REVIEW ARTICLE

Goiter and Airway Control

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ABSTRACT

Goiter or thyroid swelling in neck has been known to be a risk factor for difficulty in airway management during anesthesia and surgery. The factors associated with difficult direct laryngoscopy and intubations in any patient are also the factors to predict difficult intubation in goiter patients. The huge goiter and long standing goiter especially with intrathoracic extension predispose for tracheomalacia. The tracheomalacia can be diagnosed during surgery but the airway obstruction usually develops after the extubation. Tracheostomy may be required in the event of loss of airway. A better understanding by surgeons and the anesthesiologists about the airway problems in goiter shall improve the outcome.

KEYWORDS: Goiter, difficult intubation, tracheomalacia.

INTRODUCTION

Thyroid swelling or goiter has been considered a risk factor for difficult direct laryngoscopy and intubation[1] and respiratory complications.[2] Therefore preoperative detection of any difficulty in maintaining airway or intubation during induction of anesthesia and airway control after the thyroid surgery is essential.[3,4] The incidence of difficult endotracheal intubation defined as inadequate exposure of the glottis by direct laryngoscopy has been shown as 8.5%[5] and 5.3% by Bouaggad A et al 2004[6] to as high as 10% Rios et al 2008[7] and 11.1% by Amathieu R et al 2006.[8] Thyroid swelling is not only associated with distortion of airway but also carries the risk of hyper or hypothyroid function leading to generalized endocrine disturbances and metabolic effects. Thus a comprehensive assessment of thyroid function is necessary part of preparing a patient for thyroid surgery. Respiratory problems associated with goiter has been equally addressed in surgical as well as the respiratory journals and a better understanding of the need of each other is likely to improve the success in airway management and reduce related complications. The present article is presenting a comprehensive review of the airway control and intubation problems associated with thyroid swelling and the perioperative approach to avoid airway related catastrophes in patients with thyroid swelling.

AIRWAY CONCERNS IN GOITER

Difficulties in airway control are expected at three levels: Supraglottic; Glottic or at the vocal cord level; and Infra-glottic, i.e. at the level of trachea.

1. **Supraglottic airway factors:** The supraglottic factors to affect direct laryngoscopy and intubation include wide mouth opening, tongue size and pharynx[9] submandibular space (thyromental distance)[10] head and neck mobility, neck circumference and obesity. The direct laryngoscopy is expected to be difficult in patients with Mallampati grades III or IV, restricted mouth opening (< 20 mm), thyromental distance (< 6 cm)[11] Wilson angle of neck movement (< 80°) obesity (BMI $\geq$ 40 kg/m^2)[13] and neck circumference (> 50 cm) in obese patient.[14]

2. **Glottic airway factors:** Indirect laryngoscopy is advised to look for vocal cord movement and any evidence of cord palsy.[6]

3. **Infraglottic airway factors:** The infraglottic factors presenting with airway problems are related are mainly related with deviation and compression of trachea or the tracheomalacia by the long standing thyroid swelling. These problems like transient recurrent laryngeal palsy commonly unilateral are more common with intra-thoracic extension of thyroid[15] so it must be carefully looked for.

PREOPERATIVE AIRWAY ASSESSMENT TESTS

The factors commonly related to direct laryngoscopy and intubation should be evaluated and documented in detail in patients coming for thyroid surgery. Thus to predict anticipated difficult intubation, a detailed evaluation of patient should be performed for his body weight, height, body mass index (BMI; weight in kilograms divided by the square of the height in meters), protruding maxilla (marked forward protrusion of the upper incisors beyond the lower incisors), the mouth opening and submandibular space. Battery of objective tests is described for suproglottic airway factors in laryngoscopy and intubation. Mallampati test[9] graded oropharyngeal view in a upright sitting patient into four classes (class I-soft palate, fauces, uvula, anterior and posterior tonsillar pillars; class II-soft palate, fauces, uvula; class III-soft palate, base of uvula; class IV-soft palate not visible at all). It was subsequently reviewed by Samsoon and Young[16] and later Lewis et al[17] recommended that this test should be performed with patients in the sitting position, with the head in full extension, the tongue out, and with phonation "Ah" and thyromental distance (in cm) be measured from the thyroid cartilage to inside of the mentum and concluded that of the two tests, either used alone or in combination, may fail to predict a few difficult laryngoscopies, these can also predict difficult laryngoscopy in a significant number of patients in whom the trachea is easy to intubate.

