IJTA

International Journal of Therapeutic Applications
ISSN 2320-138X

ANAESTHETIC MANAGEMENT FOR LASER SURGERY OF AIRWAY LESIONS

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ABSTRACT

Introduction: Laser surgery poses critical challenges to the anaesthesiologist which is compounded further by the different indications for laser surgery. Problems include the conflicting needs of the surgeon and the anaesthesiologist for access of the airway, fire hazards associated with the laser beams, the absolute necessity to ensure the adequacy of ventilation and the intense cardiovascular presser response. Every conceivable mode of airway management and ventilation has been used for laser surgery of the airway.1,2,3,4

Aim: To highlight various methods of airway control, to evaluate intra-operative hemodynamic changes and any complications.

Material and method: Thirty five patients of both sexes and all age groups posted for surgeries of an airway (nose, oral cavity, larynx, trachea and bronchus) have been included. In all the patients ventilation was performed with an air / oxygen mixture and total intravenous anaesthesia at the time of laser ablation. The patients were ventilated by side arm of a ventilating bronchoscope or laser endo-tracheal tube using IPPV or LFJV.

Results: Adequate oxygenation and ventilation was achieved in all patients. The changes in SpO2, EtCO2 & hemodynamic variables were significantly less in surgery for nasal, oral, palatal and laryngo-tracheal surgeries of short duration. No complications including airway fire, major haemorrhage, or aspiration of debris secondary to the ventilation technique were observed. Barotrauma occurred in one patient for bronchial laser ablation and required ICD and postoperative mechanical ventilation.

Conclusion: LFJV is a better mode of ventilation for laryngo-tracheal surgeries of short duration. It is preferable for laser surgeries.

Keywords: airway lasers, endoscopy, airway surgery, Jet ventilation, Safety measures

INTRODUCTION

Airway surgery demands a high level of cooperation between surgical and anaesthetic teams In addition to facilitating surgery through providing an unobstructed and immobile operative field, anaesthetists must provide oxygenation, carbon dioxide elimination, adequate anaesthesia, and a rapid return of consciousness and airway reflexes after surgery.[5]

Surgery of an airway is a special endeavour where the airway is shared by the surgeon and the anaesthesiologist. Knowledge of the various techniques for airway management is crucial since it is also necessary to provide the surgeon with a still and non-obstructed field.[6]

Lasers provide a source of intense energy that can ignite flammable material, such as tracheal tubes, catheters, sponges, or latex gloves in the operative field.[4,7]

Risk of fire is particularly enhanced in oxygen (0_2) and nitrous oxide (N_20) enriched atmospheres. There are available methods of airway management that reduce the risk of fire during operations in which a laser is used. Each method has its own risks and benefits.[2,4]

The objective of this clinical case series study is to highlight anaesthetic management, alternative methods of airway control, intra-operative hemodynamic changes and the problems and solutions of problems in airways management.

MATERIAL AND METHODS

In this clinical case series study 35 patients, between 2.5 to 60 years of age, either sex, weight 5 to 70 kg, ASA Status: II-III and Elective laser surgery on an airway (oral cavity, larynx, trachea and bronchus) under general anaesthesia are included. Patients with history of bleeding, coagulation disorder and surgeries under local anaesthesia were excluded from the study.

Preoperative assessment was done on the day before surgery. Routine investigations including Hb, RFT, LFT, X ray chest and ECG were noted. Informed and written consent for ASA grade was taken.

In operation theatre, monitors applied were ECG, NIBP, SpO2, etCO2. Intravenous line was secured with 22, 20 or 18 gauge intracath and I.V. fluids normal saline or ringer lactate was started. I.V. premedication in form of Inj. Ondansetron (0.15 mg/kg) , Inj. Glycopyrrolate (0.004mg/kg) , Inj. Fentanyl (1-2µgm/kg) and inj. Hydrocortisone 100-200mg was given. Basal pulse rate, blood pressure, oxygen saturation and end tidal CO2 was recorded.

All patients were pre-oxygenated for 3-5 minutes. Induction of anesthesia was done using inj. Propofol 2mg/kg I.V. Jaw relaxation was facilitated with inj. scoline 1.5-2 mg/kg or atracurium 0.5mg /kg I.V. Anesthesia was maintained with TIVA (total intravenous anesthesia) using propofol infusion 200µg/kg/min. and intermittent scoline 0.4mg/kg or NDMR inj.atracurium 0.1mg/kg. Airway was secured with laser tube; aluminium foiled attached endotracheal tube or no device. IPPV was done with air using ambu bag with/without O_2 4-6 liters/min. or LFJV (Low Frequency Jet Ventilation) had given through side arm of ventilating bronchoscope.

