NOVEL TECHNIQUES FOR DIFFICULT AIRWAY MANAGEMENT IN VARIOUS CLINICAL SCENARIOS: CASE SERIES AND REVIEW OF LITERATURE

Anesthesiology

Abinash Patro	MD. Assistant Professor, Dept. of Anesthesiology & Intensive Care, Nizam's Institute of Medical Sciences, Hyderabad, India.
Abhishek Kumar	MD. Senior Resident, Dept. of Onco-Anesthesia and Palliative Medicine, Institute Rotary Cancer Hospital, All India Institute of Medical Sciences, New Delhi, India.
Puneet Goyal	MD, DM, Dip NBE. Professor, Dept. of Anesthesiology & Intensive Care, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, UP, India
Tanvi Bhargava	MD. Senior Resident, Department of Anesthesiology, Dr Ram Manohar Lohia Hospital and PGIMER, New Delhi, India.
Tapas K Singh	MD. Assistant Professor, Dept. of Anesthesiology & Intensive Care, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, UP, India
Aarti Agarwal*	MD. Additional Professor, Dept. of Anesthesiology & Intensive Care, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, UP, India. *Corresponding Author

ABSTRACT

Difficult airway management has till date been the most fearsome and challenging part of any anaesthetic management. Meticulous planning is always done prior to anaesthetic induction of such patients with multiple back up plans and rescue strategy. Significant advancements in terms of clinical protocols, techniques, and devices / gadgets in this field have led to decreased incidence of airway related complications. We hereby present a case series of 3 clinical cases with different airway scenarios; 1) Patient with huge goitre, who was intubated with the help of an indigenously developed fish mouth valve device, 2) a temporomandibular joint ankylosis case, managed with awake fiberoptic guided intubation 3) Patient with post burn contracture of face and neck, in which fiberoptic intubation was performed after partial release of scar under tumescent anaesthesia. Extensive preoperative airway evaluation and preparation to handle any emergency by multiple backup plans always helps in smooth sailing through these difficult clinical scenarios

KEYWORDS

Difficult airway, Novel techniques, Fibre-optic bronchoscopy, Awake intubation

INTRODUCTION

Airway management has always remained the most vital part of anaesthetic plan of any surgical patient. Airway complications contribute significantly to Anaesthesia related morbidity and mortality.¹ Hence, difficult airway management continues to be a major concern for every anaesthesiologist.

A difficult airway is defined as a clinical situation in which a conventionally trained anaesthesiologist experiences difficulty with facemask ventilation, tracheal intubation, or both.² Significant advancements in airway management devices, techniques, patient monitoring and revised protocols, have led to reduction in airway related complications. We hereby present a case series of three patients, each with different airway problems, managed with some novel airway gadgets, techniques and protocols.

Figure 1. Case 1 with huge goitre, lower border of swelling visible and moving with deglutition (not seen in this picture)

Case 1:

A 54-year-old lady presented with a gradually increasing swelling in anterior part of neck for last 10 years (Figure 1). She was diagnosed to have a clinically euthyroid multi-nodular goitre with poor respiratory reserve, and was thus planned for thyroidectomy.

Airway management in large goiter is always challenging due to varying degrees of tracheal compression and deviation.^{3,4} Presence of mass anterior to trachea may hinder surgical airway access like tracheostomy or cricothyroidotomy. Amongst limited choices for

securing airway in these patients, most reliable is fiberoptic bronchoscope (FOB) guided intubation with a spontaneously breathing patient.⁵

Awake fiberoptic bronchoscopy was not possible in this patient because of obscured landmarks for airway nerve blocks. Standard monitoring (non-invasive blood pressure, pulse oximeter and electrocardiogram) connected to patient, wide bore intravenous line secured and difficult airway cart was kept ready. Patient was nebulized with 3 ml of 4% lignocaine to obtund upper airway reflexes, pre medicated with intravenous midazolam 2mg to allay her anxiety and glycopyrrolate 10mcg/kg to decrease airway secretions.

An indigenously developed Fish mouth valve device was used in this case to facilitate FOB guided intubation, that allowed continuous supply of oxygen with inhalational anaesthetic agents to patient, simultaneously, along with fibre optic intubation. (Figure 2A). This device was attached with facemask through a T connector and then to breathing circuit through 22mm/22mm connector (Figure 2 B). Patient was pre-oxygenated with 100% oxygen for three minutes.