A quick thyromental distance assessment can be performed on the operative table by the anesthesiologist standing at head end of table and asks the patient to "look at him or her" by voluntarily extending his/her the neck (Fig. 1). The thyromental distance is then measured from thyroid cartilage to inner margin of mentum.[18] In this achievable head and neck position desired in direct laryngoscopy and intubation a distance ≤ 5 cm is associated with difficult grades of laryngoscopy view even after external laryngeal manipulation.[18] Head and neck movement as described by Wilson et al by asking the patients to fully extend the head and neck and the range of change in angle from horizontal plane during motion from full extension categorized as ≥ 90°, 80° − 90° or ≤ 80°.[12]

The combination methods based of multiple factors has also been described to improve predictability of difficult intubation.[12] The five risk factors, measured at three levels of severity, were identified to score from 0 to 2 score (Table 1). This simple predictive rule was developed and tested on a prospective set of 778 patients, in 1.5% of whom laryngoscopy was found to be difficult. Depending on the threshold chosen, the rule allowed the detection of, for example, 75% of the "difficult" laryngoscopies at a cost of falsely identifying 12% of the "not difficult" patients.

Factors concerning glottis level are related to cord paresis or paralysis due to recurrent nerve involvement diagnosed by indirect laryngoscopy using mirror. Position of vocal cords can be factor to add on to difficult intubation especially, if the cords are in abduction or are edematous. It will present an impediment to tube passage. It may so accommodate smaller size endotracheal tube (7.0 or 7.5) or the gum elastic bougie followed by endotracheal tube.

The infraglottic assessment mainly concerns with thyroid swelling. Thyroid enlargement defined clinically as the ability to palpate the goiter (a normal thyroid gland is not

Fig. 1: Patient lying supine on operation table voluntarily extends head by looking at the anesthesiologists standing at the head end of table and thyromental (from thyroid notch to inner side of mandible in midline) distance is measured using ruler or scale

| Table 1: Wilson's difficult intubation score		
Risk factors	*Levels*	
Weight	0	< 90 kg
	1	90-110 kg
	2	> 110 kg
Head and neck	0	Above 90°
Movement	1	About 90° (i.e. ± 10°)
	2	Below 80°
Jaw movement	0	IG > 5 cm or Slux > 0
	1	IG < 5 cm and Slux = 0
	2	IG < 5 cm and Slux < 0
Receding	0	Normal
Mandible	1	Moderate
	2	Severe
Buck teeth	0	Normal
	1	Moderate
	2	Severe

palpable) the size of the goiter measured in (in millimeters) along the main straight line of the goiter, with the head fully extended. The variables needed to be looked for in clinical examination include; nature of swelling, malignant lesions being more infiltrative than benign disorder, compressive symptoms (dyspnea, dysphagia, hoarseness, or a change in voice quality) and restricted neck extension.[19] Preoperative neck X-ray of both antero-posterior and lateral view are desired to assess and confirm the tracheal position. The tracheal deviation of more than 1 cm from the median line in neck X-ray is considered significant to cause respiratory problems. Tracheal compression or stenosis is defined as a significant tracheal compression with the goiter causing more than a 30% tracheal lumen narrowing. In case of suspicion CT scanning should be performed to get better visualization of deviation (Figs 2A and B) or compression (Fig. 3). In case of suspicion for infiltration by the tumor it should be confirmed by the CT scan, which is more informative than simple neck X-ray (Fig. 4). Radiological evidence of deviation increases difficult intubation six fold in positive predictive value of difficult intubation.[5]

DIFFICULT INTUBATION GRADING METHODS

Since a complex mechanism evolves in direct laryngoscopy and intubation a varied set of factors have been studied in different reports with variable incidences of difficult intubation from study-to-study.[20,21] Similarly different studies have also used different methods to define difficult intubation probably adding on to varied incidence reporting. A vary popular grading has been described by Cormack and Lehane.[22] This grading is based on glottic view during direct laryngoscopy. The technique of laryngoscopy has also been reported to be assessed on the basis of percent of glottis opening (POGO).[23] The POGO score represents the linear span extending from the anterior commissure to the inter-arytenoid notch of the vocal cords (Fig. 5).

