International Journal of Otorhinolaryngology and Head and Neck Surgery
Mittimanj K et al. Int J Otorhinolaryngol Head Neck Surg. 2022 Aug;8(8):672-676
http://www.ijorl.com
pISSN 2454-5929 | eISSN 2454-5937

DOI: https://dx.doi.org/10.18203/issn.2454-5929.ijohns20221831

Case Series

THRIVE: a different approach in microlaryngeal surgeries

Kavya Mittimanj[1], Malathi Jabanathan[1]*, Shishir Chandrashekhar[1], Shantanu Tandon[2]

[1]Department of Anaesthesia, [2]Department of Otorhinolaryngology, Sakra World Hospital, Bangalore, Karnataka, India

Received: 01 July 2022
Revised: 14 July 2022
Accepted: 15 July 2022

***Correspondence:**
Dr. Malathi Jabanathan,
E-mail: dr.maalu05@gmail.com

ABSTRACT

Microlaryngeal surgeries (MLS) are typically performed under general anaesthesia either by employing a microlaryngeal tube or without endotracheal intubation using high frequency jet ventilation. Recently, trans-nasal humidified rapid insufflation ventilatory exchange (THRIVE) without ET tube can be used. It has no compromised view/ access as in MLS tube and no barotrauma/movement of vocal cords/ tumour implantation as in jet ventilation. We aimed to assess the feasibility and safety of tubeless MLS using THRIVE. From December 2019 to December 2020, all the patients undergoing tubeless MLS were included. Anaesthesia was conducted with target controlled propofol infusion and muscle relaxation with THRIVE oxygen support. Perioperative data was collected and analysed. A total of 21 patients underwent MLS using THRIVE as the sole method of ventilation. Mean age was 52.6 (±13.77) years, and mean body mass index (BMI) was 25.63 (±4.91) kg/m^2. The surgical indications were vocal cord tumor/ biopsy and vocal polyp/cyst excision. Mean apnoea time was 27 min. At the end of surgery, mean end tidal CO_2 was 66 mmHg. Surgeon's satisfaction about the operating field was recorded and he rated it as either excellent (70%) or good (30%). In carefully selected patients, a combination of THRIVE and TIVA offers a good alternative to conventional anaesthesia with tubes. Our study demonstrated a considerable safe apnoea time with an acceptable CO_2 build up. Surgeon acceptance of the technique was extremely promising and the operating conditions were highly rated by them.

Keywords: MLS, THRIVE, Apnoea

INTRODUCTION

Micro-laryngeal surgeries (MLS) are typically performed under general anaesthesia either by employing a micro-laryngeal tube or by providing apnoeic oxygenation without endotracheal intubation using high frequency jet ventilation.[1-3]

Though the micro-laryngeal tube impedes surgical access less than conventional endotracheal tubes (ETT), it does not provide an unobstructed view of the larynx.

Jet ventilation used as alternative to endotracheal anaesthesia, but it may cause movement of vocal cords, barotrauma and tumour implantation in trachea.[4]

THRIVE is a technique that uses rapidly insufflate, heated, humidified gases administered via high flow nasal cannula (HFNC) to achieve apnoeic oxygenation.[5] While THRIVE is simple to administer, and has been used in the intensive care units since early 2000, its use in the perioperative settings is relatively new.[6]

There is emerging literature that has demonstrated the safety and feasibility of using THRIVE as the sole mode of oxygenation for such procedures.[7-10] It avoids vocal cords movement unlike jet ventilation, compromised view and access associated with ETT, and the trauma and interruptions of intermittent intubations. As far as the authors are aware, no such studies have been conducted in the Indian context. In the present study, we aimed to assess the feasibility and safety of tubeless MLS using

THRIVE under general anaesthesia with muscle relaxation.

CASE SERIES

After approval from the institutional ethics committee, a case note review was conducted of 21 patients who underwent elective MLS over a period of one year (Dec 2019-Dec 2020) using total intravenous anaesthesia and THRIVE at Sakra world hospital, Bangalore.