Figure 2A. Fish mouth valve device with various components to make it an integral part of anaesthesia breathing circuit. **2B.** Polyvinyl chloride endotracheal tube passing through device after removing its 15 mm connector. **2C.** One anaesthesiologist introducing fiberoptic bronchoscope through fish mouth valve device and another anaesthesiologist providing oxygen and inhaled anaesthetics through face mask, endotracheal tube is seen preloaded over fiberoptic bronchoscope.

Patient was now asked to hold a bite block between her teeth, for which she was counselled and allowed to practice earlier. Conventional inhalational induction was done with sevoflurane in 100% O₂. Sevoflurane dial setting was increased till loss of response to verbal command and loss of eyelash reflex. Sedation level was then maintained by titrating end tidal sevoflurane concentration to 1.5 - 2.0 MAC, so as to maintain regular breathing pattern with adequate tidal volume. Two anaesthesiologists worked in tandem; first one was responsible for performing the FOB guided intubation and second for holding face mask for continuous leak proof delivery of oxygen and inhaled anaesthetics (Fig 2 C). If during procedure, patient develops apnoea, it was planned that second anaesthesiologist would perform bag and mask ventilation while first anaesthesiologist would continue to perform bronchoscopy, but it was not required in this case.

Cuffed endotracheal tube of size 7.5 mm was preloaded over FOB, after removing its connector. Tip of FOB was introduced through fish mouth valve device, advanced into oral cavity, oropharynx, vocal cords and inside trachea, then positioned just above carina after negotiating beyond narrowed portion of trachea. Position of FOB was maintained at this level. Patient continued to breathe spontaneously throughout the procedure, with sevoflurane in oxygen, maintaining SPO₂ 98-99%, which was displayed by a well formed ETCO₂ curve on the monitor.

The second anaesthesiologist, who was holding the mask now advanced endotracheal tube through the device into trachea, and positioned it above tracheal bifurcation. This is the time when supply of fresh gas flow to the patient was briefly interrupted. Minimum oxygen saturation noted at this time was 92% and maximum heart rate was 109 in our patient. FOB was withdrawn, facemask with device removed and breathing circuit was connected to endotracheal tube after reattaching its 15 mm connector. Display of ETCO₂ curve on monitor further confirmed correct placement of endotracheal tube. SPO₂ quickly increased to 100% and tachycardia settled. Hemodynamics remained stable without any undue tachycardia, hypertension or hypotension. Standard opioid based anesthetic technique using Fentanyl, sevoflurane in air-O₂ mixture and vecuronium bromide as muscle relaxant was used after intubation.

Surgery lasted for three and half hours. Muscle relaxation was reversed with intravenous neostigmine and glycopyrrolate and trachea extubated over airway exchange catheter. Patient was shifted to post anaesthesia care unit and further course remained uneventful.

Case 2:

A 19-year-old male patient with temporomandibular joint ankylosis was posted for surgical release of ankylosis. He had no medical comorbidities. Airway examination revealed maximum mouth opening of 5 mm, with hypoplastic and receding mandible but he had normal neck movements. Thyromental and mento-hyoid distance as well as both nasal passages were within normal limits (Figure 3A & B). Tracheal intubation using oropharyngeal route or with the help of any oropharyngeal device was not possible in this patient. Since he had normal nasal passages, an awake Fibre optic guided nasotracheal intubation was planned and steps of awake fiberoptic intubation were explained to the patient.

Figure 3A & B. Case 2 with temporo-mandibular joint ankylosis with severely restricted mouth opening with receding and hypoplastic mandible. Note normal anatomy of front of neck.

Xylometazoline nasal drops were administered on the night prior and morning of surgery, to reduce the risk of nasal bleed. Patient was nebulised with 4% lignocaine solution just before wheeling inside the operating room. Standard anaesthesia monitoring was attached and an intravenous line was secured. Cricothyroid membrane was visualized on ultrasound neck and marked. Cricothyroidotomy set was kept ready. An ENT surgeon was on standby for emergency tracheostomy, in case of need.

Anterior part of neck was prepared and draped. Bilateral superior laryngeal nerve was blocked with 2 ml of 2% lignocaine on each side. Trans tracheal block was performed by administering 3 ml of 2% lignocaine after puncturing cricothyroid membrane with 22G canula. Patient started coughing after trans tracheal administration of local anaesthetic, for which he was explained earlier itself. Coughing helped to spread the local anaesthetic and anesthetised the tracheal mucosa from under surface of vocal cords, up to carina. Endotracheal tube was rail loaded over fibre optic bronchoscope. Oxygen tubing was connected to working channel of fibre optic using 2 ml syringe as connector (Figure 4) and oxygen flow of 4 litre / minute was started. This helped in continuous oxygenation of patient while fiberoptic bronchoscopy was in progress.