Later studies included performance based criteria in grading difficult intubation. Intubation difficulty scale (IDS), based on combination of seven identified factors in literature has also been described.[24] Although complex but offers details about the difficulty encountered at that time and may provide uniform approach to compare difficulty in intubation. Since in presence of poor laryngoscopic view external laryngeal manipulation can improve the view and intubation can be performed successfully by the use of aids like; bougie or stylet, a laryngoscopic intubation technique grading has been described by us. It is based on three factors: ease of Macintosh curved blade (MCB) insertion and its positioning to displace the tongue, need for external laryngeal pressure to insert the endotracheal tube, and need for aids (stylet or bougie) (Fig. 6). Scoring was as follows: 1-easy MCB placement and no external laryngeal pressure or aids; 2-mild struggling to achieve MCB placement and use of external pressure to pass tube, but no aids; 3- moderate difficulty in placing the MCB, no improvement with external laryngeal pressure, and aids used to pass endotracheal tube; and 4-failure to visualize the glottis or to place the endotracheal tube in three attempts.[18] This way of grading the performance of direct laryngoscopy and intubation procedure may be useful in assessing it in totality.
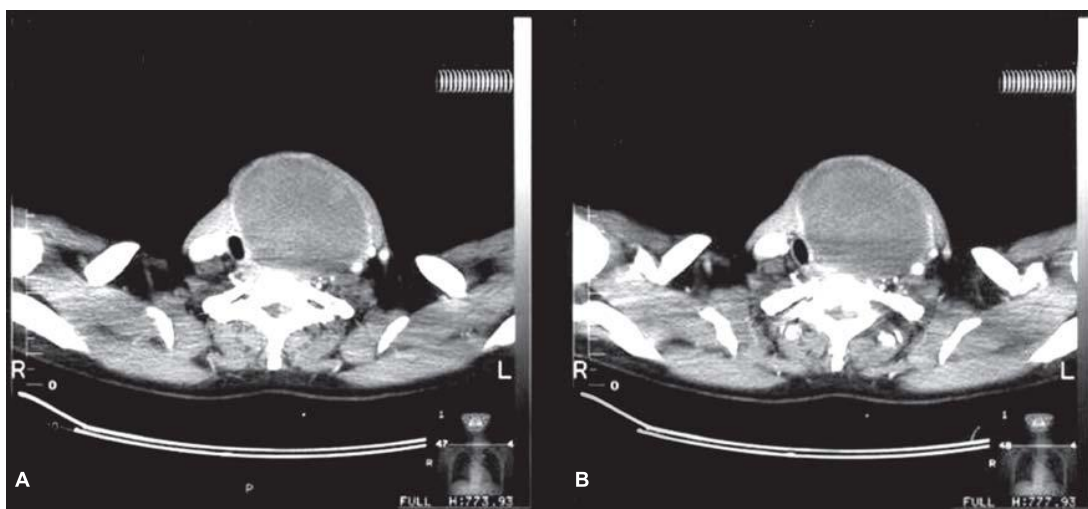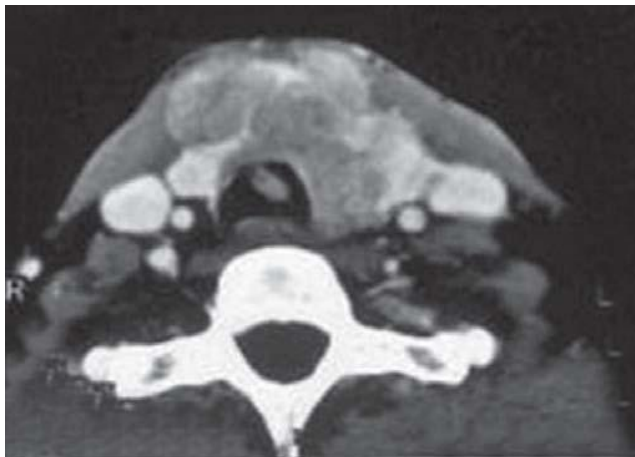