Intraoperative problems in forms of SpO2 < 90 per cent, Hypercarbia (etCO2 > 40), hypertension (SBP > 160/min.), Tachycardia (HR > 100/min), Bradycardia (HR < 60/min.), Arrhythmias and haemorrhage were noted. Desaturation and hypercarbia was treated with temporary stopping surgery and ventilating with 100% oxygen via endotracheal tube or face mask. HT refractory to deeper level of anaesthesia was treated by an infusion of nitroglycerine. Bradycardia was corrected with inj. atropine 0.5mg/kg I.V.

Postoperative problems include delayed extubation, respiratory distress, pneumothorax , dental damage and aspiration of debris were observed and treated. If needed, asthalin, adrenaline and steroid nebulisation was used.

Statistical analysis: Demographic data, type of surgery, device used, method of ventilation and peri-operative complications are presented as mean and SD in tabular form. Peri-operative changes in heart rate, blood pressure, oxygen saturation and $ETCO_2$ are calculated using mean and SD with unpaired t test and represented graphically.

OBSERVATION AND RESULTS

14 patients were between 10-30 years of age. 12 patients required multiple stage surgery. Associated medical diseases like DM, HT and IHD was present in three, two and one patient respectively. (Table 1)

Table I: Demography values

Parameter		No
Age (years)	1-10	04
	10-20	16
	20-30	04
	30-40	05
	40-60	06
Mean age (yrs)	18	------
Sex (M:F) no	-------	23:12
Surgery	Single stage	23
	Repeated	12
Associated medical	DM	03
diseases	HT	02
	IHD	01
Mean Duration of Surgery (Min)		120

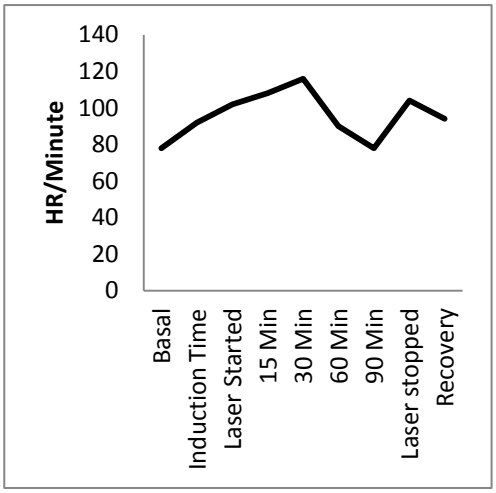
Table II: Types of Surgery, device used & method of ventilation

Type Of Surgery		No	Ventilation	Device
Lesion Of Upper Aiway	Hemangioma Lip/Tongue	2	IPPV	Laser ET Tube
	Bifid Uvulo Palatoplasty	1	IPPV	Laser ET Tube
Lesion On Larynx	Ant.Laryngeal Web	1	Supraglottic JV	No
	Laryngeal Papiloma	3	Supraglottic JV	No
Lesion Below Larynx	Post Intubation stenosis	14	Subglottic JV	Ventilating b'scope
	Post Traumatic stenosis	6	Subglottic JV	Ventilating b'scope
	Sub Glottic Mass	5	Subglottic JV	Ventilating b'scope
	SubGlottic Stenosis	2	Subglottic JV	Ventilating b'scope
	Bronchial Obstruction	2	Transtracheal JV	Ventilating b'scope

Three patients had lesion of upper airway, four patients had lesion on larynx and twenty nine patients had lesion below larynx. In upper airway lesions trachea was intubated with laser tube and ventilation was done via it. For lesions on larynx, airway was not secured with any device and ventilation done with supraglottic jet ventilation. For lesions below larynx, jet ventilation was done through ventilating bronchoscope (b'scope). (Table 2)