Figure 4. O₂ tubing attached to working channel of FOB through 2 ml syringe

After lubricating nasal passage with lignocaine gel, FOB was advanced in to nasopharynx, and then in to oropharynx. Vocal cord opening was visualised and FOB was advanced through it up to carina. Patient tolerated the procedure without any difficulty, coughing or bucking. While tip of FOB was stabilised at the level of carina by anaesthesiologist, an assistant advanced the endotracheal tube over it, into the trachea. Tip of tube was positioned 2 centimetres above carina and FOB was withdrawn. There was no tachycardia and no fall in oxygen saturation level of patient at any time during procedure. Breathing circuit was connected and ETCO₂ graph was demonstrated on monitor. General anaesthesia was induced thereafter with injection fentanyl 150 micrograms, midazolam 1 mg, propofol 80 mg and muscle relaxation was achieved with injection vecuronium bromide 5 mg. Surgery remained eventful and patient was extubated over airway exchange catheter, which was removed 2 hours later in post anaesthesia care unit.

Case 3:

20-year-old male patient presented to our hospital with post burn contracture involving face, neck, chest extending up to shoulders and arms. His airway examination revealed limited mouth opening with Mallampatti class 4. His facial contracture was extending from perioral region to anterior chest wall in such a manner that lower lip was everted and stretched up to anterior chest wall (Figure 5 A). Although soft tissue of his lower lip was stretched up to anterior chest wall, his mouth opening was only 1 cm. Plus, he had fixed flexion deformity of neck with no extension possible at cervical level. Scar on both sides of the face had engulfed the entire mandible up to its angle (Figure 5 B). Jaw lift to prevent tongue fall and upper airway obstruction during induction of anaesthesia was not possible.

Figure 5A. Case 3 with post burn scar contracture involving face, neck, chest. **5B.** Scar encasing entire mandible, with fixed flexion deformity at neck (note thickness of pillow to support the neck in figure A)

Awake fibre optic intubation was not possible in this case as the thick scar occupying front of neck, made airway blocks impossible. Inhalational induction with spontaneous respiration without muscle relaxant was also not considered safe as there was a risk of upper

airway obstruction when patient was put to sleep; and it was not possible to provide triple manoeuvre to relieve it because of fixed flexion deformity of neck and scar engulfing the mandible. It was decided to release the side scar under tumescent anaesthesia to make space for jaw lift and then plan for inhalational induction with preserved respiration. Tumescent solution was prepared by mixing 10 ml of 2% lignocaine, 0.4 ml of 1:1000 adrenaline, 4 ml of sodium bicarbonate and 40 ml of normal saline. This was infiltrated intradermally in the scar. Surgeon released the side scar (Figure 6 A) and patient tolerated this well without complaining of pain. Angle of mandible could now be palpated and jaw lift could be performed.

Figure 6A. Scar release after tumescent anaesthesia on both sides of face to create access to jaw of patient. 6B. Nasopharyngeal airway being split along entire length.

Nasopharyngeal airway of size 7 was split along its entire length (Figure 6 B) and then introduced through left nostril after lubrication with 2% lignocaine gel (Figure 7A). Nasopharyngeal airway would help to guide the FOB tip towards laryngeal inlet and splitting would make it possible to remove the airway after ET tube is inside. Splitting firstly, helps to decrease its diameter by overlapping its cut edges thereby making it easier to introduce without producing nasal trauma, secondly it would allow passage of endotracheal tube by expanding. Selection of a proper face mask was difficult as the lower lip was stretching up to anterior chest wall and no face mask would cover that much area. Hence it was decided to apply size 2 paediatric face mask as nasal mask for this purpose (Figure 7B). Mouth opening was closed with jaw lift and tight seal of nasal mask could be achieved without leak from oral cavity. This was reflected in good movement of reservoir bag (anaesthesia machine showed > 10 ml/kg of tidal volume) and display of ETCO₂ graph on monitor. Sevoflurane was used in incremental doses enough to aid inhalational induction but yet to maintain spontaneous breathing, to achieve an end tidal sevoflurane concentration of 1.5-2.0 MAC.