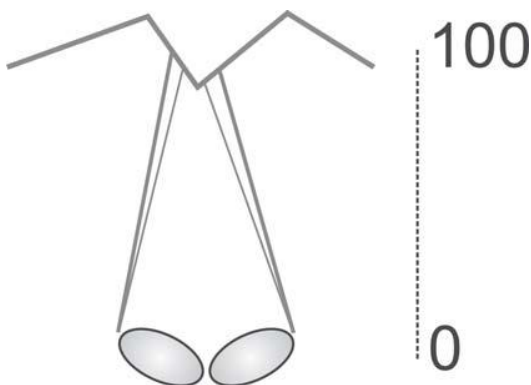Figs 2A and B: CT scan of the neck showing deviation of trachea on the right side without any compression of trachea
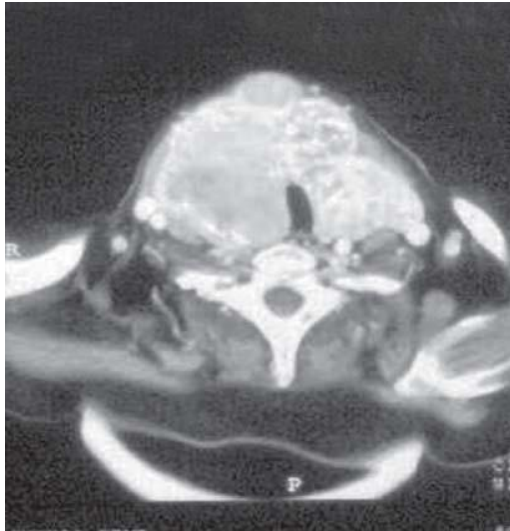
Fig. 3: CT scan of the neck showing trachea engulfed inside the thyroid swelling is getting compressed with a significant reduction in lumen

Fig. 4: CT scan of the neck showing infiltration inside tracheal lumen

Fig. 5: Percent of glottis opening (POGO) score viewed during direct laryngoscopy: the glottis view is given a percentage number by the laryngoscopist from '0' on viewing interarytenoid notch of the glottis to scale of '100' on full view of anterior commissure of the cords
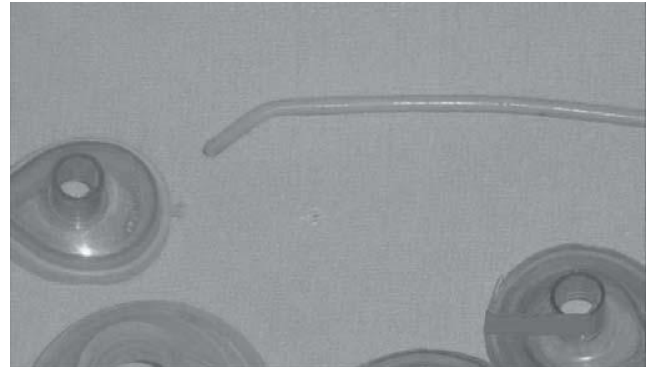
Fig. 6: Gum elastic bougie can be used to negotiate glottis in case of poor glottis view (grade IV)

AIRWAY APPROACH IN SUPRAGLOTTIC FACTORS IN GOITER

Anesthesia for Direct Laryngoscopy and Intubation

If the supraglottic factors are not predictive difficult laryngoscopy and intubation and there is no associated airway obstruction the usual protocol of induction of anesthesia with propofol and short acting relaxant suxamethonium is followed by laryngoscopy and intubation. Now if Cormeck and Lehane laryngoscopy grades 3 and 4, we can try measures to improve laryngoscopic view with maneuvers and or different aids. The direct laryngoscopy view has been identified to be influenced by patient head positioning (sniffing head position), lifting laryngoscope than making fulcrum over the upper teeth, experience of laryngoscopist and force used to visualize glottis.