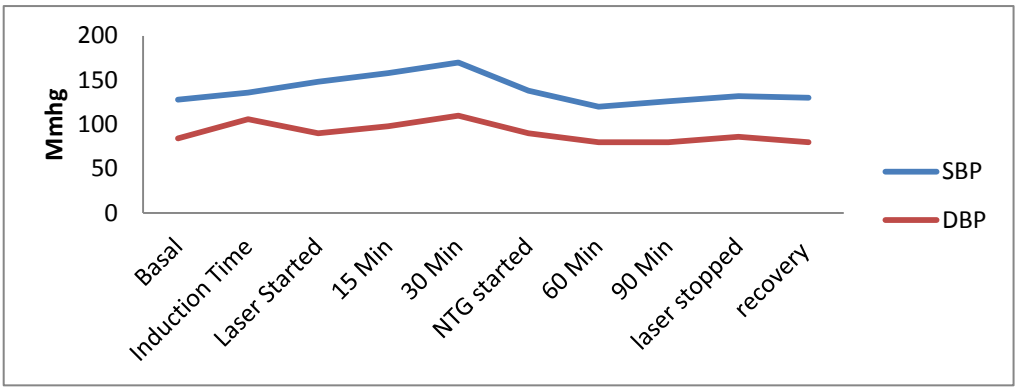
Heart rate increased from base line value after 15-30 minutes of starting laser ablation. Bradycardia was observed when SpO2 was <70%. Once laser use was stopped heart rate gradually returns to normal value. (Graph 1)

Figure 1: Peri-operative variation in Heart Rate



Both SBP and DBP increased after 15-30minutes of laser which was controlled with NTG infusion in majority of patients. (Graph 2)

Graph 2: Peri-operative variation in BP



During laser intermittent critical fall in SpO2% was observed as patients were ventilated with air and oxygen mixture or jet ventilation. Fall in SpO2% was corrected by temporary stopping procedure and ventilating with 100% oxygen. (Graph 3)

Hypercapnia was observed in all patients after 15minutes of starting laser and it was corrected by IPPV in-between the procedure or at the end of procedure within 5-15minutes. (Graph 4)

Intra-operative desaturation, hypercarbia, tachycardia and hypertension were observed in majority of patients. Four patients had delayed recovery and one patient need ICD insertion for pneumothorax. (Table 3)

Table III: Peri-operative complications

Complications	Parameter	No Of Patients
Intra-operative	Desaturation	30
	Hypercarbia	29
	Hypertension	10
	Tachycardia	8
	Bradycardia	4
	Arrhythmias	5
Post-operative	Delayed Recovery	4
	Pneumothorax	1

DISCUSSION

For the laser surgery of larynx/airway, anaesthetic risk is greater compared to surgical risk. The difficulties of balancing the surgical requirements of airway access, immobility and obtundation of respiratory reflexes against the need for ventilation, oxygenation, haemodynamic stability and narcosis have to be addressed.[6]

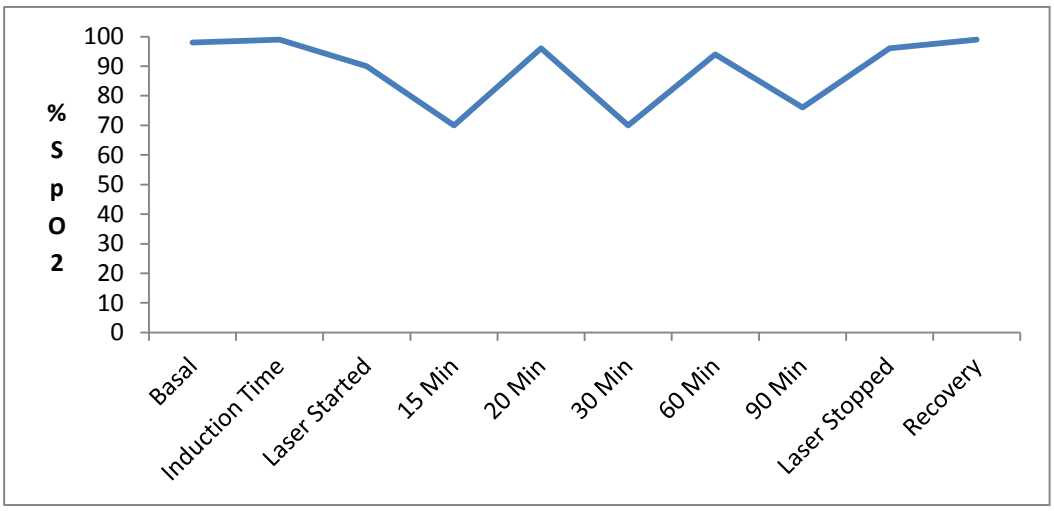
Evaluation of the location, size, extent, and mobility of any lesion is required. The effects on laryngeal function and airway patency must also be investigated. Previous anaesthetic and surgical findings are useful.[5]