Figure 7A. Nasopharyngeal airway inserted through left nostril after being split. 7B. Size 2 face mask used as nasal mask with jaw lift to prevent upper airway obstruction as well as closing the mouth to prevent air leak through it.

Endotracheal tube was rail loaded over FOB and oxygen tubing was connected to its working channel and 4 litre/minute of oxygen flow was provided. We prefer reinforced endotracheal tube as it is more flexible and has smaller tracheal cuff diameter in comparison to similar sized pvc tube. FOB was introduced through nasopharyngeal airway (in left nostril) and as soon as the tip of FOB went beyond the distal end of nasopharyngeal airway, vocal cords could be seen. Quickly, the FOB was advanced through glottis, 2 ml of 2% lignocaine was administered through working channel soon after FOB tip crossed vocal cords to anaesthetise tracheal mucosa. After visualizing the carina, endotracheal tube was advanced over FOB and split nasopharyngeal airway easily allowed its passage. After demonstrating ETCO₂ graph on monitor, general anaesthesia was induced with muscle relaxation and surgery remained uneventful thereafter. Patient was extubated over airway exchange catheter to facilitate reintubation in post-operative period if need arises.

DISCUSSION:

First Case was a patient with large goitre, which highlights airway

implications due to presence of huge mass in the front of neck but with normal mouth opening. Second case was Temporo-mandibular joint ankylosis with almost nil mouth opening but normal front of neck access, whereas third patient was post burn contracture involving face and neck with issues pertaining to both mouth opening and neck movement as well as no front of neck access.

Traditionally various techniques have been used to facilitate fiberoptic bronchoscopy in such patients like gargle with 2% lignocaine viscous,⁶ nebulization with 2-4% lignocaine solution and "spray as you go technique"⁵ using 2%, 4% or 10% lignocaine spray⁶ to anesthetize airway and prevent gag, cough and laryngospasm during airway instrumentation. Loco sedative techniques¹ utilizing combination of local anesthetics with intravenous sedation and varying combination of drugs like midazolam,⁴ remifentanyl,⁷ propofol⁸ and dexmedetomidine^{7,9} have been used to minimize patient discomfort, bucking and coughing at the time of tracheal intubation.

For the first time, we describe use of a novel device with fish mouth valve, used in case 1, which facilitated continuous delivery of oxygen and inhaled anaesthetics to patient simultaneously while performing fiberoptic intubation, so that oxygen saturation and sedation level were maintained throughout and operator got sufficient time to complete fiberoptic intubation without interruption.

This device offers many advantages like; uninterrupted supply of oxygen to patient during bronchoscopy to prevent drop in oxygen saturation level, simultaneous administration of inhaled anaesthetics to maintain adequate level of sedation while preserving spontaneous respiration and ability to provide positive pressure ventilation if patient develops apnoea. No leakage of fresh gas flow during fiberoptic intubation as tubes of varying diameter can be passed through fish mouth valve device, including adult FOB (outer diameter 5 to 6 mm) and endotracheal tubes of sizes 6 to 9 mm.

There was slight fall in SPO₂ levels (up to 92%) and mild tachycardia (heart rate up to 105 / minute) in our case, at time when device was dismantled and endotracheal tube was connected to breathing circuit. This shows that patient was unable to sustain even brief interruption in oxygen delivery, still could tolerate entire procedure well because of uninterrupted delivery of oxygen and inhaled anaesthetics.

Traditionally, inhalational induction is considered superior to intravenous induction with propofol, because with former if a spontaneously breathing patient hypo-ventilates or develops apnoea the delivery of inhaled anaesthetics is reduced or stopped respectively.¹⁰ Therefore it is easy to preserve spontaneous respiration of patient in difficult airway scenario like enlarged goitres. Although propofol may better suppress airway reflexes as compared to inhalational anaesthetics and can achieve adequate anaesthetic depth irrespective of respiratory efforts of patient,¹⁰ but in our opinion, titration is better with inhaled anaesthetics in situation where preserving spontaneous respiration is our utmost priority.

While using this device; FOB guided intubation can be completed in shorter time interval and in single attempt, as patient does not develop hypoxemia while using this device, in contrast to routine bronchoscopy where bronchoscope needs to be withdrawn intermittently to oxygenate patient in difficult airway cases. Laryngospasm, bronchospasm, coughing and bucking are prevented with adequate plane of anaesthesia. Beginners can learn FOB easily because they get relatively more time, as SPO₂ remains maintained. Although high flow nasal oxygen delivery systems are now available to maintain oxygenation during awake fiberoptic intubations¹¹ but cannot be used to deliver anaesthetics, are costly and have limited availability.

