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Research Article

Transoral Robotic Surgery for Obstructive Sleep Apnea: Experience of 100 Cases in Our Tertiary Care Hospital

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Abstract

Aim: Reporting of the personal experience of 100 cases of transoral robotic surgery (TORS) using da Vinci Si system for obstructive sleep apnoea (OSA) in terms of feasibility, result, complications and challenges.

Methodology: The review presents our 3 years of experience of TORS using the da Vinci Si systems (Intuitive surgical systems, CA, USA) at our center in moderate to severe cases of OSA. We performed base of tongue (BOT) reduction with or without partial epiglottoplasty and palatal surgery using TORS. Patient selection is critical for TORS. Failed and patients non-compliant to continuous positive airway pressure (CPAP) were recruited for surgery. Polysomnography was the key diagnostic investigation. Along with da Vinci Si robot, we used Maryland dissector (5mm), monopolar cautery with a spatula (5mm) and a 30 degrees binocular 3 dimensional scope (12mm). BOT, palate and epiglottis were addressed by robotic assistance.

Results: 8 patients underwent TORS base of tongue (BOT) reduction alone, 6 patients also had partial epiglottoplasty, 26 patients had BOT reduction with uvulopalatoplasty and 60 patients had BOT reduction with both uvulopalatoplasty along with partial epiglottoplasty. Due to poor follow up only 45 patients were reviewed for postoperative polysomnography after 4 to 6 months. Apnea-Hypopnea Index (AHI) was compared; cure (that is AHI <5) was seen in 13 out of 45 patients (28.88%) and success (that is AHI <20) was seen in 31 out of 45 patients (68.88%). Unfortunately, one patient did not show any improvement subjectively and on the basis of AHI also. None of our patient suffered from major complications.

Conclusion: Experience of TORS for tongue base reduction with or without partial epiglottoplasty and palate surgery for OSA at our tertiary center was excellent with overwhelming results showing both subjective and objective improvements with minimal complications and uneventful postoperative period.

Keywords: Transoral Robotic Surgery (TORS); Obstructive Sleep Apnoea (OSA); da Vinci Si; Base of Tongue (BOT); Epiglottoplasty; Polysomnography; Apnea-Hypopnea Index (AHI)

Introduction

Obstructive sleep apnea (OSA) is a major worldwide health problem which not only causes excessive daytime somnolence, poor work performance and higher incidence of road traffic accidents but it also results in grave outcomes like cardiovascular and cerebrovascular morbidity, poor neurocognitive function and overall reduced quality of life [1]. It affects 1 to 4% of the adult population and more commonly males, ratio being 2:1 [2]. OSA is characterized by multilevel collapse of the upper airway anatomical segments like base of tongue, soft palate, lateral and posterior pharyngeal wall and epiglottis during sleep resulting in oxygen desaturation and sleep interruption; surgical treatment of which aims to alleviate this collapse resulting in increased airway volume [3]. Miller., *et al.* stated, OSA if not treated for 15 years increases the mortality rate by 30% [4].

Nasal continuous positive airway pressure (CPAP) is the gold standard treatment for OSA (moderate to severe). CPAP acts like a pneumatic splint, which increases the pressure within the pharyngeal lumen. For non-compliant patients and in failed CPAP mode of therapy, various surgical options are available which aims to modify or stabilize the airway passage. In these procedures various soft tissue sub sites are repositioned or removed to prevent collapse during respiration [5,6].

According to the apnea hypopnea index (AHI) evaluated by polysomnographic study, OSA is graded as mild, moderate and severe as value between 5 and 15, between 16 and 30 and more than 30 respectively. The AHI is the number of apnea plus hypopnea episodes per hour of sleep. As stated by Vicini, Friedman and Lee, cure is called when AHI become less than 5/hour whereas success

is called when AHI reduced to <20/hour or >50% reduction in AHI postoperatively [7,8].

Throughout the world robotic surgery in otorhinolaryngology started gaining ground as a favored mode of surgery. In the field of ENT and head and neck surgery, the history of robotic surgery is brief and is a new concept. It is now being used successfully for many indications in ENT and head and neck surgery, out of which transoral robotic surgery (TORS) for OSA is one of the accepted indication. Food and Drug Administration (FDA) in 2014 approved TORS for removal of benign tissue from base of tongue (BOT), demonstrating its safety and efficacy [9].

The role of multilevel surgery in OSA has been proved in literature to address the collapsible sub sites of upper aerodigestive tract. Transoral robotic surgery (TORS) for tongue base reduction and partial epiglottoplasty for OSA is a novel technique in surgical world, the efficacy and safety of which has been proven in many studies all over the world [7,10]. The credit for robotic surgical settings and techniques for tongue base reduction goes to O'Malley., *et al*. and Vicini., *et al.* [11,12].