The population presenting for airway surgery mainly falls into three categories. The first group comprises elderly patients with coexisting respiratory and cardiovascular morbidity resulting from long-term smoking and high alcohol intake. These patients often have malignant lesions and may show side-effects of its treatment (e.g. radiotherapy). The second group comprises young children or those with learning difficulties who inhale or ingest foreign objects. The third group consists of middle aged population with benign laryngotracheal lesions. There is a growing incidence of post-intubation stenosis which has been estimated as 4.9 cases per million per year.[5,6]

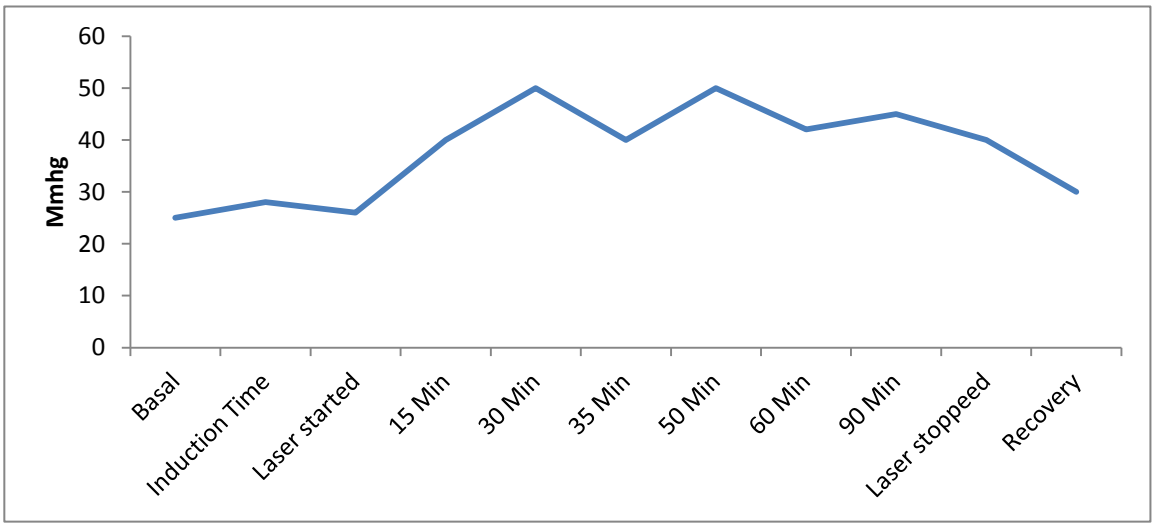
In our study twenty patients were below twenty years, nine patients between 20-40years and six patients were above 40years of age.

There are different types of laser. Diode laser has 980 nm wavelengths. It can be delivered by fiberoptic scope. It has tissue-cutting and coagulation effect, higher degree of absorption by tissue and large penetration in biologic tissue. CO2 laser has 10.6 um wavelengths. It is absorbed in 1st few cell layers. It produces minimal peripheral injury. It cannot be used with fiberoptic scope and cause corneal damage. CO_2 laser (10,600nm) are completely absorbed by water in the first few layers of cells leading to explosive vaporisation of the tissue surface and little damage to underlying tissue.[2,3,8] In this study CO2 and diaod laser were used. Several ventilation techniques have been used for microlaryngeal surgery and endoscopic surgical interventions in the larynx and the trachea each with its characteristic advantages and disadvantages.[6]

Graph 3: Peri-operative variation in oxygen saturation



Graph 4: Peri-operative variation in EtCO2



In **non-intubation techniques**, tracheal tube is not used. As there is no flammable material in the airway, risk of fire is minimized. This method provides excellent visibility of the surgical field.[1,4] In spontaneous breathing techniques, patient is breathing spontaneously, an oxygen-enriched gas with or without potent inhalation. Anaesthetic is insulated through a side port of the operating laryngoscope or a catheter. The anesthetic may be supplemented with intravenous agents and/or regional anesthesia to the airway. Disadvantages are adequacy of ventilation cannot be assessed with capnography or spirometry. Pulmonary aspiration of gastric contents, surgical debris, and/or laser plume is a risk. Ventilation cannot be assisted or controlled. Depth of anesthesia may fluctuate and patient may move.[1,2,4,5]

In apneic techniques patient s lungs are ventilated with a mask, through a tracheal tube or via a bronchoscope using an oxygen-enriched gas, with or without potent inhalation anesthetic. The anesthetic may be supplemented with TIVA and/or regional anesthesia to the airway. During ventilation, the laser is not used. Periods of ventilation alternate with periods of laser resection/apnea. This technique is not recommended for more than 10 minutes. It carries the risk of hypoxaemia and hypercapnia. Disadvantages are same as spontaneous breathing techniques.[4,6]

In intubation techniques, ventilation can be monitored and controlled, and both inhalation and intravenous agents can be administered.[4] Intermittent, positive-pressure ventilation is usually delivered using a MLT tube. There is reduced access to the surgical field and the tracheal tube obscures the posterior one third of the glottis.[5] In present study three patients having lesion of upper airway were intubated with laser endotracheal tube and IPPV using ambu bag was given.