Besides patient position some maneuvers have also been described to improve laryngoscopic view. In 1993, Knill coined the term "BURP" standing for backward-upward-rightward pressure on the thyroid cartilage by an assistant to improve laryngeal view at laryngoscopy.[25] The bimanual laryngoscopy involving operator-directed manipulation of the thyroid cartilage,[26] has been demonstrated to improve laryngoscopic view of cords in the hands majority of laryngoscopists in a cadaveric study than cricoid pressure or the BURP.[27] These external manipulation techniques at the neck improve laryngoscopic glottic view during direct laryngoscopy and can be tried in presence of poor glottic visualization, but the thyroid swelling might limit the utility of these maneuvers subject to limitation in identifying the structures under the swelling. Factors like experience of laryngoscopist or presence of two anesthesiologists have been reported to affect the intubation related complications in emergency scenario.[28,29] Such factors although not

assessed by any study may be significant in these patients too, where laryngoscopy and intubation are anyway anticipated to be difficult and demanding expertise in laryngoscopy and intubation.

The laryngeal manipulation or aids like; external laryngeal manipulation, cricoid pressure, and alternative aids (change of blade, gum-elastic bougie). The intubation will be successful in majority of the patients. Smaller blade use has also been suggested in patients with short thyromental distance (< 5 cm) and be used with higher success in improving Cormack and Lehane laryngoscopy view by one grade.[18] Therefore intubation can be successful in many difficult glottis viewed patients but with some trick in technique. If laryngsocopy fails and ventilation possible laryngeal mask airway with positive pressure ventilation can be used for surgery except in case of subglottic obstruction.

Fiberoptic Intubation

Keeping spontaneous breathing is the principle of management of airway in these patients. Three important steps are to be followed for anesthetizing the nasopharyngeal tract in case we intend to use nasopharyngeal fiberoptic intubation. A suggested method is the use of cocaine sticks which help in desensitization and decongestion of nasopharyngeal passage. Lignocaine jelly (2%) with Oxymetazoline (0.5%) (Nasovian®) drops can be alternative approach for nasopharyngeal decongestion. The next step is use of lignocaine (10%) swallow to desensitize the post-pharyngeal wall and after that intratracheal injection of lignocaine (2%) is performed to anesthetize infraglottic part of larynx and trachea. Since it triggers a vigorous coughing tracheal puncture should be done with cannula (22 G) and needle should be removed at the time injection of lignocaine intratracheally. The main disadvantage of this technique is that patients being awake may be apprehensive and uncooperative. The local anesthesia technique can be combined with light sedation using propofol infusion. The spontaneous ventilation with sedation can also be maintained by inhalational anesthetic (Sevoflurane)[30] and then oropharyngeal airway designed for fiberoptic intubation (Ovassapian airway)[31] can be used to facilitate fiberoptic intubation instead of nasopharyngeal intubation. Fiberoptic intubation in sitting position has also been successfully used in acutely enlarging thyroid mass associated with airway obstruction and not allowing patient to lie supine.[32] However, awake fiberoptic intubation is not without problems and complete airway obstruction during awake

FOI has been reported in whom the use of local anesthetic precipitated acute loss of the airway and an urgent surgical intervention was required.[33]

Blind Intubation Techniques

If fiberoptic intubation is not available a time tested old technique of 'blind nasal' intubation can be tried.[34] A liberal use of local anesthetic [lignocaine (2%) jelly] and nasal decongestant (nasovian nasal drops) in nasopharyngeal passage are instilled to facilitate smooth passage and minimize bleeding. The suggested method is that maintain spontaneous breathing with inhalational anesthetic or propofol infusion and guide the endotracheal tube into glottis under the guidance of listening for best heard breathing sound through endotracheal tube. The problems of trauma and bleeding increase the chances of aspiration and it definitely requires a little more experience and expertise in practicing the technique. Other alternative techniques described would be the use intubating laryngeal mask (LMA).[35] The intubating LMA is first placed in oral cavity and then endotracheal tube is passed through it.