Anaesthetic technique

A standardized anaesthesia protocol was adopted for all the patients. ASA standard monitors were attached and the nasal cannula of THRIVE (Optiflow™, Fisher and Paykel healthcare, New Zealand) was placed. Preoxygenation was started with 100% oxygen at a rate of 20 l/min or as tolerated by the patient for 5 min. Intravenous anaesthesia was started with target-controlled infusion of propofol using Schneider model, effect site concentration to maintain a concentration of 4 to 6 µg/ml. Oxygen flow rate of THRIVE was increased to 50-60 litres/ min once the patient lost consciousness (Figure 1). Depth of anaesthesia was monitored using Bi-spectral index (BIS). Once the patient was draped and surgeon was ready, injection atracurium 0.5 mg/kg was given and the apnoea timer was started. After 3 min, suspension laryngoscope was introduced by the surgeon to commence the surgery (Figure 1). Anaesthesia was maintained by propofol, fentanyl 1-2 mcg/kg and paracetamol 1 g. Patient hemo-dynamics, saturation were maintained within 20% of baseline. During the surgery, BIS value was maintained between 40 and 60. Airway cart with various sizes of MLS tube and supra glottic airway devices were kept ready to replace THRIVE if necessary. In case of desaturation (SpO_2<90%) either I gel or endotracheal tube insertion was considered as a back-up plan, depending on the stage of the surgery.

Figure 1: Nasal cannula of thrive *in situ* during preoxygenation and suspension laryngoscope placed during the procedure.

The I-gel laryngeal mask airway was inserted immediately after the surgery by removing the THRIVE and patients were ventilated to normal ventilation (tidal volume 8 ml/kg and respiratory rate 12/min). $EtCO_2$ values were noted immediately after resuming ventilation, i.e.; 0 min, 2 min and 5 min. Apnoea time was calculated from the time of injection of atracurium to the commencement of normal ventilation with I-gel. Patients were reversed and extubated after adequate suction. Patients were shifted to postoperative recovery room for monitoring.

Parameters studied were patient demographics, American society of anaesthesiologist's physical status class (ASA class), history of comorbidities, airway assessment, details of surgical procedure, baseline hemodynamic parameters, duration of surgery and total theatre time. Pertaining to THRIVE, the following parameters were collected-Duration of safe apnoea, (defined as SpO_2 >90%), need for rescue ventilation, and build-up of CO_2. $EtCO_2$ values were recorded following the normal ventilation using I-Gel. Also in this study, surgeon was asked to rate the following using a 5-point Likert scale: 1. Ease of introduction of DL scope; 2. Ease of reaching the lesion; 3. Field quality and 4. Overall impressions.

Results of case series analysis: The data of 21 patients, who had undergone elective micro laryngeal surgeries receiving a combination of total intravenous anaesthesia with high-flow nasal oxygen delivery without intubation, during the period from December 2019 to December 2020 were reviewed. Because the outcome of this study is descriptive, no power analysis was done. Data are presented as mean±SD, median, or number (%) in appropriate places. Demographic data and patient characteristics are presented in (Table 1).

Table 1: Demographic data and patient characteristics, (n=21).

Demographic details	N (%)
Gender	
Male	15 (71.4)
Female	6 (28.58)
Mean age (years)	52.6±13.77
Mean BMI (kg/m^2)	25.63±4.91
ASA	
1	6 (28.58)
2	15 (71.4)
Comorbidities	
Diabetes mellitus	10
Hypertension	6
Ischemic heart disease	2
Hypothyroid	1
OSA	2
Surgical procedures	
Vocal cord tumor biopsy	9 (42.85)
Vocal polyp/cyst/ growth excision	12 (57.14)

The study parameters including the total theatre time, operating duration, apnoea time and haemodynamic parameters are presented in (Table 2).

Table 2: Study parameters.

Parameters	Mean±SD
Total theatre time in min (in-out time)	56.6±11.87*
Operation time in minutes	26.61±5.49*
Apnea time in minutes	27.85±5.87*
HR at the end of the case	102 (88-113)#
Systolic BP at end case (mmHg)	128 (103-176)#
Diastolic BP at end case (mmHg)	86 (101-64)#
First $EtCO_2$ recorded at I-gel insertion	66.95±8.86*
SpO_2 at the end of the surgery	99 (78-100)#

*mean±SD, #median (range).

Saturation (SpO_2)

Median baseline SpO_2 for the 21 patients was 100% (Range 92%-100%). During the surgery time, the median SpO_2 was 99% (Range 78%-100%). Median SpO_2 after 5 minutes in postoperative recovery room was 100% (range 98%-100%).