Low-frequency jet ventilation (LFJV) which mimics physiological ventilation provides excellent gas exchange. It is easy to perform, requiring uncomplicated anaesthetic equipment, produces an unobstructed view of the operative field. LFJV is frequently delivered using a high pressure gas source via a narrow cannula attached to a suspension laryngoscope or bronchoscope. This stream of high velocity gas entrains air, increasing the tidal volume generated and diminishing the oxygen concentration of the inspired gas. This allows the operating field to be immobile, maintain adequate ventilation for unlimited time in apnoeic and relaxed patient without rise in PaCO2.

Disadvantages are risk of barotraumas especially if the jet is below the larynx. Despite chest movement being clearly visible, adequacy of ventilation is difficult to assess owing to the lack of end-tidal CO2 monitoring. Inhalational anaesthesia may not be delivered via LFJV, so total intravenous anaesthesia (TIVA) is required.[1,2,4,5,6]

In our study, four patients having lesion on larynx supraglottic LFJV was used. In twenty seven patients with subglottic lesion subglottic jet ventilation via ventilating bronchoscope was used and in two patients with bronchial lesion, transtracheal jet ventilation via bronchoscope was done.

Presently available studies indicate that amongst the conventional tubes red rubber and silicone rubber tubes combust more readily than PVC tubes in air. Polyvinyl chloride tracheal tubes are highly combustible when used in an oxidizing atmosphere.[3,4,7] Conventional tubes such as PVC, red rubber, and silicone can be wrapped with metallic tape. Metallic wrapping may prevent the laser beam from igniting the tube. Disadvantages are metallic tapes may reflect the laser beam onto non targeted tissues. If the tape is not applied smoothly and continuously it may abrade mucosa and expose the tube to the laser beam.[2,4,7]

Laser resistant tubes have aluminum and silicone rubber spiral embedded with a silicone covering and a self-inflating foam sponge cuff. It has a traumatic external surface with a non-flammable inner surface. The cuff tends to maintain a seal despite penetration by the laser.[4,6] Laser tubes resist damage and dissipate the high energy of the laser, thus diminishing the risk of tube fire and reflection damage to adjacent tissue. These tubes allow conventional positive pressure ventilation.[3,5] Metal tubes are non-inflammable and thick walled. The tube maintains its shape during intubation and is kink resistant. The proximal cuff serves as a shield for the distal tracheal cuff. Although metal may reflect the laser onto non-targeted tissues and result in damage.[1,4,5]

For rigid bronchoscopy, anaesthesia is induced and maintained intravenously (usually using propofol). Profound muscle relaxation is achieved with intermittent succinylcholine (combined with atropine to avoid bradycardia) or a short-acting non-depolarizing agent (e.g. mivacurium). Topical laryngeal anaesthesia and administration of a short-acting opioid will diminish the stress

response to surgery during instrumentation. Usually, LFJV is provided using a high-pressure oxygen source directed down the bronchoscope.[1,3,5]

Anaesthetic techniques for direct laryngoscopy include intermittent apnoea without endo-tracheal intubation or Jet ventilation.[5]

In a target controlled total IV anaesthesia (TIVA), propofol, remifentanil infusions and mivacurium by bolus and infusion.is useful at a rate that maintains normal pulse rate and blood pressure.[1,6] Perera et al in their study of endoscopic laser resections of central airway lesions under general anaesthesia have reported that intravenous anaesthesia (thiopentone & diazepam) was associated with a longer duration of recovery room care and a higher incidence of postoperative respiratory complications than inhalation anaesthesia.

In our study anaesthesia was managed with TIVA using propofol and atracurium and jet ventilation through bronchoscope in majority of patients.

Intra-operatively the anaesthetist must pay special attention to protect eyes, neck, and teeth while optimizing surgical access.[5] Risks of laser surgery include airway fire, damage to healthy tissue, and injury to theatre staff. Nitrous oxide and high concentrations of oxygen support combustion and should be avoided.[1] In practice inspired oxygen concentration is 21%. There should be a 'fire-drill' in place so that all staff is prepared for an airway fire; there should be a pre-filled 50 ml syringe of 0.9% saline available.