Endotracheal tube with removable 15 mm proximal connector (e.g. PVC tubes) can only be used with this device. Reinforced endotracheal tubes cannot be passed through this device as their connectors are not removable. This device can be explored for its utility in GI endoscopy suites to administer oxygen and anaesthetics to patient requiring sedation during upper GI endoscopy and Endoscopic Retrograde Cholangio-Pancreaticography (ERCP).¹²

Second case in this series had severely restricted mouth opening and awake fibre optic intubation technique was used. Three methods have been described to secure airway in patient with TMJ ankylosis; blind

nasal intubation used to be done before the advent of FOB,¹³ fibreoptic guided nasotracheal intubation is current gold standard, and in the absence of expertise of both of them, surgical tracheostomy is performed.¹⁴ Airway blocks are crucial for the success of awake FOB guided nasotracheal intubation. Pre-treatment of nasal passage by xylometazoline drops reduces the risk of nasal bleeding and is the standard of care whenever nasotracheal intubation is planned.¹⁵

Laryngospasm and coughing can occur during awake FOB guided intubation if airway blocks are not effective. Topical spray of 2% local anaesthetic through working channel of FOB can help to overcome this issue. In addition, low dose opioids like fentanyl 1mcg/kg, administered intravenously helps to suppress cough reflex, reduce the anxiety of patient and prevent hemodynamic disturbance like tachycardia and hypertension.¹⁶

Cervico-facial contractures pose further challenge to airway management as even front of neck access is not available. Methods to manage these patients include; tumescent anaesthesia or sedation with ketamine, induction of general anaesthesia and intubation following contracture release.^{17,18}

Ketamine sedation in titrated doses and by experienced hands is considered relatively safe as it does not precipitate apnoea and airway reflexes are preserved.¹⁹ Tumescent anaesthetic solution for local infiltration is safe and effective way of pain free contracture release. Solution contains local anaesthetic in varying concentration from 0.1 to 0.4%, adrenaline and sodium bicarbonate in normal saline or ringer lactate. Total amount of local anaesthetic drug infiltrated should not exceed 7mg/kg to prevent local anaesthetic toxicity.^{20,21}

Our third patient had scar contracture involving circumoral area and entire mandible, extending up to anterior chest wall. We performed partial scar release under tumescent anaesthesia, followed by, inhalational induction with preserved spontaneous respiration. Scar release from both sides of face and neck provided us the access to jaw of patient. This would allow us to perform jaw lift in case of upper airway obstruction during inhalational induction. Front of neck scar was very thick hence could not be released prior to induction of general anaesthesia; therefore, fixed flexion deformity of neck persisted till induction of anaesthesia.

Due to distorted perioral anatomy, no face mask was fitting adequately, size 2 paediatric face mask was utilised to cover the nose to support respiration, and mouth opening was closed after lifting the jaw up from sides, thereby preventing leak of fresh gas flow from mouth.

Since scar tissue is fibrotic and non-elastic in nature, epiglottis and vocal cords can be displaced anteriorly in many cases, and jaw movements can be hindered.²² Ultrasound guided needle cricothyroidotomy and surgical tracheostomy should always be a part of the backup plan but may not be possible in every scenario like first and third patients in this case series. Preserving spontaneous breathing of the patient becomes utmost important in these patients. We did not use muscle relaxant in any of our cases before securing airway with endotracheal tube. Maintenance of spontaneous respiration of patient can keep "Cannot Ventilate Cannot Intubate" situation at bay.

Extensive preoperative airway evaluation and preparation to handle any emergency by multiple backup plans always helps in smooth sailing through these difficult clinical scenarios.