We are reporting our personal experience of TORS tongue base reduction with or without partial epiglottoplasty and palatal surgery for treatment of moderate to severe OSA at our center. This article portrays our clinical experience of 100 TORS using Da Vinci system for OSA in time period of 3 years, demonstrating accelerated improvement in robotics as well as surgical outcomes using a team approach. To our best knowledge, this is the first paper to report the same from India.

Methods

We performed 100 cases of TORS for OSA from November 2016 to October 2019. Most of our patients were international (n=63), from various parts of the world like Africa, Russia, Middle East and other parts of Asia. TORS base of tongue reduction with or without partial epiglottoplasty and palatal surgery was performed in patients for whom the first line treatment that is CPAP had failed or in patients who were non-compliant and rejected it. We provided all pertinent information regarding alternative surgical modalities available to our patients like maxillomandibular advancement devices, genioglossal advancement, hyoid suspension, radiofrequency and coblation assisted (endoscopic) reduction of tongue base. All patients were briefed regarding safety and efficacy of TORS for OSAHS, possibility of complications, our preceding experience and results. After counselling, written informed consent was taken from patients.

Detailed history of patient including previous treatment history was recorded not only from the patient but also from the partner of the patient, ENT examination including diagnostic nasopharyngoscopy using flexible fiberoptic nasoendoscope to examine the contribution to the obstruction by the sub sites of the upper airway; the bulkiness of the base of tongue including lingual tonsil, gross deviated nasal septum and tonsillar hypertrophy was noted. Patients having significant obstruction due to gross deviated nasal septum were recommended to undergo a septoplasty as the initial operation. These patients were then evaluated after healing to determine whether they still require surgical correction for OSA or not. Finally the overnight polysomnography was performed. Along with polysomnographic data like sleep architecture, apnea hypopnea index (AHI), respiratory effort related arousal index, respiratory disturbance index, lowest oxygen saturation and time spent in hypoxia (oxygen saturation less than 90%), BMI (body mass index) were recorded. Careful patient selection for TORS is of utmost importance. Those having moderate to severe OSA (AHI >15) and BMI less than 30 kg/m^2 were recruited for TORS. Usually patients with a higher BMI (>30 kg/m^2) respond poorly [7]. The surgical cure and success was defined according to the traditional surgical criteria as already discussed earlier.

In all patients nasotracheal intubation was preferred because it does not produce hindrance to surgical field unlike oropharyngeal intubation. The surgical robot we are using at our center is the da Vinci Si (Intuitive surgical systems, Sunnyvale, CA, USA). We used 30 degrees angled 3-dimensional scope (12 mm) with monopolar cautery with a spatula tip in one arm and a Maryland dissector (5 mm) in another. For all the TORS for OSA we used Crockard retractor for gaining access, providing excellent exposure of BOT and epiglottis. This specialized retractor allowed us easy resection and adequate mobility of the robotic arms in such a concise space, making TORS ideal for multilevel surgery without demanding open access.

After exposing the surgical field with the help of retractor, a 1-0 silk suture was used for retracting the body of tongue after piercing through it so that BOT is pulled more anteriorly. Surgery started with the midline incision at the tongue base extending from the foramen cecum to vallecula and extending laterally (1 to 1.5 cm) on both right and left sides maintaining haemostasis. Extension of the resection beyond 1.5 cm from foramen cecum can lead to neurovascular injury (hypoglossal/lingual), so it is safe to limit the resection within this range from foramen cecum [13].

For patients who required epiglottoplasty in cases of floppy, edematous and retroflexed epiglottis, we resected upper third of epiglottis using da Vinci robot only. Epiglottis was grasped with Maryland dissector, and incision beginning from free edge of midline of epiglottis, extended towards base of epiglottis until junction of upper $1/3^{rd}$ and lower $2/3^{rd}$. The incision was then extended laterally to lateral edge bilaterally achieving resection with excellent hemostasis. For patients having hypertrophic uvula and collapsed soft palate, an uvulopalatoplasty was performed using robot only. And when needed, the posterior pillars and soft palate were sutured at the end after removing robotic arms from the surgical field.

Most of the surgeons at some centers prefer overnight intensive care unit (ICU) stay with continued intubation. But we are in practice of extubating the patient on table after cautious examination

of the airway by our anesthesiologist. Postoperatively, patients were kept under monitoring for 3 hours in recovery room. Patients were given intraoperative and postoperative intravenous steroids which helps in reducing airway edema, nausea and inflammation. Patients were kept nil per oral for 6 hours and oral feeding was started under supervision of nursing staff, beginning with cold liquids and soft diet. Adequate postoperative analgesic was given. Each patient was discharged in good condition on second postoperative day.

Results

Between November 2016 and October 2019, 100 patients underwent TORS for moderate to severe sleep apnea (men = 81 and women = 19, mean age = 49.87 years and range 24 to 79 years). Out of total 100 TORS for OSAHS, 8 patients underwent TORS base of tongue (BOT) reduction alone, 6 patients also had partial epiglottoplasty, 26 patients had BOT reduction with uvulopalatoplasty and 60 patients had BOT reduction with both uvulopalatoplasty and partial epiglottoplasty. As tongue base is the major contributor for narrowing the airway, it was addressed in every case of OSA.