Three patients underwent desaturation (defined as SpO_2 <90%). Among the three patients, one 72-year-old male patient, who underwent laryngeal tumour biopsy experienced desaturation after 38 minutes of apnoea time. (lowest SpO_2, 78%) and patient had to be intubated to proceed with the surgery. A 5 mm micro laryngeal ET tube was smoothly inserted by the lead anaesthetist, patient was hand ventilated to regain the SpO_2 to 100%. Two other patients desaturated to 89% and 85% respectively after 22 and 23 minutes. Since the surgery was completed, they were managed by insertion of I gel and mechanical ventilation. Their age was 65 and 68 and BMI were 33.5 and 31.2 respectively. None of the patients had desaturation in the postoperative period.

End tidal carbon dioxide ($EtCO_2$)

$EtCO_2$ at 0 min, 2 min and 5 min of the end of apnoea time and resumption of normal mechanical ventilation were recorded as shown in Figure 2. Pearson correlations co-efficient when computed between intraoperative parameters, apnoea time and $EtCO_2$ at the end of apnoeic time was 0.5771. There was a positive correlation between the two (Figure 3). The increase in $EtCO_2$ for every minute of apnoeic time could not be calculated as the baseline $EtCO_2$ was not known.

Surgeon's satisfaction

Surgeon's satisfaction was recorded under 4 headings which is shown in the (Table 3) and all the parameters were rated as excellent or good by the surgeon and none of the parameters were rated below that.

No major complications or hemodynamic deteriorations were observed both in the intraoperative and the postoperative phase. No prolonged hospital stay was observed in any patient.

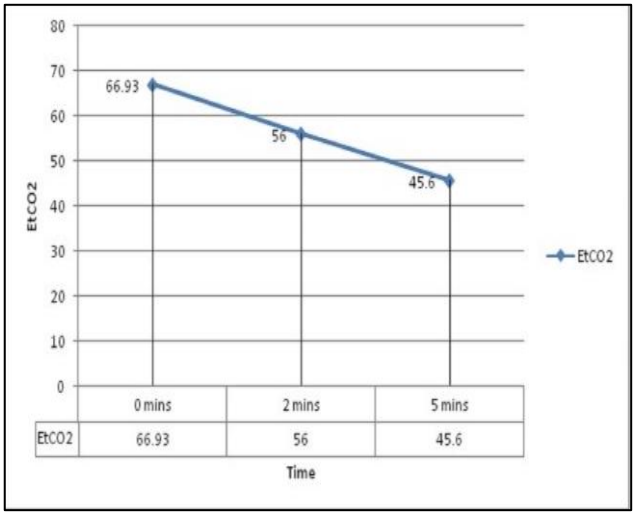

Figure 2: Mean $EtCO_2$ concentration at the end of apnoea time.

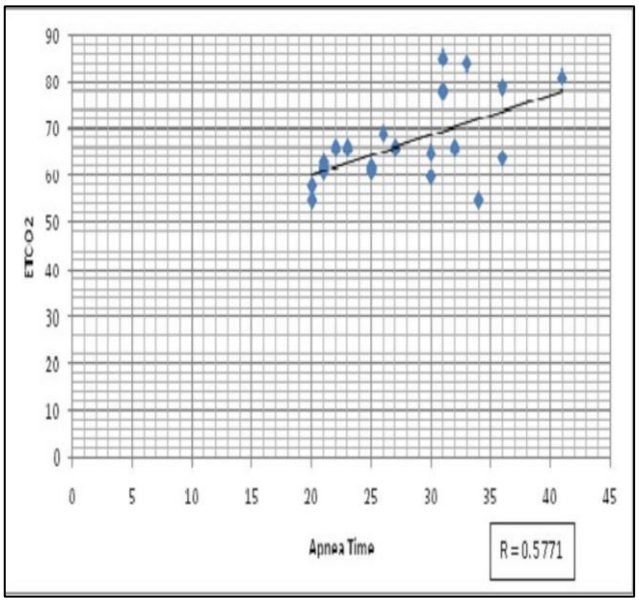

Figure 3: Correlation between $EtCO_2$ and duration of apnoea time.

Table 3: Surgeon's satisfaction with the operating field.