AIRWAY APPROACH IN GLOTTIC FACTORS IN GOITER

Glottic factors related to vocal cord palsy is not a common before surgery and can develop only in infiltrating malignant lesions. Stridor and voice change is likely to be present as warning signal. It usually do not require any treatment if patient can breath and talk properly as post induction anyway cords will be relaxed and cannot give problem to intubation if laryngoscopy is possible. Bilateral adductor palsy commonly related to recurrent laryngeal nerve injury may lead to reintubation in postoperative period.

AIRWAY APPROACH IN INFRAGLOTTIC FACTORS IN GOITER

Infraglottic factors are mainly related to the size and duration of thyroid swelling affecting airway structures by tracheal deviation and/or compression. Loss of airway due to compression on the trachea is very uncommon at the time of induction of anesthesia than after tracheal extubation and in recovery room.[36,37] So in patients breathing normally, i.e. without breathing difficulty, securing airway during induction of anesthesia will be more determined by supraglottic factors than infraglottic.

RESPIRATORY PROBLEMS AND TRACHEOMALACIA IN GOITER

The incidence of tracheomalacia has been reported from 0.001% to as high as 1.5%.[38-40] Tracheomalacia leading to tracheal collapse results from prolonged compression of the trachea by a huge goiter, particularly within the confines of the thoracic inlet having retrosternal extension.[41] It is a life-threatening complication which must be taken care before extubation. The absence of a leak around the deflated cuff of the tracheal tube should alert the anesthetist to the possibility of tracheomalacia. Sinha and colleagues reported that measurement of the volume of air required to inflate the cuff of the tracheal tube so that an airtight seal is produced. A similar test is performed at the end of the procedure and tracheomalacia can be detected if there is any decrease in the volume required to inflate the cuff to an airtight at the end of the procedure.[42]

Tracheal collapse mostly takes place after surgery as the thyroid tissue supporting trachea is excised. In majority of the patients intubation is possible in absence of other associated difficult intubation factors. Criteria to diagnose tracheomalacia during surgery can be based on any one or more of the observations on the table; soft and floppy trachea on palpation by the surgeon after withdrawing endotracheal tube for a short distance, obstruction to spontaneous respiration during gradual withdrawal of the ETT after thyroidectomy, or difficulty in negotiating the suction catheter beyond the ETT after gradual withdrawal, absence of peritubal leak on deflation of ETT cuff, loss of volume pressure loop on ventilator or the development of respiratory stridor along with a falling hemoglobin oxygen saturation (SpO_2) on pulse oximetry despite oxygen supplementation by face mask.[43] In this series of 900 patients, tracheomalacia was treated in 28 (1.9%) patients. By following this protocol the tracheomalacia was detected before extubation in 20 and after extubation in 8 patients.

LOCAL ANESTHESIA AND GOITER SURGERY

In huge thyroid swelling regional anesthesia under cervical plexus block has been reported to facilitate surgery[44,45] earlier reports have also suggested that spontaneous breathing can be facilitated by lifting thyroid swelling before securing airway.[46,47] After failed intubation with FOI under local anesthesia in an awake spontaneously breathing patient, preoperative tracheotomy was performed under local infilteration anesthesia and anesthesia was given.[19]

POSTSURGICAL RESPIRATORY COMPLICATIONS

Respiratory distress is a well-known complication of thyroid surgery, a recently published report on 262 patients has found that 7.6% patients developed respiratory complications. The significant factors associated with complications were the goiter of at least 5 years duration, giant size of goiter, associated tracheal narrowing, malignant goiter, preoperative recurrent laryngeal nerve palsy and retrosternal extension in order incidence of complications. Postoperative tracheostomy was required in 6 (6%) patients and tracheostomy was performed in five. The author suggested a further study in the line of presence of combinations of multiple risk factors to alert the management team for respiratory complications.[48] We have also reported that 26 (2.8%) patients required tracheostomy of due to tracheomalacia and eight patients developed respiratory obstruction and desaturation in postoperative ward.[43]