We followed up each of our patient postoperatively after one week showing splendid subjective improvement with respect to snoring, daytime sleepiness and overall satisfaction. But unfortunately we were able to measure the outcome objectively on the basis of sleep study between 4th and 6th month postoperatively in only (N = 45) patients due to poor follow up. As most of the patients turned in our hospital were international (63/100), they were not be able to report after 4 to 6 months of surgery for repeat sleep study.

Cure from TORS that is AHI <5 was achieved in (13/45) patients (28.88%) while success that is AHI<20 or >50% reduction in AHI was seen in (31/45) patients (68.88%). Unfortunately, one patient did not show any improvement in AHI with persistence of the preoperative symptoms. Patient response in terms of relief was overwhelming because of significant improvement in AHI level and quality of life. During follow up we observed that patients with severe OSA had more improvement in symptoms as compared to patients with moderate OSA. As per surgeon's point of view, superb surgical exposure with excellent precision and distal control of instruments makes TORS a superior alternative for surgical management of OSA.

None of our patient required perioperative tracheostomy or nasogastric tube insertion for feeding and none suffered major complications of TORS like lingual nerve, hypoglossal nerve or lingual artery injury. Most of our patients suffered only from minor temporary complications like swelling of tongue, numbness of tongue, transient dysphagia and dysgeusia. But as we are in practice of relieving retractor after every 20 minutes for 5 minutes, we further curtailed the severity of these minor complications. Not even a single patient surpassed the blood loss of more than 10 ml. Postoperative functional outcomes on the basis of swallowing function and speech were excellent and the incidence of aspiration was nil during the follow up period. Patients, especially those who underwent partial epiglottoplasty were kept under supervision of nursing staff to look for signs of aspiration while feeding orally.

Discussion

Our experience of 100 cases of TORS for OSA was excellent, asserting feasibility and safety of this novel technique. TORS is becoming an acceptable modality for both patients of OSA and to surgeons, as robot makes them working in concise space precisely with outstanding results.

The prime target of the robotic technology is to provide safe and precise surgeries with minimal morbidity to the patients. Review of literature affirms the subjective improvement and significant reduction in AHI after TORS with excellent functional outcomes [14-17].

TORS for moderate to severe OSA undoubtedly is a safe and acceptable option, offering definite advantages over conventional approaches. Apart from shorter hospital stay and less bleeding, it provides multiple other benefits like 3-dimensional magnified high definition visualization of BOT and hypopharynx, use of the EndoWrist articulated instruments provides improved dexterity with seven degrees of freedom, excellent precise handling of tissues, tremor filtration, motion scaling and surgeon ergonomics [18,19]. Before the introduction of TORS, treatment of OSA basically was represented by pharyngeal surgeries like uvulopalatopharyngoplasty (UPPP) with very inconsistent results [20-22]. TORS is an efficient technology which allows multiplanar visualization and easy access to the tongue base and epiglottis. As we know that BOT is recognized as the major contributor for obstruction, robotic surgery eliminated the need for external incisions for addressing tongue base. Difficulties like inadequate exposure and technical difficulty due to nonarticulated instruments which were seen in conventional procedures are also eliminated by the TORS.

Patient selection for TORS is very critical. Anatomical limitation like retrognathia, micrognathia and inadequate mouth opening (trismus) are few of the challenges for TORS; so in this scenario preoperative assessment of mouth opening becomes essential as adequate mouth opening is a pre requisite for TORS. Patients with comorbidities like uncontrolled hypertension, hyperglycemia or cardiovascular issues should be looked for and referred to physician for medical clearance and management prior to surgery. BMI is another critical patient factor which predict success of TORS. Hoff., *et al.* stated that favorable outcome is inversely correlated with preoperative BMI [23].

Like any other surgical intervention, robotic surgery do have specific drawbacks. First is the absence of haptic feedback. Secondly, the high cost of the surgery remains a significant concern

at present. One more specific drawback in countries like India is awareness among general public and even amongst many medical practitioners regarding robotic surgery (TORS) for OSA.

In less than 10 years of introduction of TORS for OSA, this application has spread all over the world. This surgical management of OSA is appealing for both patients and surgeons, helping patients to get rid of CPAP. When correctly indicated the outcomes are excellent and the robotic technology is a promising tool.

Conclusion

Experience of TORS for tongue base reduction with or without partial epiglottoplasty and palate surgery for OSA in our tertiary center is excellent with overwhelming results showing both patient satisfaction and objective improvement with minimal complications and uneventful postoperative period. Careful patient selection is the key for success of TORS. In future, TORS may become a compelling tool in the armamentarium of the ENT and head and neck Surgeon to productively treat airway collapse in OSA surgically.

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Conflicts of Interest

None.

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