Surgeon's satisfaction	Excellent (%)	Good (%)
Ease of introducing DL scopy	70	30
Ease of reaching the lesion	30	70
Field quality and visibility	60	40
Overall impression	70	30

DISCUSSION

The usage of THRIVE in anaesthesia as the sole ventilatory technique became well known after several case series were published which supported the usage of apnoeic oxygenation in a small group of patients requiring upper airway surgery.[2-4]

In this case series, we analysed the apnoeic oxygenation without intubation using THRIVE for short duration elective micro laryngeal surgeries. These surgeries are more likely to benefit from using THRIVE technique as the airway patency is ensured with rigid suspension laryngoscope by the surgeon. The mean apnoea time observed in our study was 27.85±5.87 min which is comparable to similar studies in the literature like, Gustafsson et al (22.5 min), Huang et al (23 min), and longer than To et al and Benninger et al where the median apnoea time was 18 and 16 min respectively. The physiological basis of apnoeic oxygenation is, there is a mass movement of gases from the pharynx into the alveoli, provided that the upper airway is patent. This process of apnoeic oxygenation may improve arterial oxygen saturation, thus prolonging the safe apnoeic period.[11-15]

No major complications were observed, except the three patients who had desaturation. In the patient (72 year/M: BMI of 24.9) who desaturated after 38 min of apnoea, we postulate that the reason for desaturation was the duration of apnoea rather than the body habitus of the patient. Two other patients who desaturated after a mean apnoea time of 22 and 23 min had BMI of 32 and 35 respectively. The lowest saturation observed was 85%, intubation was avoided in both the patients. Our results were comparable to a case report presented by Lee et al where the mean duration of apnoea was 24 min and BMI was 40.[16] Functional residual capacity (FRC) and respiratory compliance decrease as body mass index (BMI) increases.[17] Patel et al suggested that the apnoeic time in higher BMI patients will differ from those with a normal BMI.[6]

Total theatre time (time in-time out of theatre) was 56.6 minutes (±11.8 min). Another case series conducted by Yang et al also had similar operating time with no complications.[9] From our review of the anaesthesia records of similar cases performed under conventional general anaesthesia in our hospital, the total duration of theatre time and operating time both were found to be much shorter with THRIVE. However, this has to be formally compared by further prospective studies.

One of the major limitations of apnoeic oxygenation technique is the accumulation of carbon dioxide. Typical rise of CO_2 in apnoea is noted to be 2.62-3.37 mmHg/minute in historic studies.[18] $EtCO_2$ was measured immediately after resuming normal mechanical ventilation with the help of supra glottic airway at the end of surgery. Mean $EtCO_2$ at 0 min was found to be 66 mmHg and the $EtCO_2$ at 2 min was 53 mmHg. After 5 min of normal min volume ventilation (100 ml/kg/min) mean $EtCO_2$ was found to be 45 mmHg which was in the upper normal range of normal $EtCO_2$. Assuming that our patients had normal baseline $EtCO_2$, the rate of rise of CO_2 in our series was similar to that found in other comparable studies which suggests that THRIVE along with providing excellent apneic oxygenation also helps with helps with elimination of CO_2. Surgeon's satisfaction about the operating field was recorded immediately after surgery by a semi quantitative 5-point Likert's scale and was rated as either excellent (70%) or good (30%) in all patients.

Limitations

Partial pressure of carbon dioxide in the arterial blood was not measured in any patient as these procedures did not mandate placement of an arterial cannula. Base line $EtCO_2$ of patients were not known, hence the rate of rise of CO_2 could not be quantified, however the authors feel that it is reasonable to assume that the baseline values would have been normal as our patients did not have any major respiratory co morbidities. Our study was limited to vocal cord polyp or tumor biopsy and consequently its results may not be extrapolatable to more complex or longer surgeries.

CONCLUSION

The authors propose that, in carefully selected patients, a combination of THRIVE and TIVA offers a good alternative to conventional anaesthesia with micro-laryngeal tubes. Our study demonstrated a safe apnea time of 27 mins with an acceptable CO_2 build up. Also, compared to historical controls in our institution, theatre time was greatly reduced in these patients. Finally, surgeon acceptance of the technique was extremely promising, and the operating conditions were highly rated by them. We propose that a formal prospective case control study might add further credence to the safety and efficacy of this novel technique.

ACKNOWLEDGEMENTS

Author would like to thanks to Sakra world hospital anaesthesia, ENT department and theatre staff.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Benjamin B, Gronow D. A new tube for micro-laryngeal surgery. Anaesth Intensive Care. 1979;7(3):258-63.
2. Biro P. Jet ventilation for surgical interventions in the upper airway. Anesthesiol Clin. 2010;28(3):397-409.

