty: a treatment for severe obstructive sleep apnea. *Laryngoscope* 1999;**109(8)**:1273-80.
5. Friedman M, Hamilton C, Samuelson CG, et al. Transoral robotic glossectomy for the treatment of obstructive sleep apnea-hypopnea syndrome. *Otolaryngol Head Neck Surg* 2012;**146(5)**:854-62.
6. Vicini C, Montevecchi F, Campanini A, et al. Clinical outcomes and complications associated with TORS for OSAHS: a benchmark for evaluating an emerging surgical technology in a targeted application for benign disease. *ORL* 2014;**76(2)**:63-9.
7. Lin HS, Rowley JA, Folbe AJ, et al. Transoral robotic surgery for treatment of obstructive sleep apnea: Factors predicting surgical response. *Laryngoscope* 2014; [Epub ahead of print] doi:10.1002/lary.24970.
8. Vicini C, Dallan I, Canzi P, et al. Transoral robotic surgery of the tongue base in obstructive sleep apnea-hypopnea syndrome:anatomic considerations and clinical experience. *Head Neck* 2012;**34(1)**:15-22.
9. Lee JM, Weinstein GS, O'Malley BW Jr, Thaler ER. Transoral robotic-assisted lingual tonsillectomy and uvulopalatopharyngoplasty for obstructive sleep apnea. *Ann Otol Rhinol Laryngol* 2012;**121(10)**:636-9.

Konstantinos Chaidas,

ENT Senior Clinical Fellow, St Mary's Hospital, Imperial College Healthcare NHS Trust, London, UK.

E: konchaidas@gmail.com

Declaration of competing interests
None declared

Neil S Tolley,

Consultant ENT Head & Neck Surgeon, St Mary's Hospital, Imperial College Healthcare NHS Trust, London, UK.

Declaration of competing interests
None declared

Bhik Kotecha,

Consultant ENT Surgeon, Royal National Throat Nose and Ear Hospital, London, UK.

Declaration of competing interests
None declared