The FiO2 should be limited to the lowest concentration necessary to maintain acceptable arterial 02 saturation. The balance of the fresh gas flow should be nitrogen and/or helium potent nonflammable inhalation agents may be added as clinically indicated. Nitrous oxide should not be used.[1,2,3,4] The laser output should be limited to the lowest clinically acceptable power density and pulse duration.[4] Filling tracheal tube cuffs with saline serves as a protection against fire should the laser beam strike the cuff.[4]

Initially, a small dose of glycopyrollate (0.2–0.3 mg) is administered which to counter the vagotonic effect of remifentanil and the vasovagal effect of rigid bronchoscopy. Also it does not make the bronchial secretions too viscid.[6]

Paranjpe et al mentioned that desaturation episodes were more frequent, more severe and were slower to respond to treatment during periods of venturi ventilation. Significant arterial oxygen desaturation (less than 90 per cent) was treated by cessation of laser firing, withdrawal of the rigid broncho- ventilation with an increased F1O2 and if necessary, re-intubation with a cuffed endotracheal tube followed by ventilation with 100 per cent oxygen. At the end of the procedure, patients were re-intubated with a cuffed endotracheal tube for airway toilet and ventilated with 100 per cent oxygen until recovery of neuromuscular function and protective airway reflexes were satisfactory.[6]

Endoscopic laser resections predispose to intraoperative arrhythmias which respond to IV lidocaine. Precipitation of arrhythmias may occur due to prolonged airway instrumentation, hypoxaemia, hypercarbia, haemodynamic instability, topical administration of epinephrine containing local anaesthetic solutions.[6]

Following surgery to the airway, there is the risk of laryngeal spasm, aspiration, or airway obstruction due to oedema or haematoma formation. To minimize the risk of laryngospasm, the patients should be positioned semi-sitting and should have their trachea extubated either awake or under deep anaesthesia (to allow airway reflexes to return without the stimulus of the tracheal tube).[3,5]

Oedema may be reduced by the administration of dexamethasone. If stridor develops. nebulized epinephrine (2–3 ml of 1:1000) may be useful. If a small degree of airway obstruction develops during recovery then the use of helium may reduce the work of breathing and prove a useful short term measure.

The risk of aspiration may be reduced by ensuring full reversal of neuromuscular blockade.

To reduce the drying of the oral mucosa and the inspissations of secretions, humidified oxygen should be administered to all patients postoperatively.[3]

With use of safety measures and special techniques for anaesthesia, the problems of laryngeal laser surgery are minimized.

REFERENCES

1. Shruti M. Shah, Manisha S. Kapadi, Darshna R. Shah Anaesthesia For Laser Surgery Of Larynx .GUJARAT MEDICAL JOURNAL MARCH-2014 Vol. 69 No.1, 17-20

2. Dr John Loadsman . Laser Surgery and Anaesthesia**.www.anaesthesia.med.usyd.edu .au /resources/lectures/LaserSx.html**

3 . Odilar Paiva Filho, José Reinaldo Cerqueira Braz . Laser Surgery and Anesthesia Revista Brasileira de Anestesiologia Janeiro – Fevereiro. 2004,101 Vol. 54, Nº 1

4 Anesthesia patient safety foundation newsletter. Volume 8, No. 2 Summer 1993

5. James English, Andrew Norris, Nigel Bedforth Anaesthesia for airway surgery http://ceaccp.oxfordjournals.org/ Number 1,1093 . Continuing Education in Anaesthesia, Critical Care & Pain | Volume 6 Number 1 2006

6. Dr. Jyotsna S. Paranjpe, Dr. Manohar V Mane, Dr. Mohan R. Patil , Dr. Rajesh B Navale Anaesthesia for tracheal surgeries. International J. of Healthcare & Biomedical Research, Volume: 1, Issue: 4, July 2013, Pages 302-314

7 P Gupta, S Verma, R Saxena. Managing Airway In Dohlmann's Procedure Using Carbon Dioxide Laser By An Innovative Method .The Internet Journal of Anesthesiology Volume 12(2)

8 Michael J. Ruttera,b, Aliza P. Cohenb and Alessandro de Alarcon Endoscopic airway management in children Current Opinion in Otolaryngology & Head and Neck Surgery 2008, 16:525–529