3. Cook TM, Alexander R. Major complications during anaesthesia for elective laryngeal surgery in the UK: a national survey of the use of high-pressure source ventilation. Br J Anaesth. 2008;101(2):266-72.
4. Evans E, Biro P, Bedforth N. Jet ventilation. Continuing Education in Anaesthesia Critical Care and Pain. 2007;7(1):2-5.
5. Jagannathan N, Burjek N. Trans-nasal humidified rapid-insufflation ventilatory exchange (THRIVE) in children: a step forward in apnoeic oxygenation, paradigm-shift in ventilation, or both? Br J Anaesth. 2017;118(2):150-2.
6. Patel A, Nouraei SA. Trans-nasal Humidified Rapid-Insufflation Ventilatory Exchange (THRIVE): a physiological method of increasing apnoea time in patients with difficult airways. Anaesthesia. 2015;70(3):323-9.
7. Huang L, Athanasiadis T, Woods C, Dharmawardana N, Ooi EH. The use of trans-nasal humidified rapid insufflation ventilatory exchange in laryngeal and pharyngeal surgery: Flinders case series. Aus J Otolaryngol. 2019;2.
8. To K, Harding F, Scott M, Milligan P, Nixon IJ, Adamson R et al. The use of Trans-nasal Humidified Rapid-Insufflation Ventilatory Exchange in 17 cases of subglottic stenosis. Clin Otolaryngol. 2017;42(6):1407-10.
9. Yang SH, Wu CY, Tseng WH, Cherng WY, Hsiao TY, Cheng YJ et al. Non-intubated laryngomicrosurgery with Trans-nasal Humidified Rapid-Insufflation Ventilatory Exchange: A case series. J Formos Med Assoc. 2019;118(7):1138-43.
10. Benninger MS, Xiao R, Osborne K, Bryson PC. Outcomes Following Cordotomy by Coblation for Bilateral Vocal Fold Immobility. JAMA Otolaryngol Head Neck Surg. 2018;144(2):149-55.
11. Gustafsson IM, Lodenius A, Tunelli J, Ullman J, Jonsson Fagerlund M. Apnoeic oxygenation in adults under general anaesthesia using Trans-nasal Humidified Rapid-Insufflation Ventilatory Exchange (THRIVE)-a physiological study. Br J Anaesth. 2017;118(4):610-7.
12. Huang L, Dharmawardana N, Badenoch A, Ooi EH. A review of the use of trans-nasal humidified rapid insufflation ventilatory exchange for patients undergoing surgery in the shared airway setting. J Anesth. 2020;34(1):134-43.
13. To K, Harding F, Scott M, Milligan P, Nixon IJ, Adamson R et al. The use of Trans-nasal Humidified Rapid-Insufflation Ventilatory Exchange in 17 cases of subglottic stenosis. Clin Otolaryngol. 2017;42(6):1407-10.
14. Benninger MS, Zhang ES, Chen B, Tierney WS, Abdelmalak B, Bryson PC. Utility of Trans-nasal Humidified Rapid Insufflation Ventilatory Exchange for Micro-laryngeal Surgery. Laryngoscope. 2021;131(3):587-91.
15. Wong DT, Yee AJ, Leong SM, Chung F. The effectiveness of apneic oxygenation during tracheal intubation in various clinical settings: a narrative review. Can J Anesthesia. 2017;64(4):416-27.
16. Lee SJ, Quek KH. Facilitating Airway Surgery in a Morbidly Obese Patient Using Trans-Nasal Humidified Rapid Insufflation Ventilatory Exchange (THRIVE). Case Rep Anesthesiol. 2018;2018:5310342.
17. Parameswaran K, Todd DC, Soth M. Altered respiratory physiology in obesity. Can Respir J. 2006;13(4):203-10.
18. Eger EI, Severinghaus JW. The rate of rise of $PaCO_2$ in the apneic anesthetized patient. Anesthesiology. 1961;22(3):419-25.

Cite this article as: Mittimanj K, Jabanathan M, Chandrashekhar S, Tandon S. THRIVE: a different approach in microlaryngeal surgeries. Int J Otorhinolaryngol Head Neck Surg 2022;8:672-6.