Postextubation airway obstruction may be related with partial airway obstruction commonly related causes must be looked for e.g., mucus or blood in upper airway, incomplete recovery from anesthesia especially muscle relaxant effect, hematoma or reactionary hemorrhage with sudden increase in neck swelling, laryngeal edema[48] recurrent laryngeal nerve injury and tracheal collapse. In case of tracheal collapse with increasing effort the airway obstruction worsens but can be maintained with slow and prolonged inspiration. Stridor is suggestive of partial airway obstruction and may be related with upper airway edema, and transient adductor vocal cord palsy. Except for tracheomalacia and nerve injury, mostly obstructed breathing is transient and reintubation may be required till patient is fully awake.

APPROACH TO TACKLE AIRWAY OBSTRUCTION AFTER EXTUBATION

Thus the extubation in immediately after surgery is equally important in huge, long standing, benign and in infiltrating malignant goiter patients. An accessible back-up airway control plan is important and patients should be closely monitored for airway obstruction or breathing difficulty after extubation. There should be preparedness for reintubation and preferably by the same set of anesthesiologists involved in anesthesia during surgery.

The first and foremost attempt should be to ensure oxygenation and ventilation with oxygen supplementation

by well-fitting face-mask. A quick review must be done to assess adequate recovery from relaxant effect (sustained head lift or hand grip). Respiratory parameters may be misleading in this condition due to the obstructed respiration. A small dose of suxamethnium (25 to 50 mg) can help in case the laryngeal stridor. Reintubation with smaller size endotracheal tube is recommended in case it is indicated. Intravenous methylprednisolone can also be used to reduce laryngeal edema likely to develop after extensive neck clearance in malignancy. The LMA has also been reported to be useful in the management of stridor.[48]

COMPARISON OF INTUBATION TECHNIQUES IN GOITER

Bouaggad et al. showed that in a population of 320 patients undergoing thyroidectomy for goiter, the incidence of difficult intubation was only 5.3% with an increase in difficult intubation only when malignant thyroid was present.[6] However, another prospective study of 324 consecutive patients for thyroid surgery reported the incidence of difficult intubation in 11.1% (95% CI: 7.6 to 14.5). Median intubation difficulty scale was 0 (25th-75th percentile: 0; 2.7). Some of specific predictive criteria looked for viz palpable goiter, endothoracic goiter, airway deformation, airway compression, or thyroid-malignancy were not associated with an increased rate of difficult intubation. The usual preoperative criteria used for difficult intubation in general population, e.g. mouth opening < 35 mm, Mallampati III or IV, short neck, neck mobility < 80 degrees, thyromental distance < 65 mm, and a retrognathic mandible were significantly reliable in the univariate analysis as risk factors for difficult intubation.[8] A large series of consecutive thyroid patient from a single institution has now reported the incidence of difficult intubation (grade III or IV) in patients with hyperthyroidism, where men (8.8% difficult intubation) were found to be at higher risk for difficult intubation then female (5.5%).[1]

FINAL IMPRESSION

Supra glottic risk factors for direct laryngoscopy and intubation are similar for goiter or nongoiter patients are similar in terms sensitivity and specificity for difficult intubation. Factors related to goiter size and tracheal changes are more important for success of extubation than intubation. Patency of airway is preserved before surgery but tracheal collapse can precipitate only after thyroidectomy as peritracheal tissue support is lost after removal thyroid gland. Retrotracheal extension of thyroid can be associated with difficult intubation. Patient evaluation and planning for fiberoptic bronchoscopy and intubation must be kept as an early option for airway management in these patients. Simpler devices like **supraglottic airway control devices**, **bougie**, can still bail you out in majority of the patients if you are not blessed with fiberoptic scopes. Infraglottic factors mainly related with long standing huge goiter are of more concern in airway control in postexcision period than during induction of anesthesia and intubation.

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