REFERENCES:

1. Crosby ET, Cooper RM, Douglas MJ, Doyle DJ, Hung OR, Labrecque P, et al. The unanticipated difficult airway with recommendations for management. *Can J Anaesth* 1998;45:757-76.
2. American Society of Anesthesiologists: Practice guidelines for management of the difficult airway: An updated report. *Anesthesiology* 2003; 98:1269-1277.
3. Raval CB, Rahman SA. Difficult airway challenges-intubation and extubation matters in a case of large goiter with retrosternal extension. *Anesth Essays Res* 2015; 9(2): 247-50.
4. Srivastava D, Dhiraj S. Airway management of a difficult airway due to prolonged enlarged goiter using loco-sedative technique. *Saudi J Anaesth* 2013;7(1): 86-9. Xue FS, Liu HP, He N et al. Spray-as-you-go airway topical anesthesia in patients with a difficult airway: a randomized, double-blind comparison of 2% and 4% lidocaine. *Anesth Analg*. 2009 Feb;108(2):536-4.
5. Saxena KN1, Kumar S, Taneja B, Gaba P. Awake fibreoptic intubation in the sitting position in a patient with a huge goitre. *Case Rep Anesthesiol*. 2011; 2011:352672. doi: 10.1155/2011/352672. Epub 2011 Nov 22.
6. Liu HH, Zhou T, Wei JQ, Ma WH. Comparison between remifentanyl and dexmedetomidine for sedation during modified awake fibreoptic intubation. *Exp Ther Med*. 2015 Apr;9(4):1259-64.
7. Tan PC, Esa N. Anesthesia for massive retrosternal goiter with severe intrathoracic tracheal narrowing: the challenges imposed -A case report. *Korean J Anesthesiol*. 2012

- May;62(5):474-8.
9. He XY, Cao JP, He Q, Shi XY. Dexmedetomidine for the management of awake fibreoptic intubation. *Cochrane Database Syst Rev*. 2014 Jan 19;(1):CD009798.
10. McClelland SH, Hardman JG. Inhalational induction of anaesthesia in adults: Time for a breath of fresh air? *Anaesthesia*. 2007 Nov;62(11):1087-9.
11. Badiger S, John M, Fearnley RA, Ahmad I. Optimizing oxygenation and intubation conditions during awake fibre-optic intubation using a high flow nasal oxygen delivery system. *Br J Anaesth*. 2015 Oct;115(4):629-32.
12. Patro A, Priya V, Riaz R, Kannaujia A. Laparoscopic port as an integral component of endoscopy mask: a novel innovation. *Indian J Anaesth*. 2016 Jun; 60(6):439-41.
13. Dhasmana S, Singh V, Pal US. Awake Blind Nasotracheal Intubation in Temporomandibular Joint Ankylosis Patients under Conscious Sedation Using Fentanyl and Midazolam. *J Maxillofac Oral Surg*. 2010;9:377-381.
14. Wahal R. Temporomandibular joint ankylosis-the difficult airway. *J Oral Biol Craniofac Res*. 2015 May-Aug; 5(2): 57-58.
15. El-Seify ZA, Khattab AM, Shaaban AA, Metwalli OS, Hassan HE, Ajjoub LF. Xylometazoline pretreatment reduces nasotracheal intubation-related epistaxis in paediatric dental surgery. *British Journal of Anaesthesia*. 2010; 105(4): 501-505.
16. Tsukamoto M, Hitosugi T, and Yokoyama T. Awake fibreoptic nasotracheal intubation for patients with difficult airway. *J Dent Anesth Pain Med*. 2018 Oct; 18(5): 301-304.
17. Subramanyam KL. Anaesthetic management of post burn contracture chest with microstomia: Regional nerve blocks to aid in intubation. *Journal of Anaesthesiology Clinical pharmacology*. 2015; 31:250-252.
18. Mathur R, Jain PK, Chakotiya PS, Rathore P. Anaesthetic and airway management of post burn contracture neck patient with microstomia and distorted nasal anatomy. *Indian journal of anaesthesia*. 2014; 58:210-213.
19. Agarwal P. Safe method for release of severe post burn neck contracture under tumescent local anaesthesia and ketamine. *Indian J Plastic Surg*. 2004; 37(1): 51-54.
20. Mago V, Prasad M. Tumescent Local Anesthesia for Release of Postburn Neck Contractures. *Journal of Burn Care & Research*. 2009; 30(6): 1049.
21. Alcida dos Reis Gadelha, Thomázia Lima de Miranda Leão. Rule of four: a simple and safe formula for tumescent anaesthesia in dermatologic surgical procedures. *Surgical & Cosmetic Dermatology* 2009;1(2):99-102.
22. Han TH, Teissler H, Han RJ, Gaines JD, Nguyen TQ. Managing difficult airway in patients with post-burn mentosternal and circumoral scar contractures. *Int J Burns Trauma*. 2012; 2(2): 80-85.